DATE: November 22, 2017

TO: *Gregory Lindstadt, PE – CDM Smith, Inc.*

FROM: *David Dolengewicz – The Greenbusch Group, Inc.*
Justin Morgan, INCE – The Greenbusch Group, Inc.

RE: *North Transfer Station –2017 Q4 Noise Monitoring Report*

Transmitted by: ☐ Mail ☐ Delivery ☐ Fax ☒ E-mail

INTRODUCTION

The intent of this memorandum is to present the results of staffed sound level measurements conducted on November 1 and November 4, 2017 to document daytime and nighttime sound levels from operations at the North Transfer Station and to determine compliance with applicable regulatory criteria. A summary of noise sources attributed to exceedances of these criteria from long term noise monitoring data collected over the past monitoring year is also included.

NOMENCLATURE

The auditory response to sound is a complex process that occurs over a wide range of frequencies and intensities. Decibel levels, or "dB," are a form of shorthand that compresses this broad range of intensities with a convenient numerical scale. The decibel scale is logarithmic. For example, using the decibel scale, a doubling or halving of energy causes the sound level to change by 3 dB; it does not double or halve the sound loudness as might be expected.

The minimum sound level variation perceptible to a human observer is generally around 3 dB. A 5-dB change is clearly perceptible, and an 8 to 10 dB change is associated with a perceived doubling or halving of loudness. The human ear has a unique response to sound pressure. It is less sensitive to those sounds falling outside the speech frequency range. Sound level meters and monitors utilize a filtering system to approximate human perception of sound. Measurements made utilizing this filtering system are referred to as "A weighted" and are called "dBA".

Common sound pressure levels are presented in Table 1.

Table 1. A-weighted Levels of Common Sounds

Sound	Sound Level (dBA)	Approximate Relative Loudness[1]
Jet Plane @ 100 feet	130	128
Rock Music with Amplifier	120	64
Thunder, Danger of Permanent Hearing Loss	110	32
Power Mower	100	16
Food Blender at 3 feet	90	8
Busy Street	80	4
Interior of Department Store	70	2
Ordinary Conversation at 3 feet	60	1
Quiet Car at Low Speed	50	1/2
Average Office	40	1/4
City Residence, Interior	30	1/8
Quiet Country Residence, Interior	20	1/16
Rustle of Leaves	10	1/32
Threshold of Hearing	0	1/64

1. As compared to ordinary conversation at 3 feet.

Source: US Department of Housing and Urban Development, Aircraft Noise Impact Planning Guidelines for Local Agencies, November 1972., California Department of Transportation

Metrics

- **Equivalent Sound Level, L_{eq}**
  L_{eq} is the A-weighted level of a constant sound having the same energy content as the actual time-varying level during a specified interval. The L_{eq} is used to characterize complex, fluctuating sound levels with a single number. Typical intervals for L_{eq} are hourly, daily and annually.

- **Maximum Sound Level, L_{max}**
  L_{max} is the maximum recorded root mean square (rms) A-weighted sound level for a given time interval or event. L_{max} "fast" is defined as a 125-millisecond time-weighted maximum, while L_{max} "slow" corresponds to a 1-second time-weighted maximum. All values in this report are "fast" time-weight, which corresponds closest to the typical response time of the human ear.

- **Sound Pressure Level, SPL**
  Sound pressure level correlates with what is heard by the human ear. SPL is defined as the squared ratio of the sound pressure with reference to 20 µPa. Sound pressure is affected by distance, path, barriers, directivity, etc.

REGULATORY CRITERIA

The Seattle Municipal Code (SMC) Section 25.08 specifies permissible sound levels within the City of Seattle. SMC 25.08.410 defines allowable exterior sound level limits based on land use zoning, as listed in Table 2 below.

Table 2. Exterior Sound Level Limits, L_{eq}[1] (L_{max}[2])

District of Sound Source	District of Receiving Property		
	Residential	Commercial	Industrial
Residential	55 (70)	57 (72)	60 (75)
Commercial	57 (72)	60 (75)	65 (80)
Industrial	60 (75)	65 (80)	70 (85)

1. Measurement time is 1-minute minimum for a constant sound source, 1-hour for a non-continuous sound source.
2. During measurement intervals, L_{max} may exceed L_{eq} limits by no more than 15 dBA.
Source: SMC 25.08.410 Exterior Sound Level Limits

Modifications to the exterior sound level limits set forth in Table 2 above are outlined in SMC 25.08.420. These modifications are for certain times of the day, classification of receiving properties, and the type of sound generated. These modifications to the exterior sound level limits include the following reductions:

- 10 dBA during the nighttime hours between the hours of 10:00 PM and 7:00 AM during weekdays and 10:00 PM and 9:00 AM on weekends and legal holidays when the receiving property is within a Residential district.
- 5 dBA for sources that carry a pure tone component.
- 5 dBA for impulsive sources not measured with an impulse sound level meter.

These modifications are cumulative and independent of one another. Therefore, the permissible nighttime exterior sound level in a Residential district for an impulsive, tonal source would be 20 dBA less than the exterior sound levels described in Table 2 above.

The area surrounding the Transfer Station is a mix of Residential (SF 5000) to the North and East, Commercial (C2) to the North, East and Southwest, and Industrial Commercial (IC-45) to the West and South. The Site is zoned Industrial Buffer, Industrial Commercial as well as Commercial, however the community agreement requires that for the evaluation of compliance with Noise Code, the entire site is considered a Commercial zone. The permissible daytime sound level limits for the Transfer Station at receiving property lines are summarized in Table 3 below.

Table 3. Transfer Station Sound Level Limits, L_{eq} (L_{max})

Time Period	Residential	Commercial	Industrial
Daytime	57 (72)	60 (75)	65 (80)
Nighttime	47 (62)	60 (75)	65 (80)

SOUND LEVEL MEASUREMENTS

Staffed sound level monitoring took place between 8:00 AM and 5:30 PM on Wednesday November 1, 2017 and from 8:00 AM to 9:00 AM on Saturday November 4, 2017. Measurements on November 1, 2017 were made for the duration of the station's operating hours and coincided with the facility's peak operating times based on information provided by Seattle Public Utilities (SPU). The measurements on November 4, 2017 were conducted to assess compliance with nighttime SMC sound level limits while the station operates between 8:00 AM and 9:00 AM on weekends, when nighttime sound level limits apply.

During both measurement periods, sound levels were monitored concurrently near two residential properties north and east of the Transfer Station. During the measurement on November 1, 2017, winds were calm and temperatures ranged between 51 and 56 degrees Fahrenheit. During the measurements on November 4, 2017, winds were calm and temperatures ranged between 37 and 39 degrees Fahrenheit. No precipitation was recorded during the measurement periods. During these measurements, monitoring staff were stationed near the sound level meters to document specific on-site noise events. Measurements of operational noise were conducted in general accordance with the most recent version of ASTM E1503.

Measurement Equipment

Sound level measurements were conducted using ANSI Type 1 instrumentation calibrated by a certified laboratory within one year of the measurement date, summarized in the Table below.

