



**DATE:** January 14, 2019

**TO:** Lee Momon – Seattle Public Utilities

**FROM:** Justin Morgan, INCE – The Greenbusch Group, Inc.  
Bhawna Rathi – The Greenbusch Group, Inc.

**RE:** **DRAFT** North Transfer Station –2018 Q4 Noise Monitoring Report

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## INTRODUCTION

The intent of this memorandum is to present the results of staffed sound level measurements conducted on December 5 and December 15, 2018 to document daytime and nighttime sound levels from operations at the North Transfer Station and to determine compliance with applicable regulatory criteria.

## 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 <sup>1</sup>
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  $\mu$ Pa. 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 December 5, 2018 and from 8:00 AM to 9:00 AM on Saturday December 15, 2018. Measurements on December 5, 2018 were made for the duration of the North Transfer 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 December 15, 2018 were conducted to assess compliance with nighttime SMC sound level limits while the North Transfer 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. Wind speed on December 5, 2018 averaged two miles per hour from the North and temperatures ranged between 31 and 49 degrees Fahrenheit. On December 15, winds averaged one mile per hour from the Southeast and temperatures ranged between 45 and 46 degrees Fahrenheit. No precipitation was recorded during the measurement periods. Monitoring staff were stationed near the sound level meters to document specific on-site noise events. Measurements 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. Equipment used during the measurements are identified in the Table below.

**Table 4.** Measurement Equipment

Make and Model	Description	Serial
Svantek SV200	Sound level analyzer	39777
MK250	Microphone	10978
Larson Davis CAL200	Acoustic Calibrator	9512
Brüel & Kjaer Type 2270	Sound level analyzer	2679351
Brüel & Kjaer ZC-0032	Preamplifier	12296
Brüel & Kjaer 4189	Microphone	2695414
Brüel & Kjaer 4231	Acoustic Calibrator	3001160
Svantek 979	Sound level analyzer	46177
Svantek SV17	Preamplifier	57824
GRAS 40AE	Microphone	258193

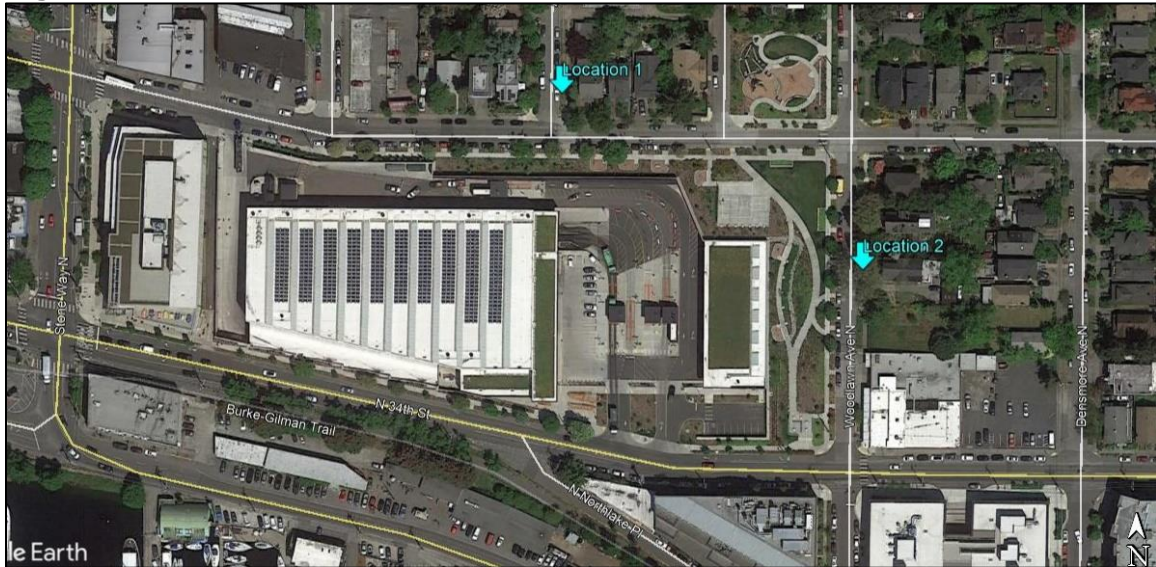
Field calibrations of monitoring equipment were performed immediately before the measurements and verified after the measurements were completed. Audio recordings were made at both monitoring locations to allow for sound source identification after the measurements were completed. One-second and hourly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

### Measurement Locations

Sound levels were measured at two residential properties near the Transfer Station. Microphones were positioned as close to residential property lines as feasible at approximately 10 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 were reviewed to identify noise events associated with SMC exceedances. 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 was restricted to maximum sound levels (hourly  $L_{max}$ ) only. Off-site sound sources included vehicle traffic, car horns and doors, aircraft, pedestrians, and wildlife. 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.

Results of the analysis show that none of the  $L_{max}$  exceedances were caused by the Transfer Station.

**Seattle Municipal Code Exceedances**

During the measurements, a combined total of 1,464 seconds of data were above either the SMC daytime or nighttime  $L_{max}$  sound level limits, all resulted from off-site sound sources including vehicle traffic, car horns and doors, aircraft, pedestrians, and wildlife. These off-site sound sources are summarized in Table 5 below and are presented graphically in the Appendix.