Table 4. Measurement Equipment

Make and Model	Description	Serial
Staffed Measurement Equipment		
Brüel & Kjær Type 2270	Sound level analyzer	2679351
Brüel & Kjær ZC0032	Preamplifier	12296
Brüel & Kjær 4189	Microphone	2695414
Brüel & Kjær Type 4231	Acoustic calibrator	3001160
Svantek 971	Sound level analyzer	51818
Svantek SV18	Preamplifier	49561
Aco Pacific 7052E	Microphone	62522
Larson Davis CAL200	Acoustic calibrator	9512
Long Term Monitoring Equipment		
Svantek SV200	Sound level analyzer	39777
MK250	Microphone	10978

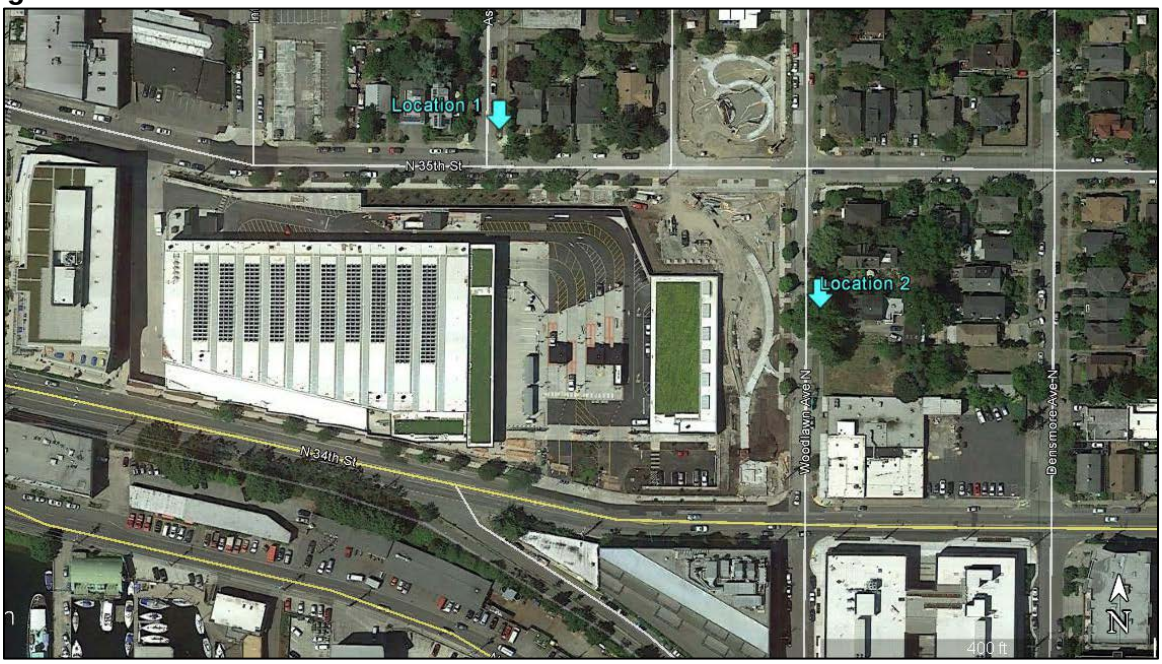
Field calibrations of monitoring equipment were performed immediately before the measurements and verified immediately after the measurements were completed. Continuous audio recordings were made at both monitoring locations to allow for sound source identification after the measurements were completed. One-second maximum (L_{max}) sound levels were collected during the monitoring.

Measurement Locations

Sound levels were measured at two residential properties near the Transfer Station as close to residential property lines as feasible at approximately ten feet above grade. A figure showing the measurement locations as well as the address closest to the monitoring locations are provided below.

- Location 1: 3512 Ashworth Avenue North (approximate)
- Location 2: 3420 Woodlawn Avenue North

Figure 1. Measurement Locations



Photos of the sound monitoring equipment at the two monitoring locations are provided in Photos 1 and 2 below.

Photo 1. Equipment at Location 1

Photo 2. Equipment at Location 2

RESULTS

After the measurements were completed, data was reviewed to identify noise events associated with on-site operations at the Transfer Station. Due to the high number of off-site sound sources at the monitoring locations, average sound levels (L_{eq}) from the Transfer Station were not able to be determined, therefore the analysis is restricted to maximum sound levels (L_{max}) only. Off-site sound sources included pedestrian and vehicle traffic, wildlife and aircraft. Figures illustrating the measured L_{max} sound levels and identifying all events above the SMC L_{max} sound level limit are provided in the Appendix.

Exceedances

A total of 382 sound events which exceeded the SMC daytime or nighttime L_{max} sound level limit were recorded and identified during the staffed monitoring periods on November 1st and November 4th of 2017. Of these exceedances, none originated from the transfer station. All of the exceedances observed resulted from off-site sound sources including: vehicle traffic (cars, busses, delivery trucks and off-site haul trucks), car horns, aircraft, pedestrians, animals, and miscellaneous noise. These off-site sound sources are summarized in Table 5 below and are presented graphically in Appendix 1.

Table 5. Number of Off-Site Sound Events Exceeding SMC L_{max} Limits

Event	November 1, 2017		November 4, 2017		Total Events
	Location 1	Location 2	Location 1	Location 2	
animal	0	16	0	7	23
birds	0	0	2	0	2
car door	1	1	0	3	5
car horn	7	0	1	0	8
car starting	0	1	0	2	3
jet	3	0	0	0	3
misc not NTS	0	0	0	8	8
pedestrian	4	1	2	1	8
plane	17	15	15	9	56
siren	2	1	0	0	3
vehicle	99	28	71	65	263
				All Events	382

A summary of exceedances observed during previous staffed monitoring days or recorded and reviewed remotely over the past monitoring year is presented in Appendix 2. In this appendix we show that potential NTS related exceedances total <1% of all exceedances.

CONCLUSION

During the staffed monitoring periods on November 1st and November 4th 2017, operations at the Transfer Station complied with the daytime and nighttime Seattle Municipal Code L_{max} sound level limits.

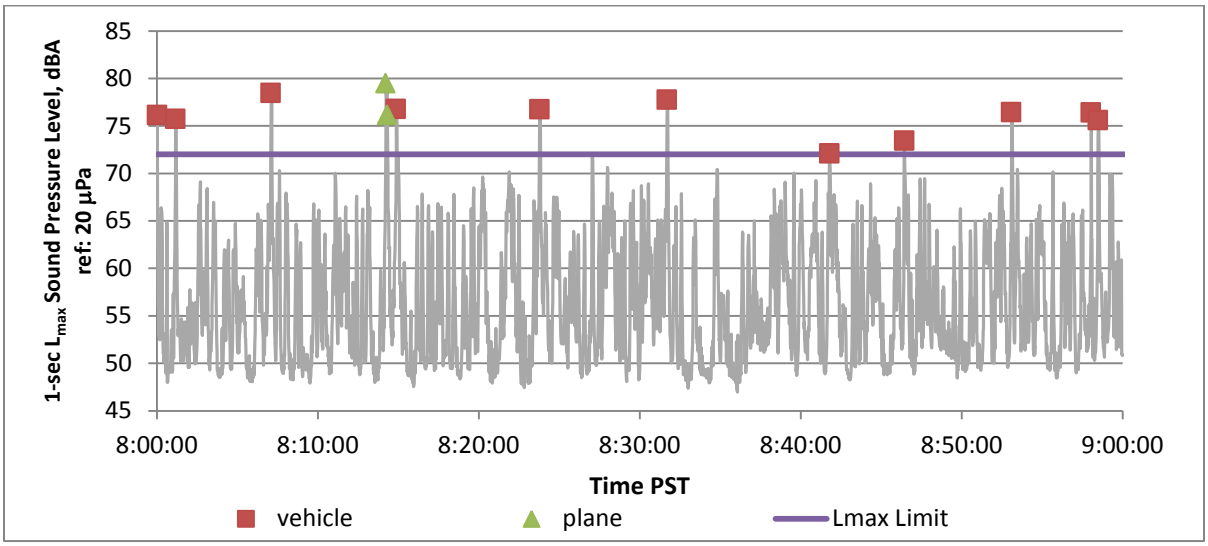
Respectfully submitted;