**Table 5.** Number of Seconds Off-Site Sound Sources Exceeded SMC  $L_{max}$  Limits

Event	December 5, 2018		December 15, 2018		Total Events
	Location 1	Location 2	Location 1	Location 2	
Vehicle	251	113	223	105	692
Car Horn	9	1	1	0	11
Plane	156	146	152	163	617
Pedestrian	5	2	4	5	16
Car Door	3	6	0	3	12
Miscellaneous	11	7	0	0	18
Plane and Vehicle	3	55	0	0	58
Animals	0	1	4	35	40

**CONCLUSION**

All operations at the North Transfer Station complied with daytime and nighttime Seattle Municipal Code  $L_{max}$  sound level limits during the measurement period.

Respectfully submitted;



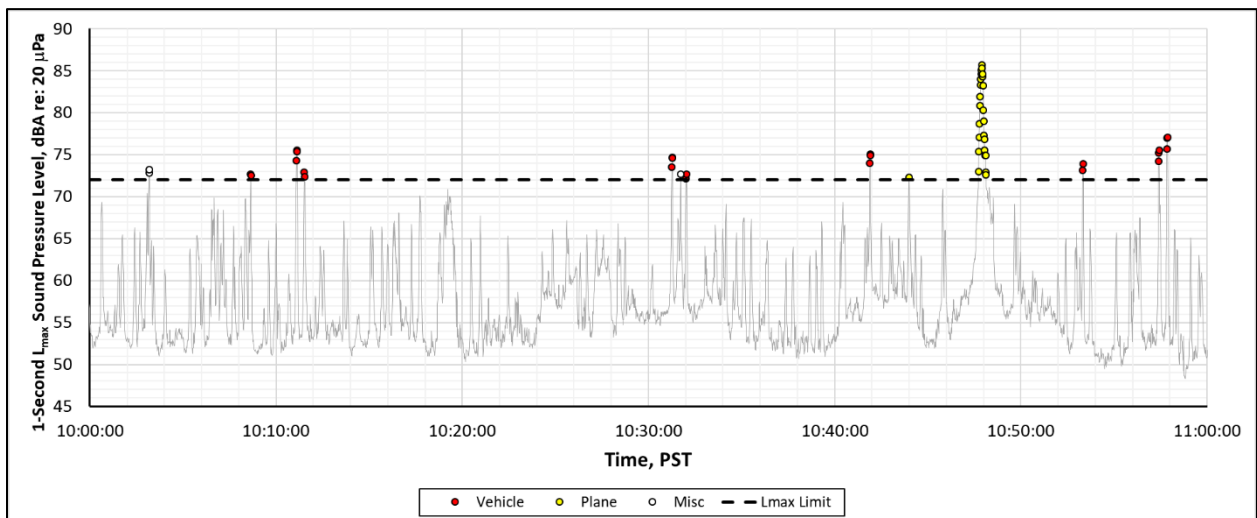
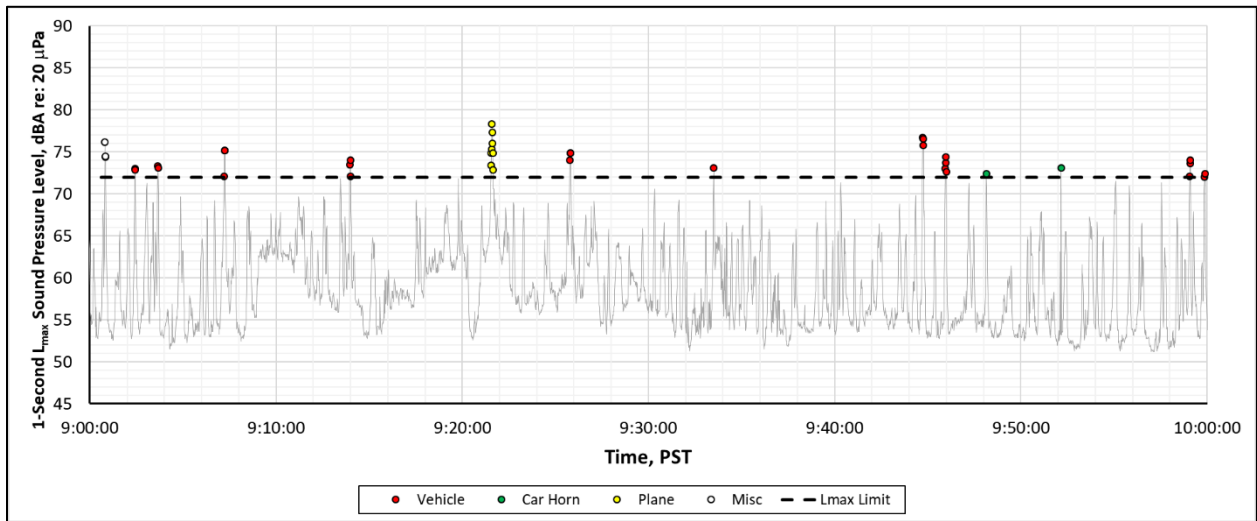
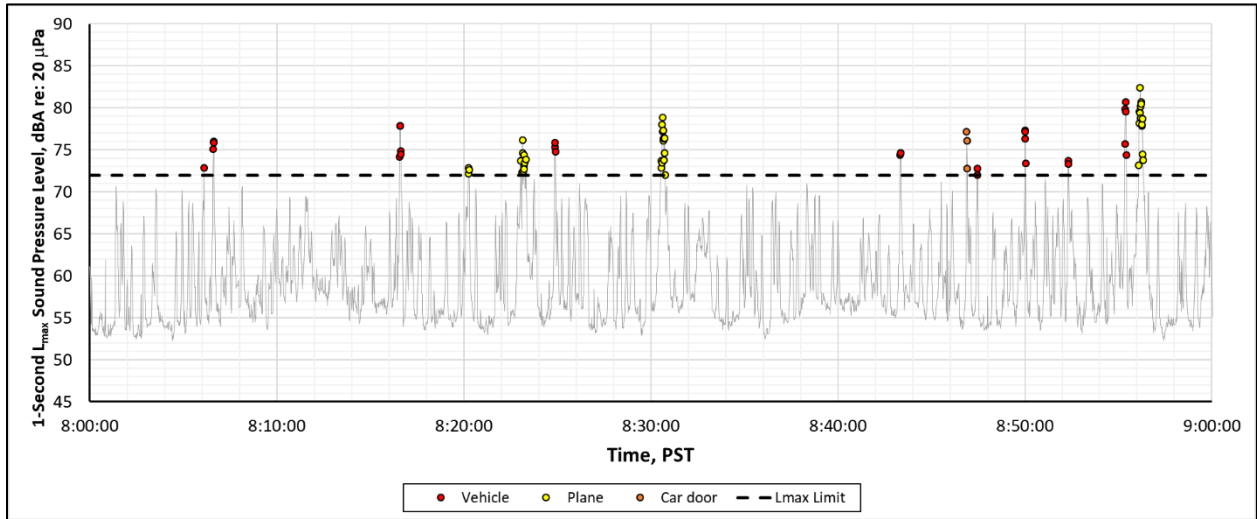
Justin Morgan, INCE

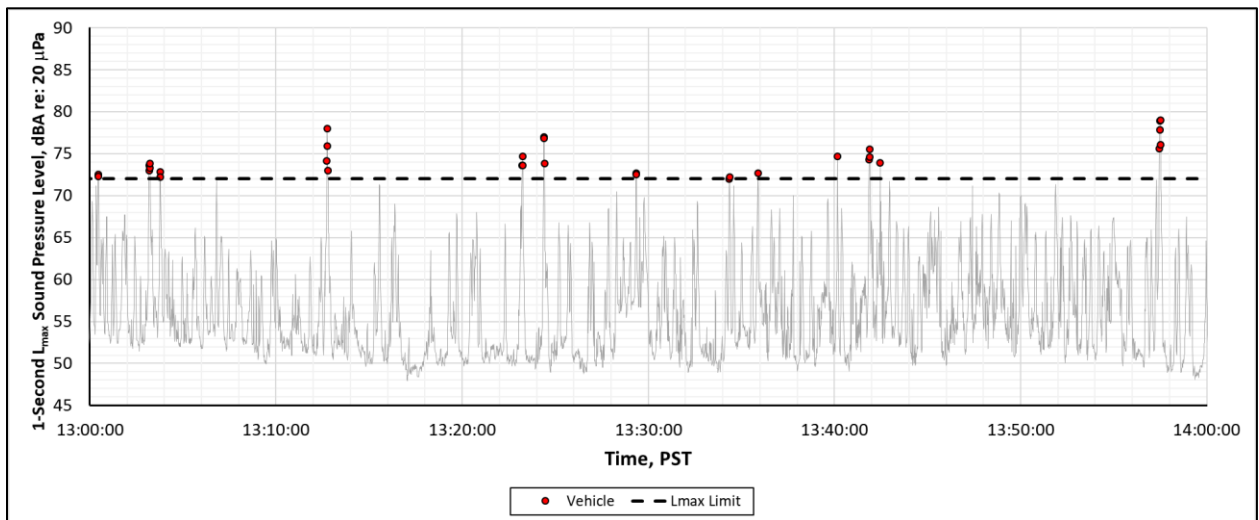
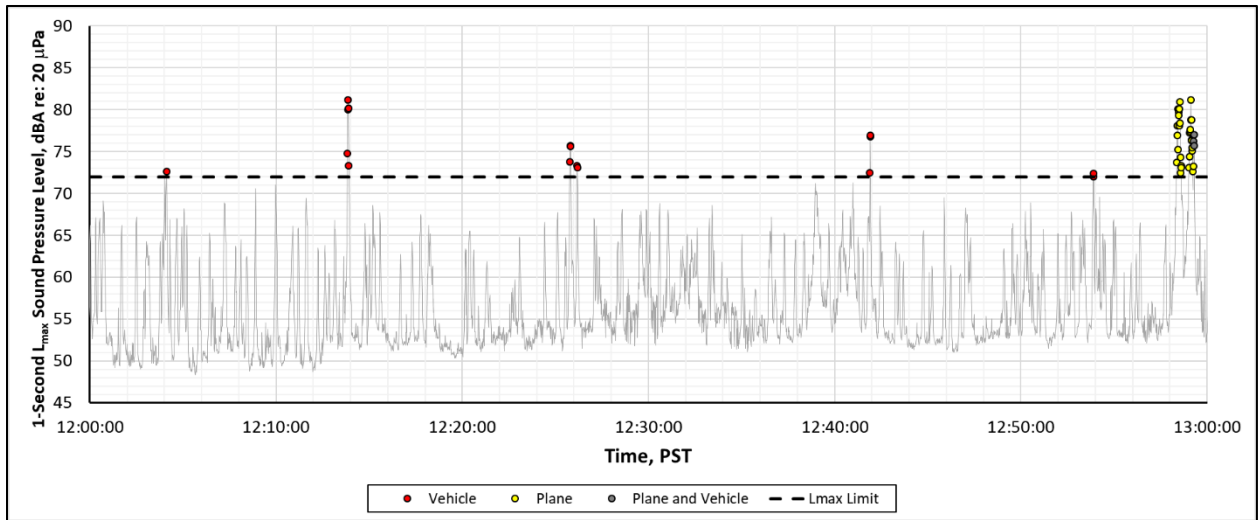
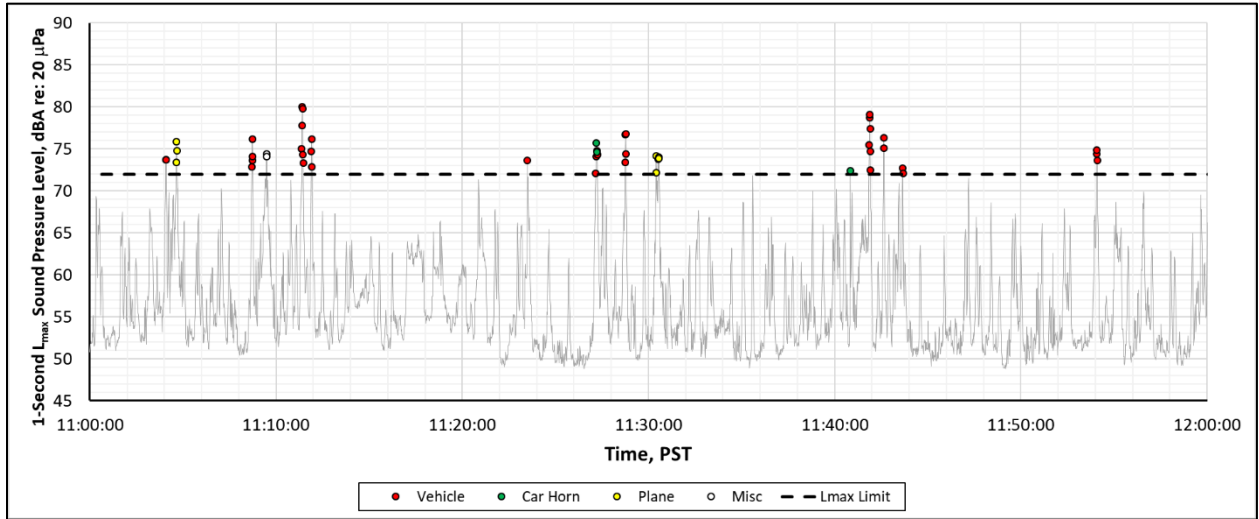