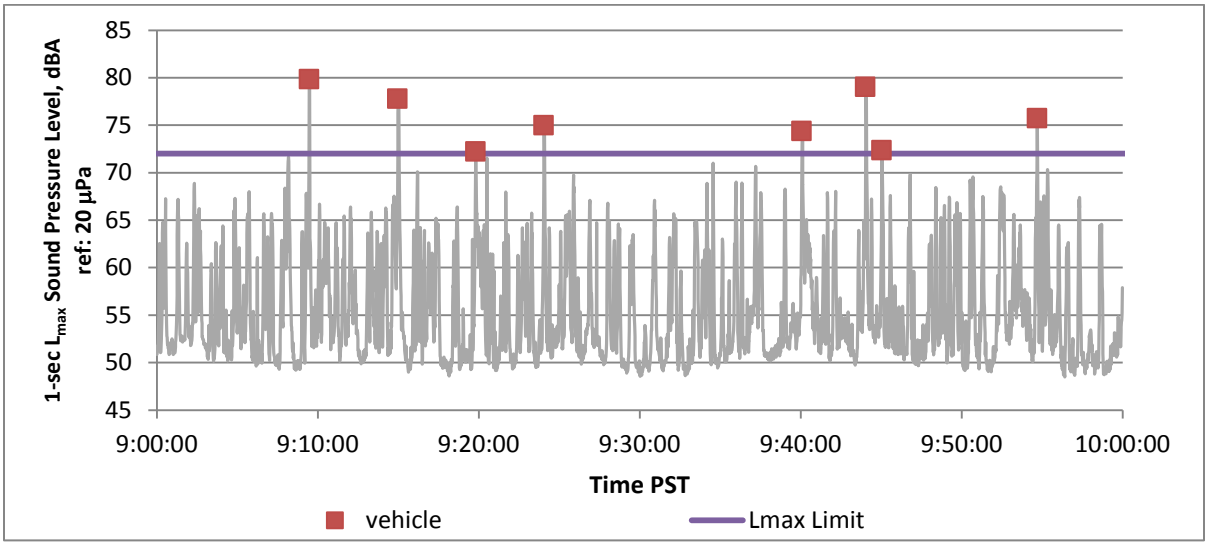
David Dolengewicz

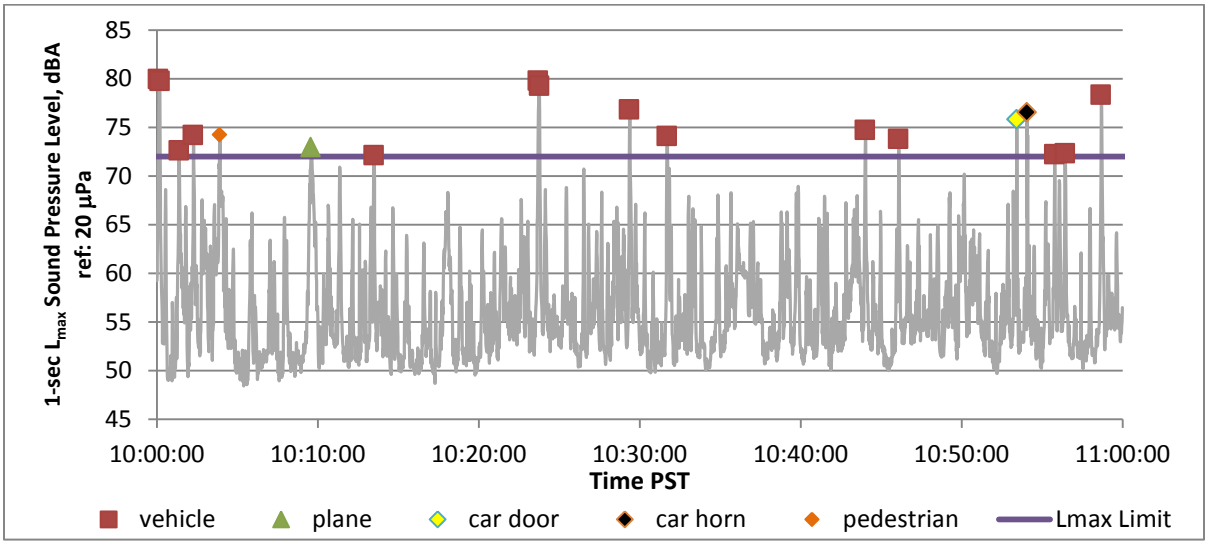
Justin B. Morgan, INCE

APPENDIX 1

Location 1 – November 1, 2017, Svantek 971, L_{max} Sound Levels



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Time PST
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car door
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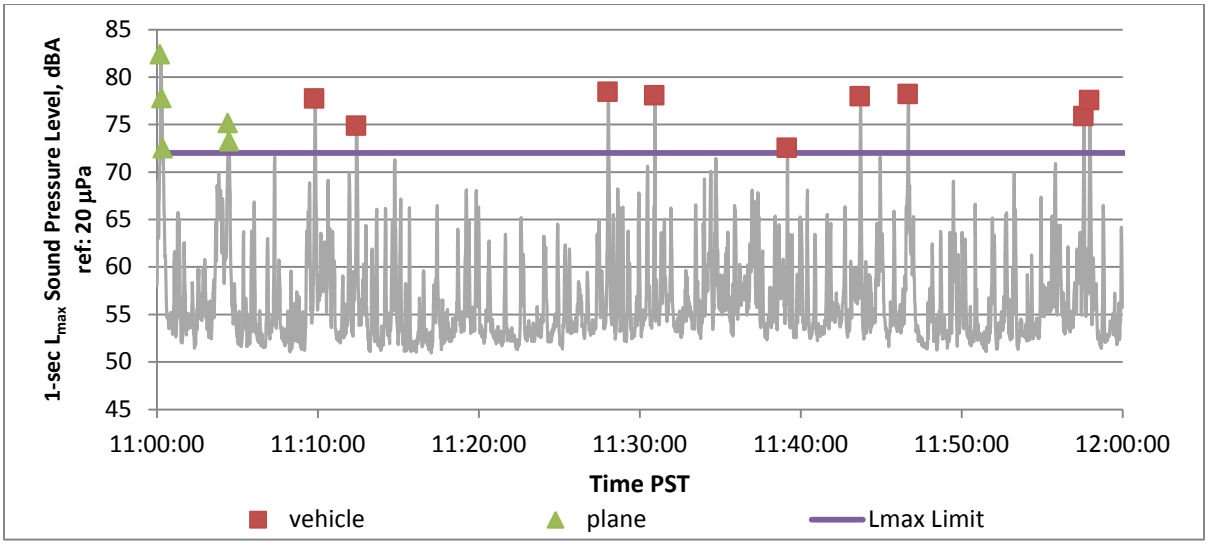