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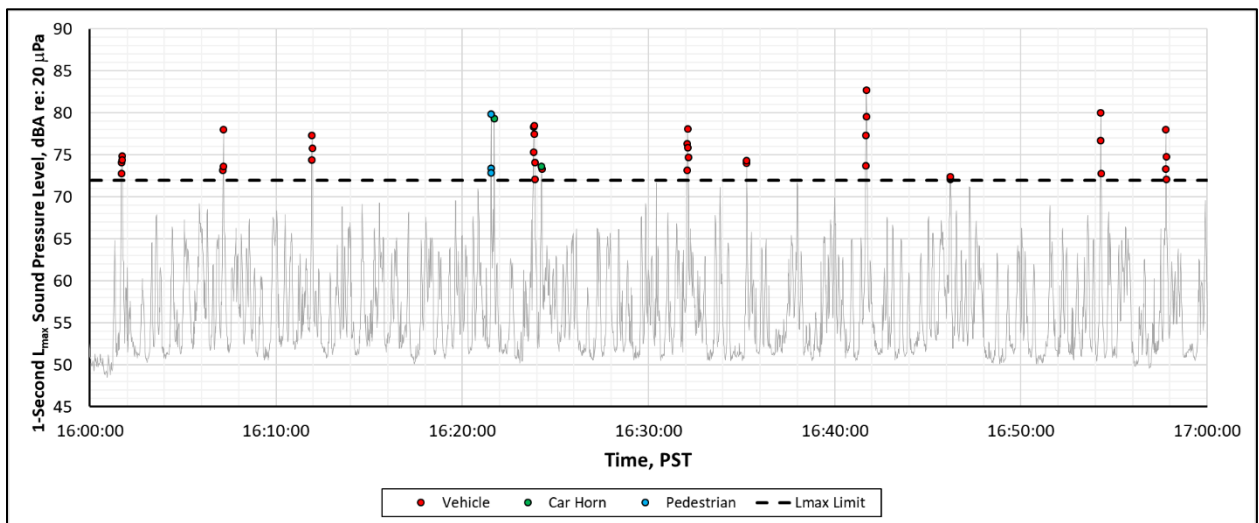
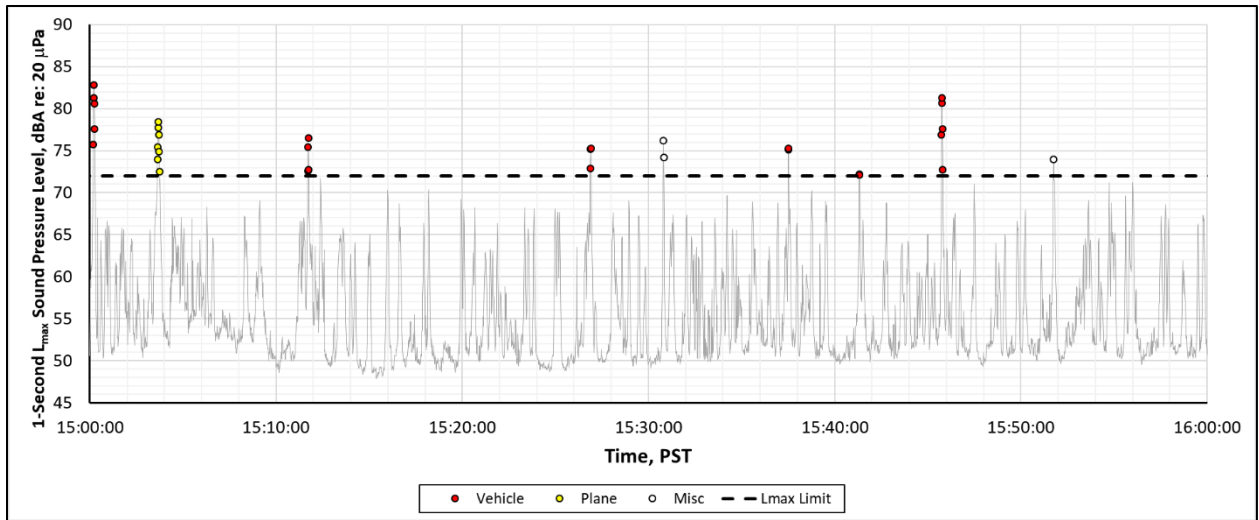
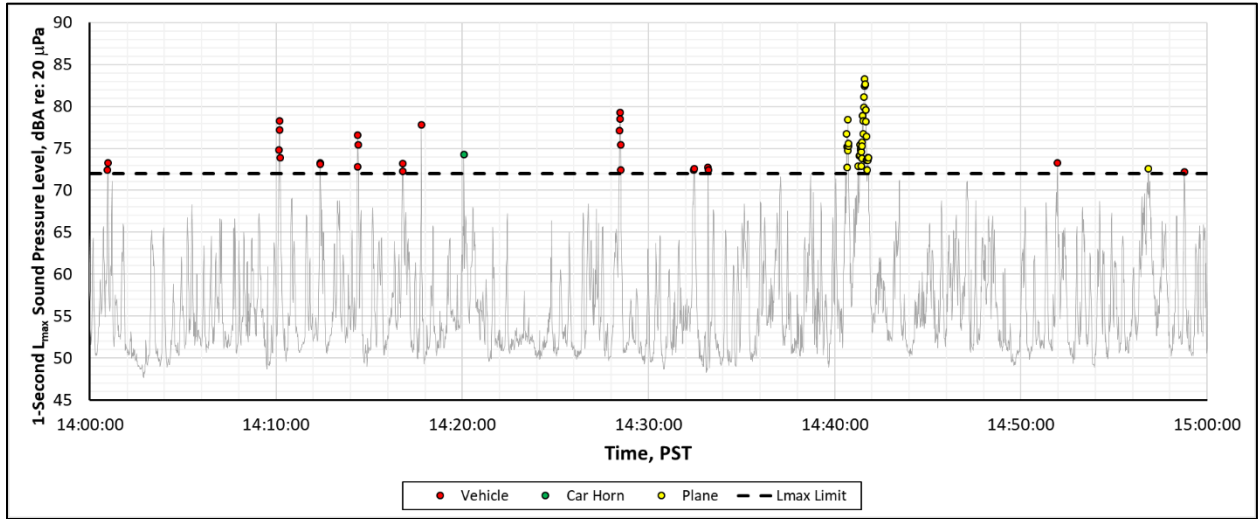
APPENDIX