pedestrian
Lmax Limit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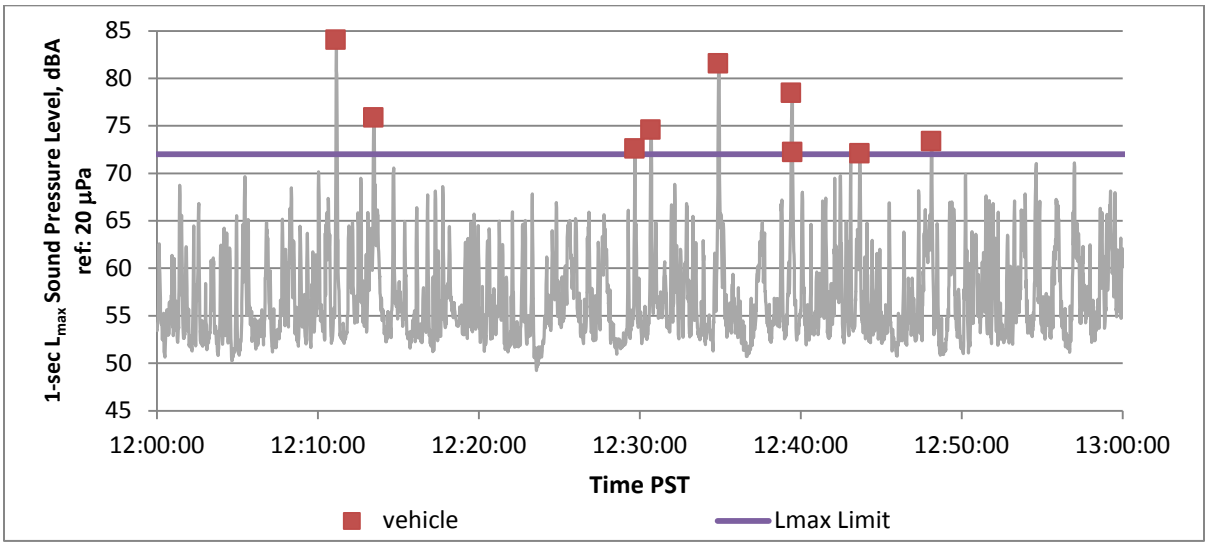
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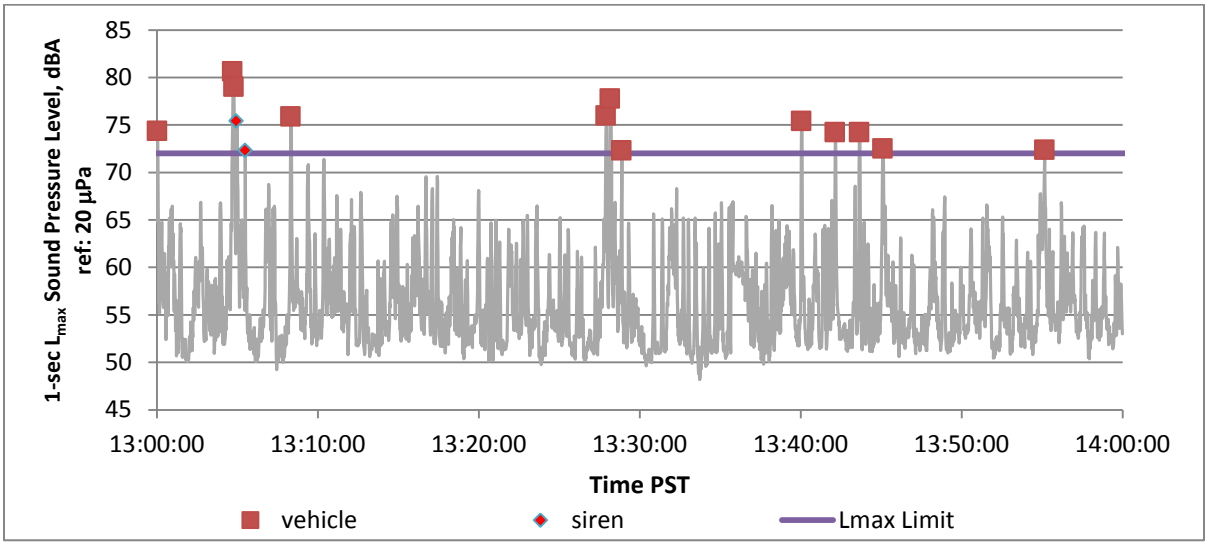
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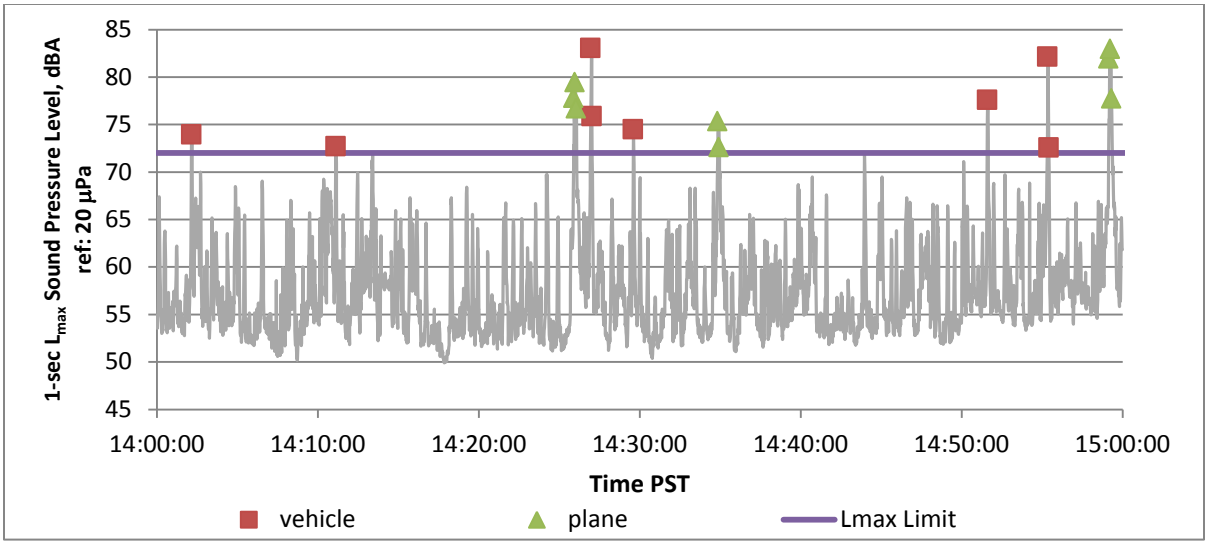
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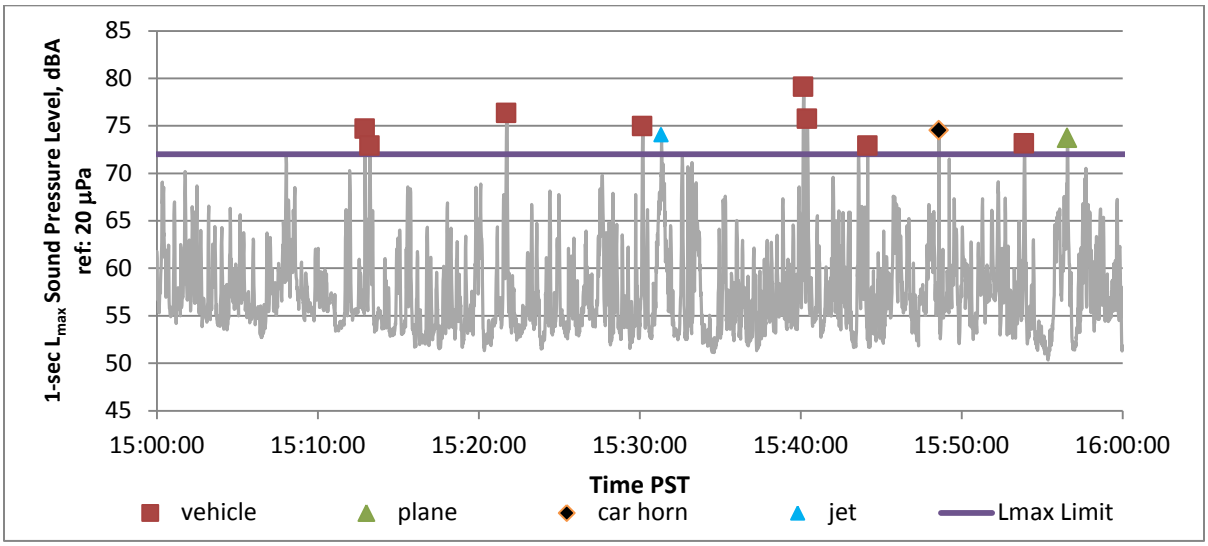
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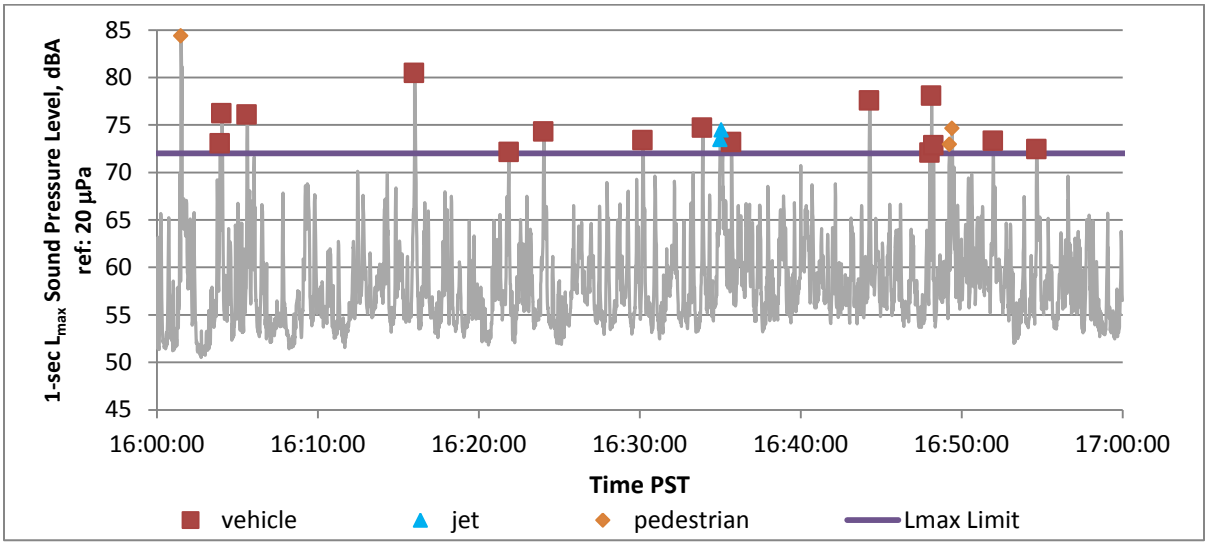
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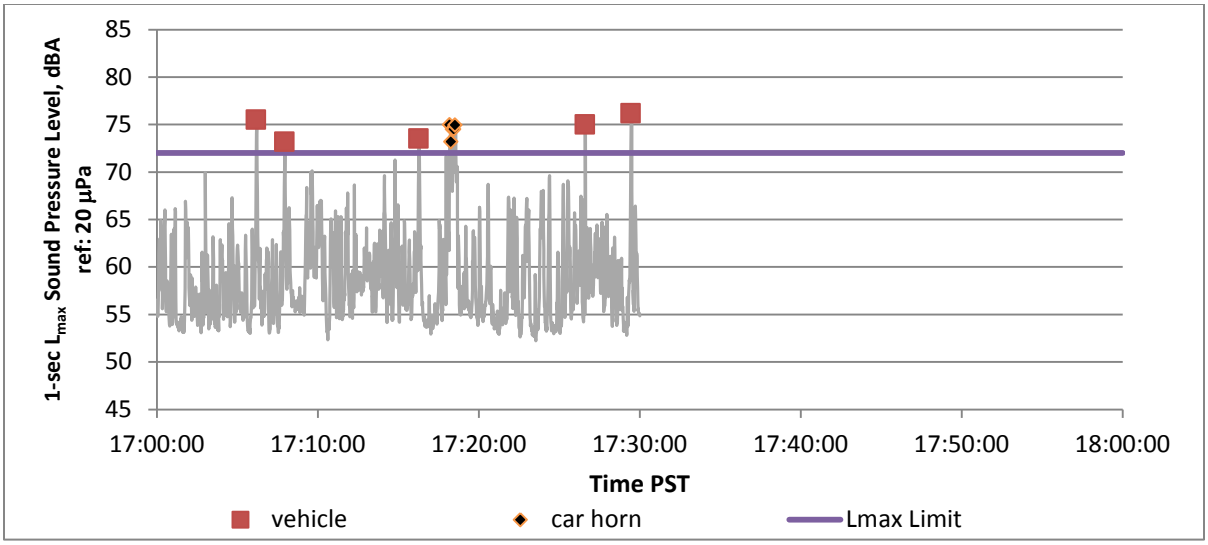
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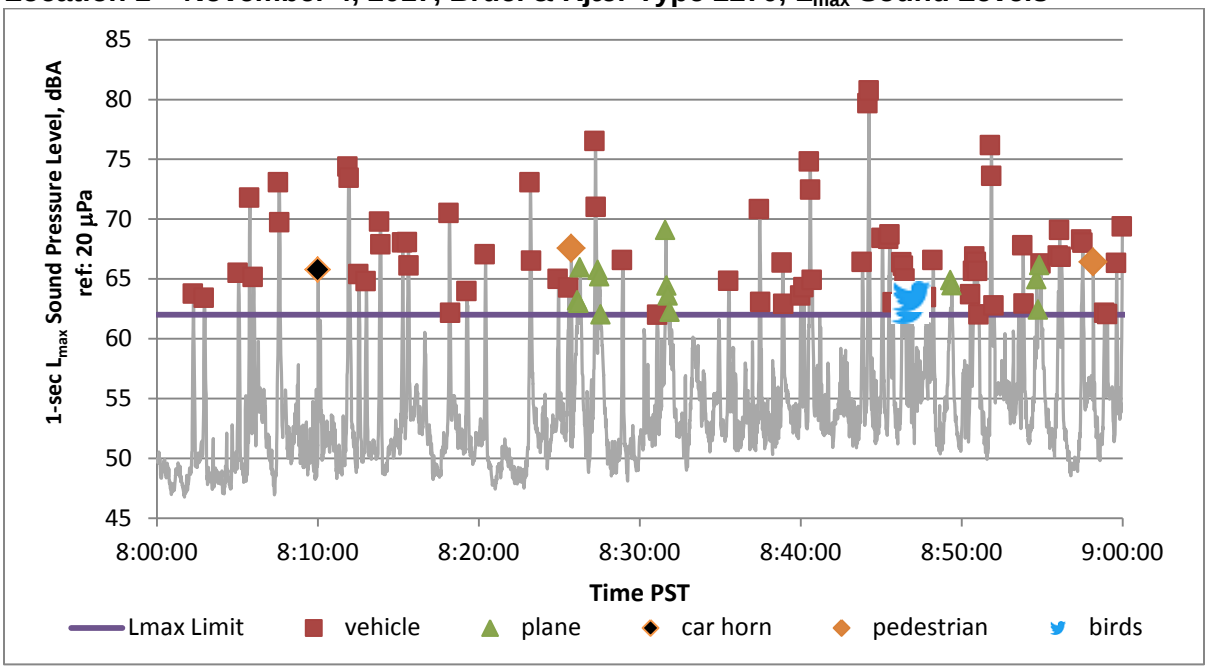
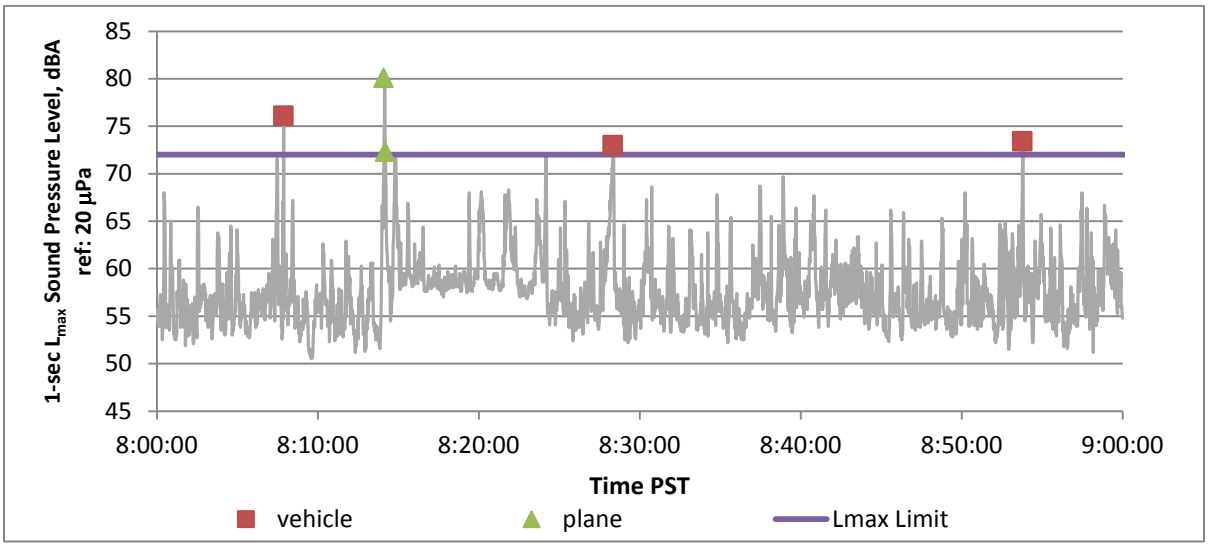
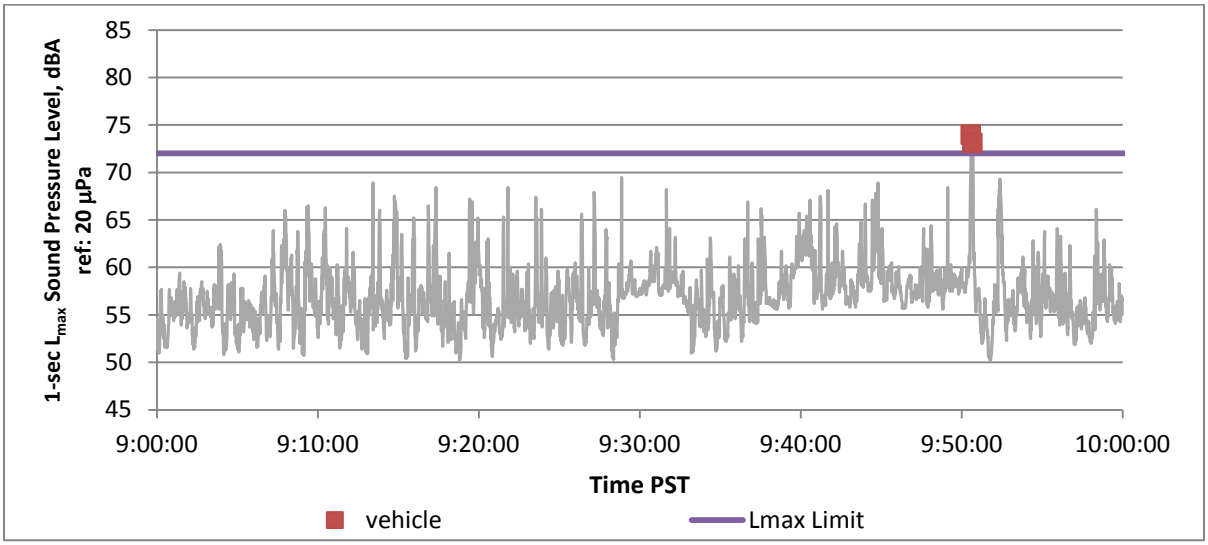
Lmax Limit