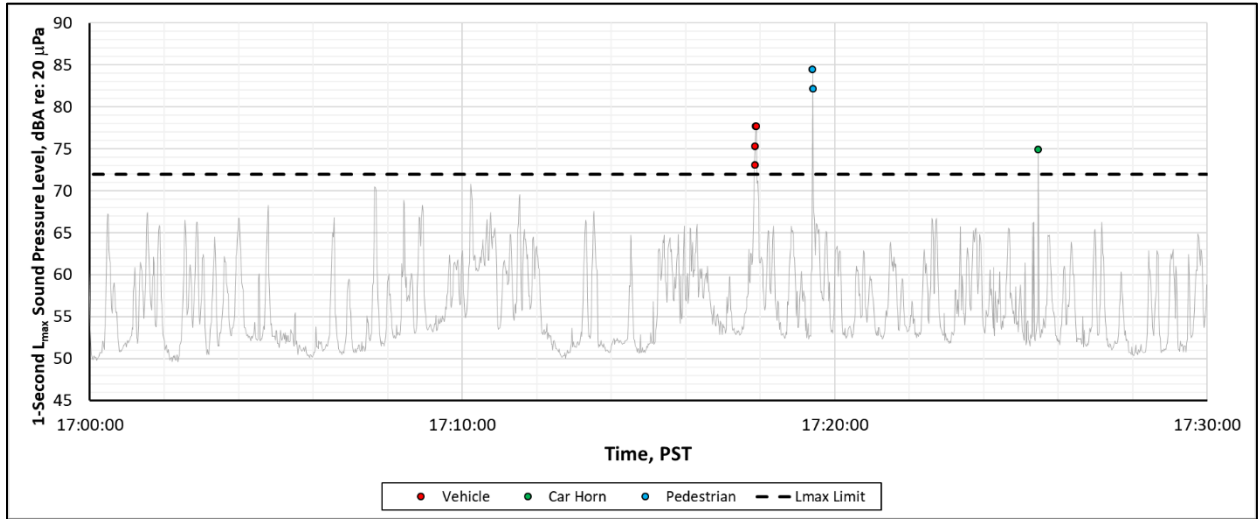
Location 1 – December 5, 2018, L<sub>max</sub> Sound Levels



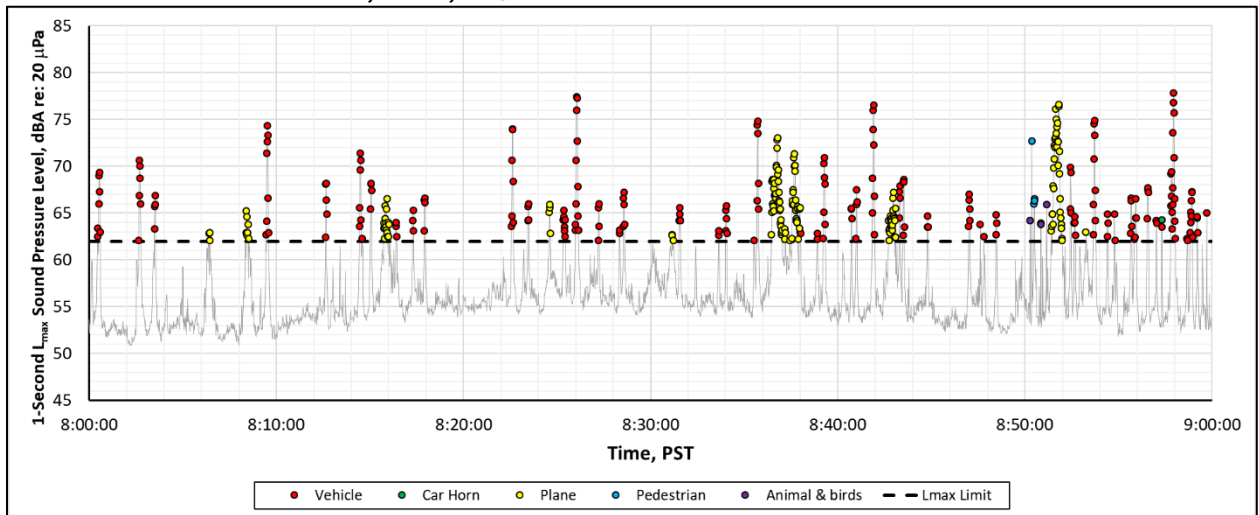




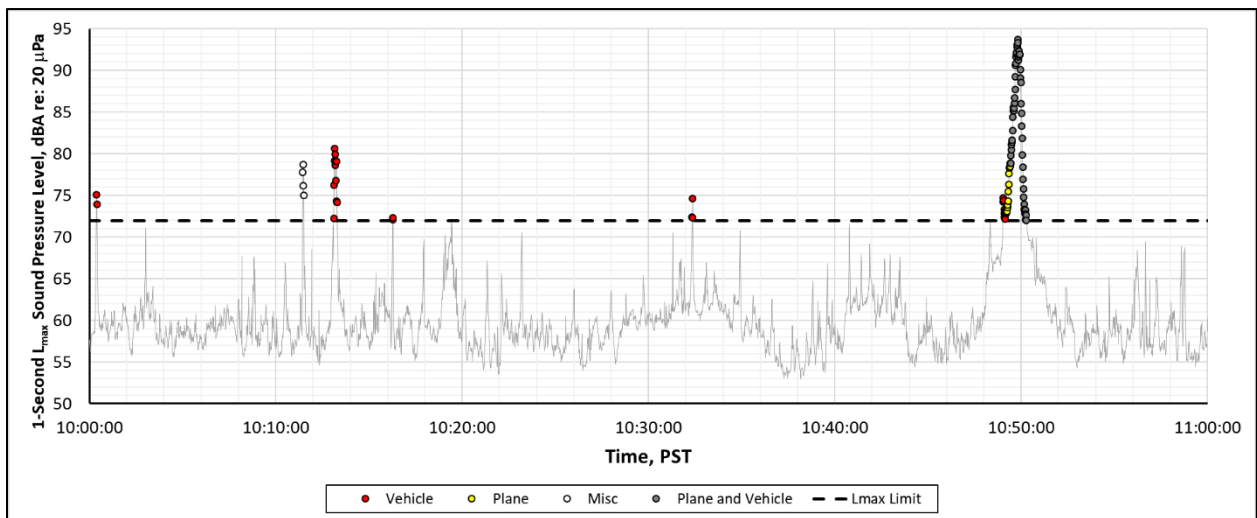