Location 1 – November 4, 2017, Brüel & Kjær Type 2270, L_{max} Sound Levels



Location 2 – November 1, 2017, Svantek SV200, L_{max} Sound Levels

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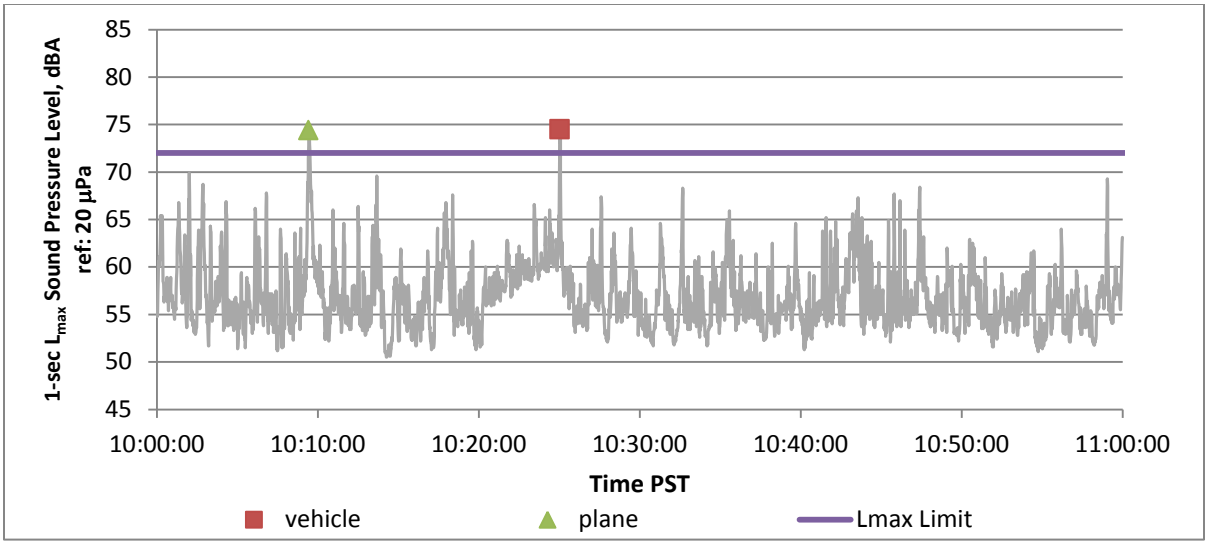
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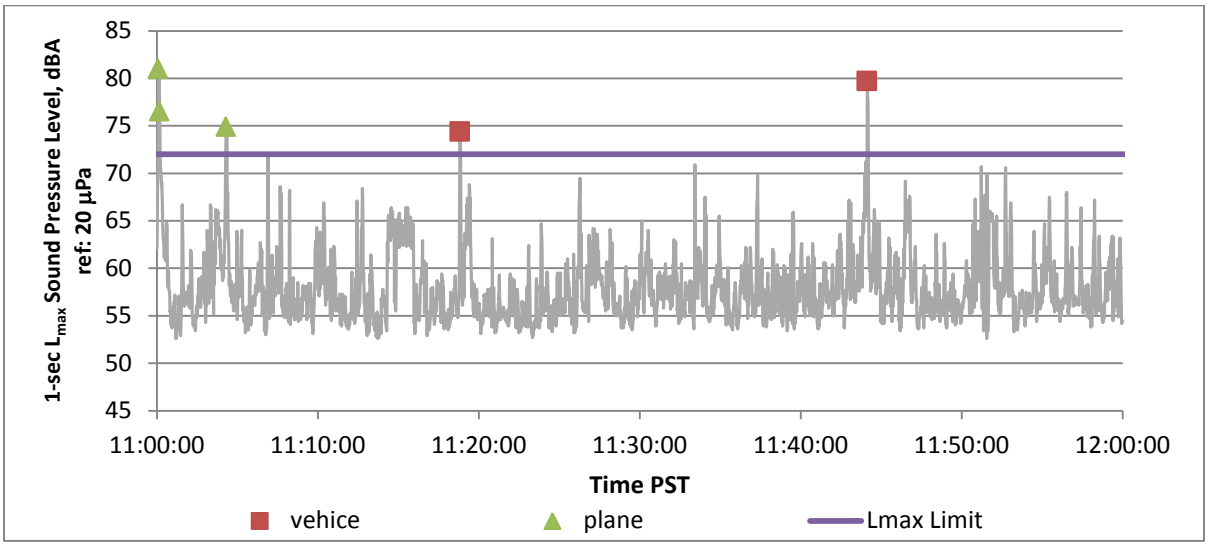
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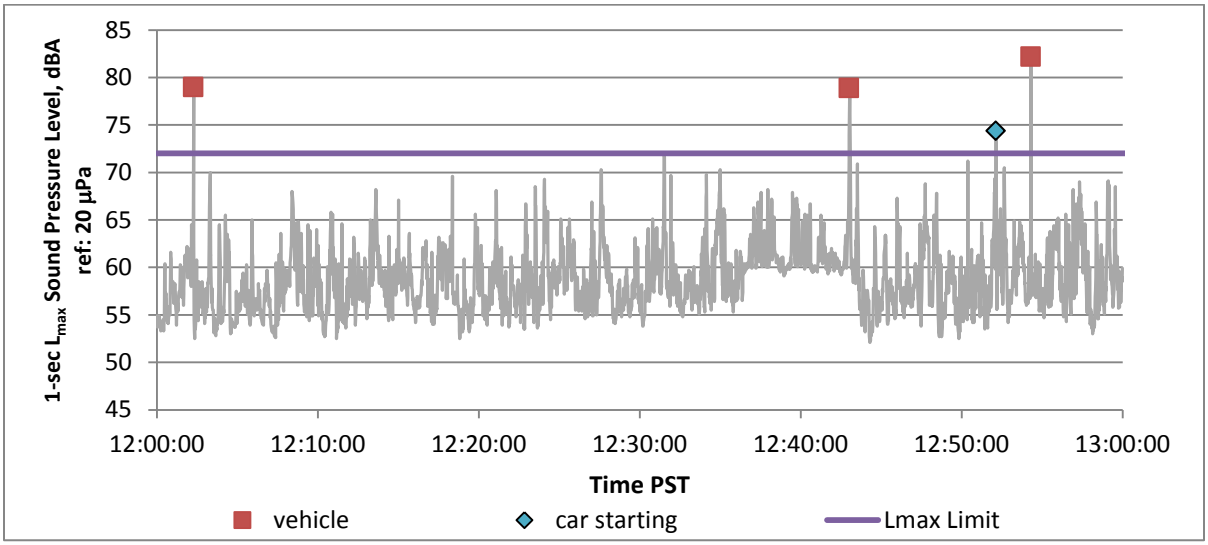
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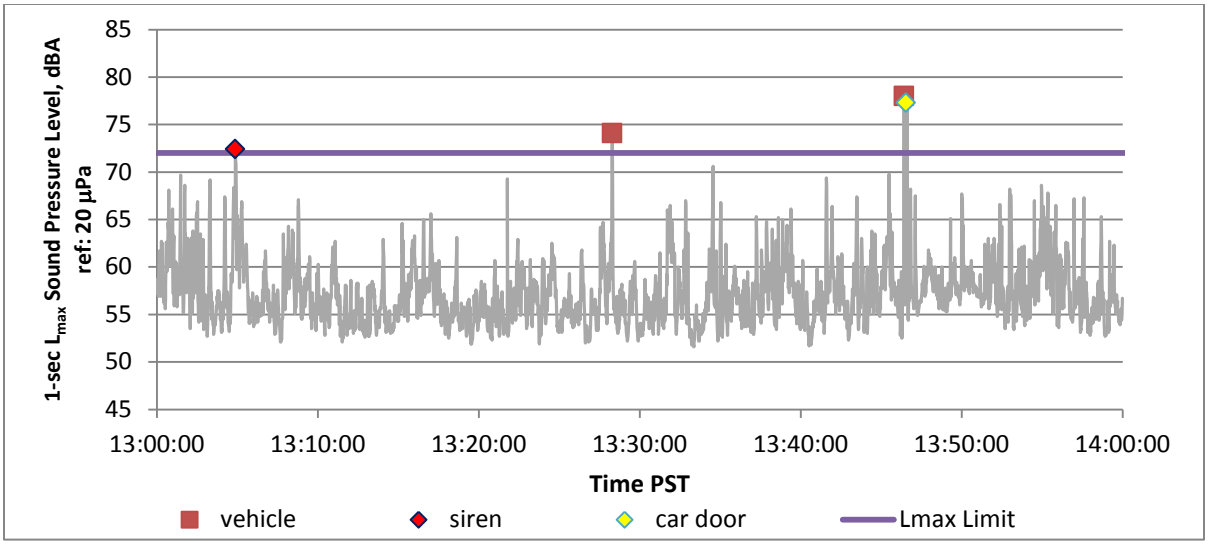
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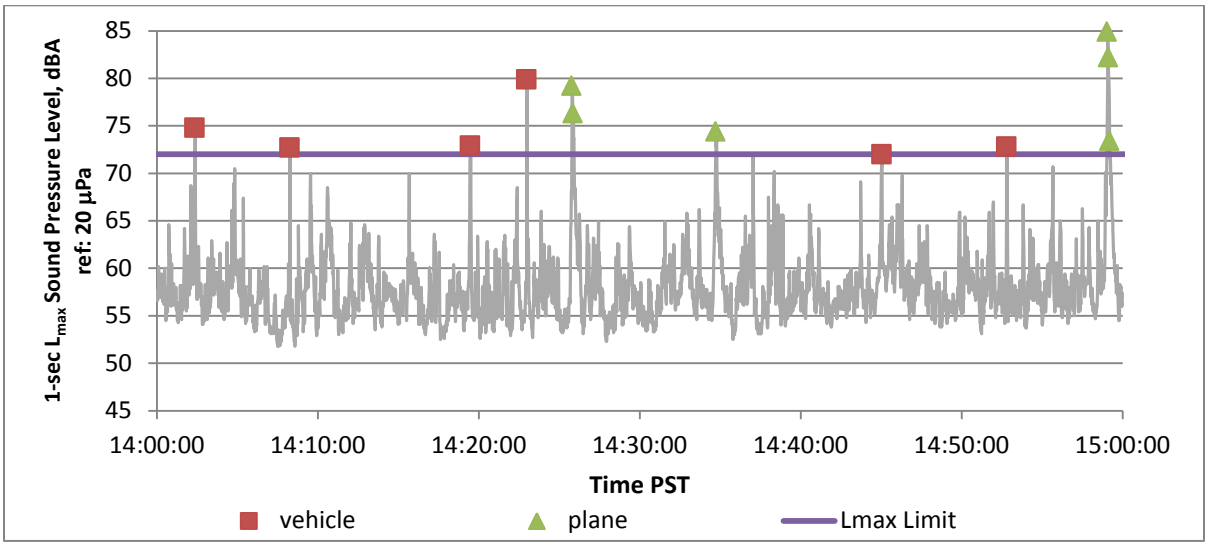
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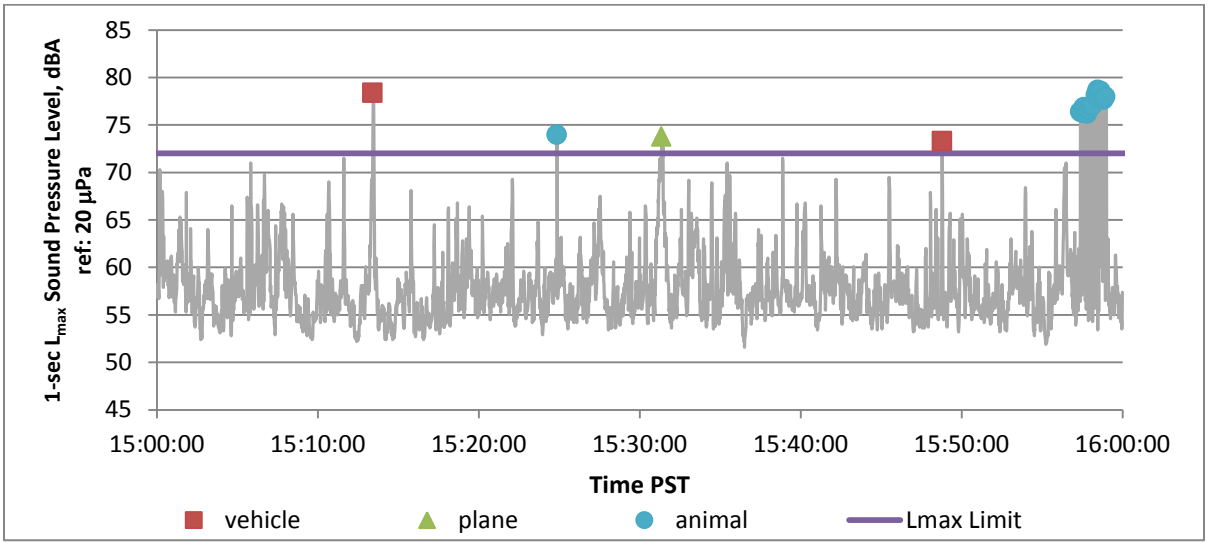
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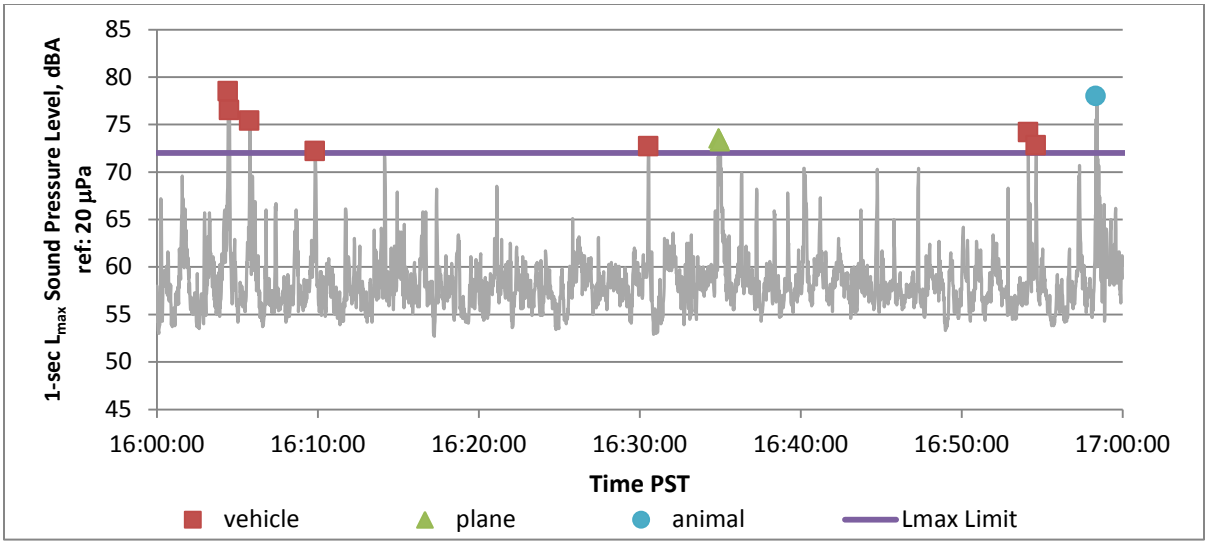
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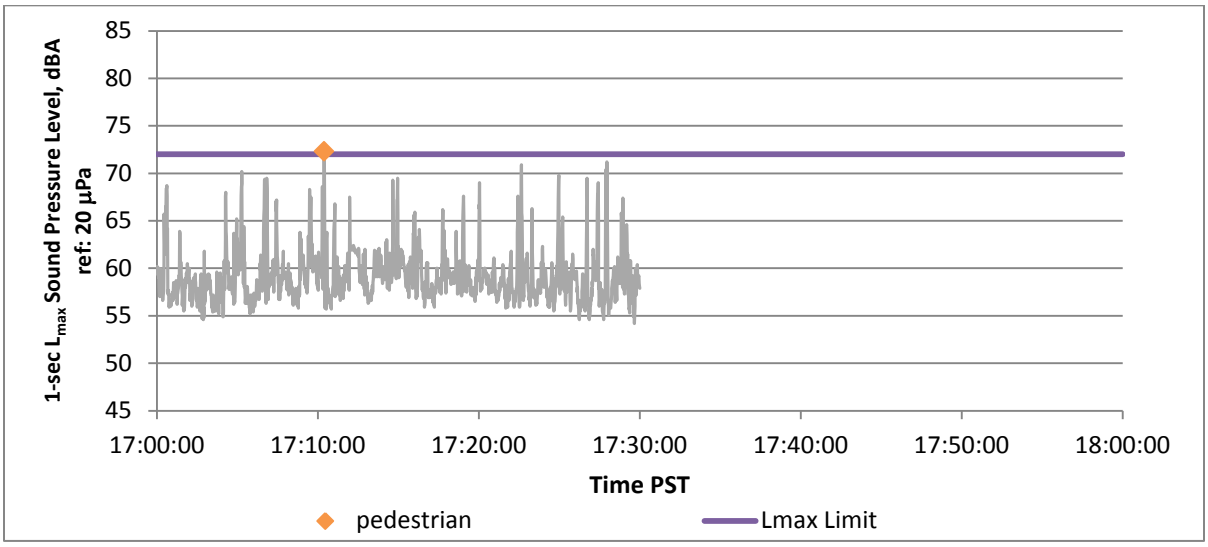
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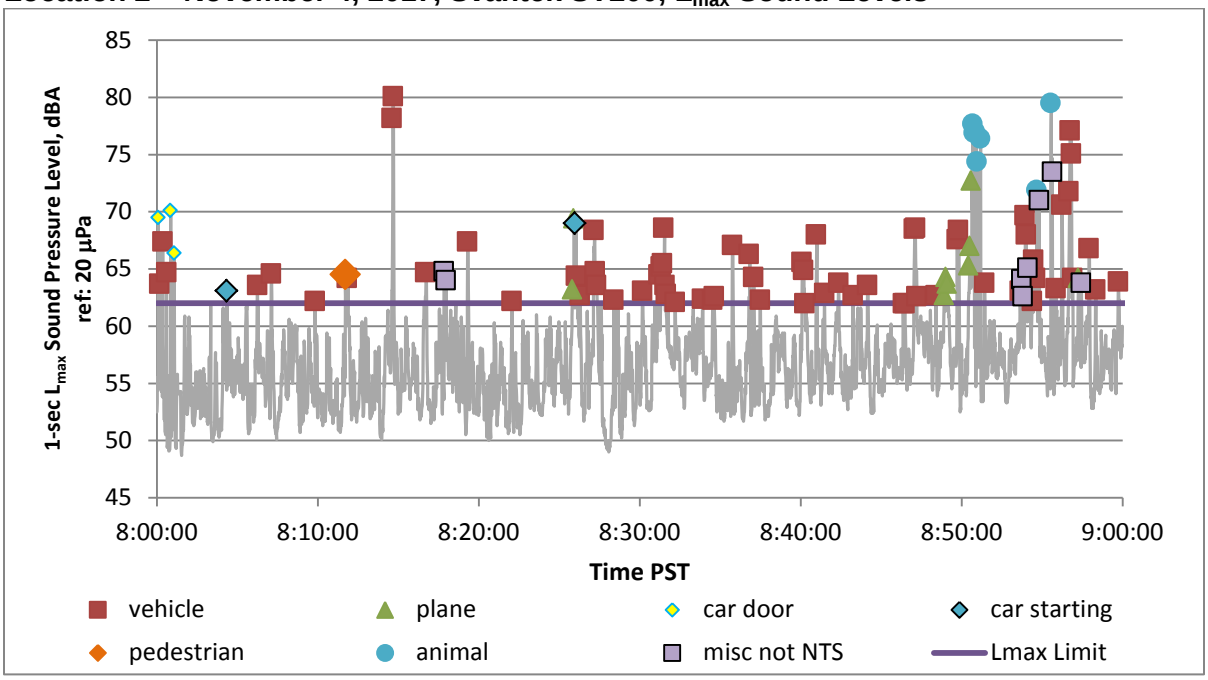
Location 2 – November 4, 2017, Svantek SV200, L_{max} Sound Levels



APPENDIX 2

Annual Noise Exceedance Summary

For additional reference, events in exceedance of the Seattle Municipal Code L_{max} sound level limits over the past monitoring year were estimated based on qualitative and quantitative review of exceedance audio files taken on Wednesdays (the facility's peak operating day based on information provided by Seattle Public Utilities) for a sample size equivalent to 10% of the monitoring days. A graphical summary of this exceedance source analysis is shown below.