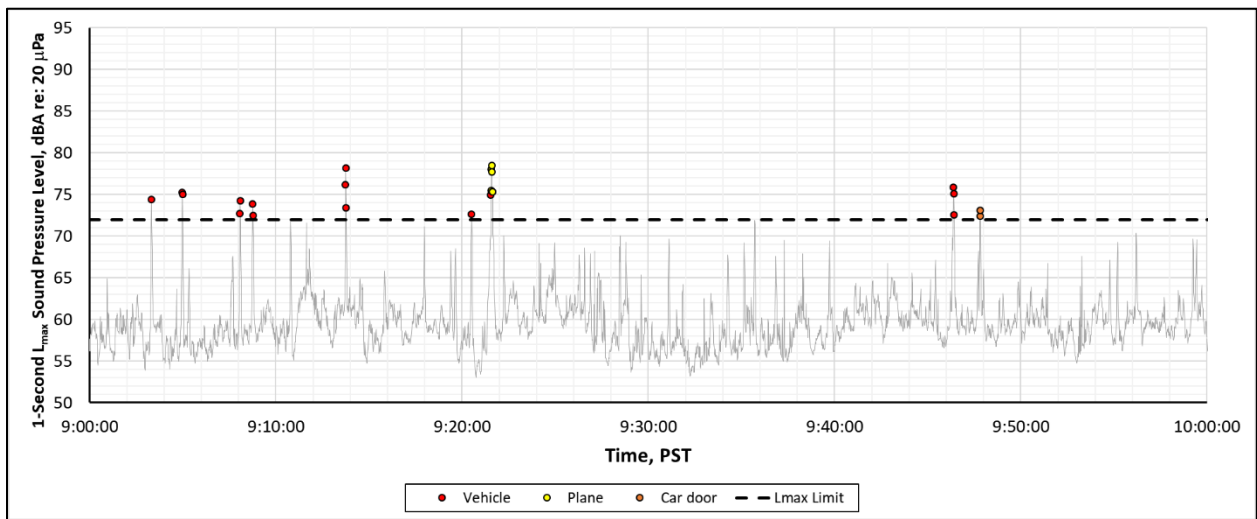
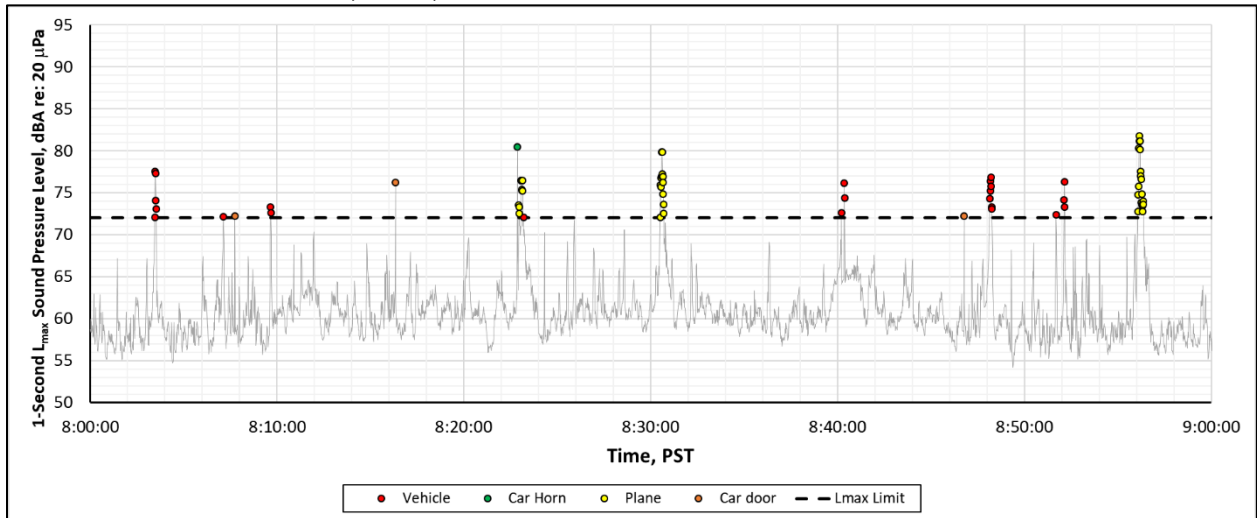


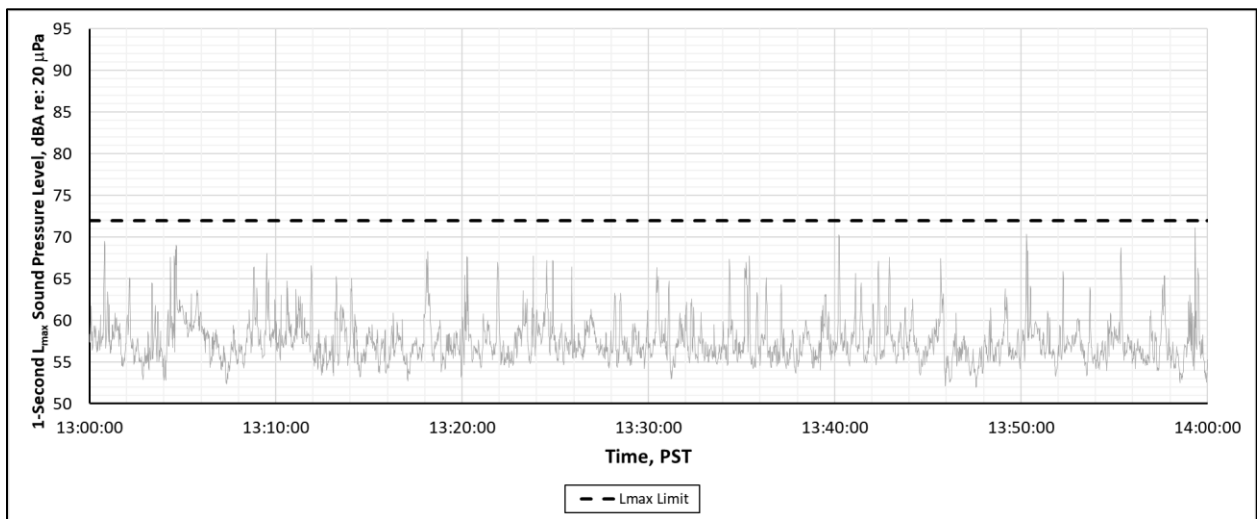
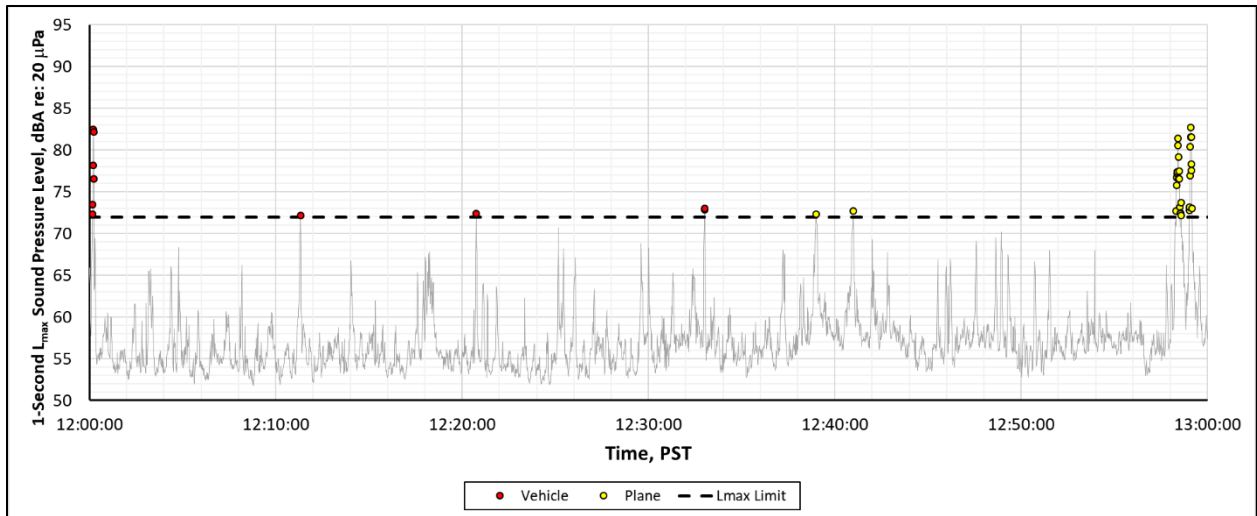
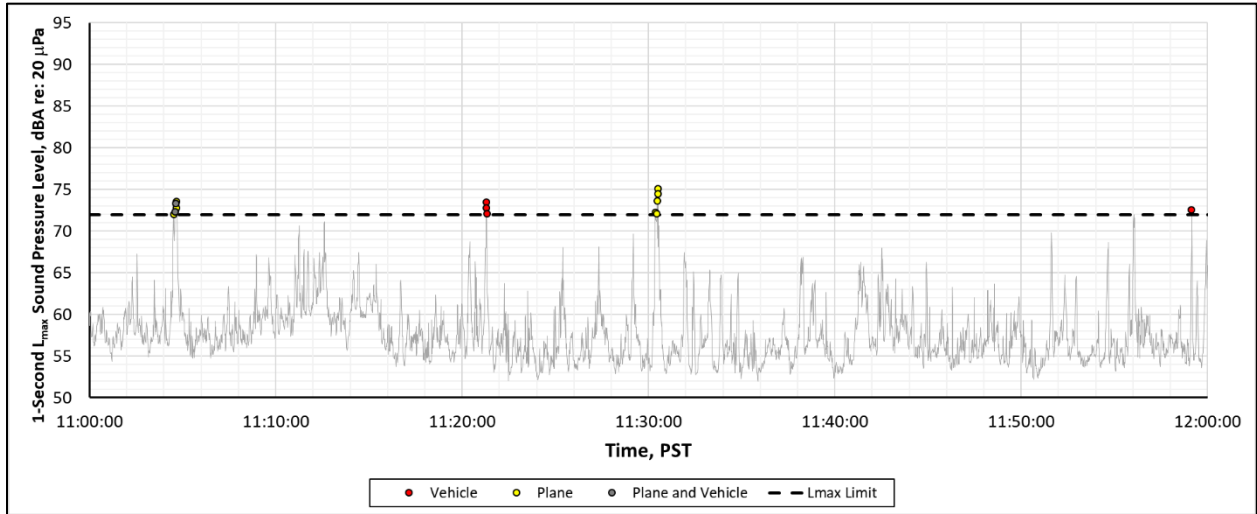


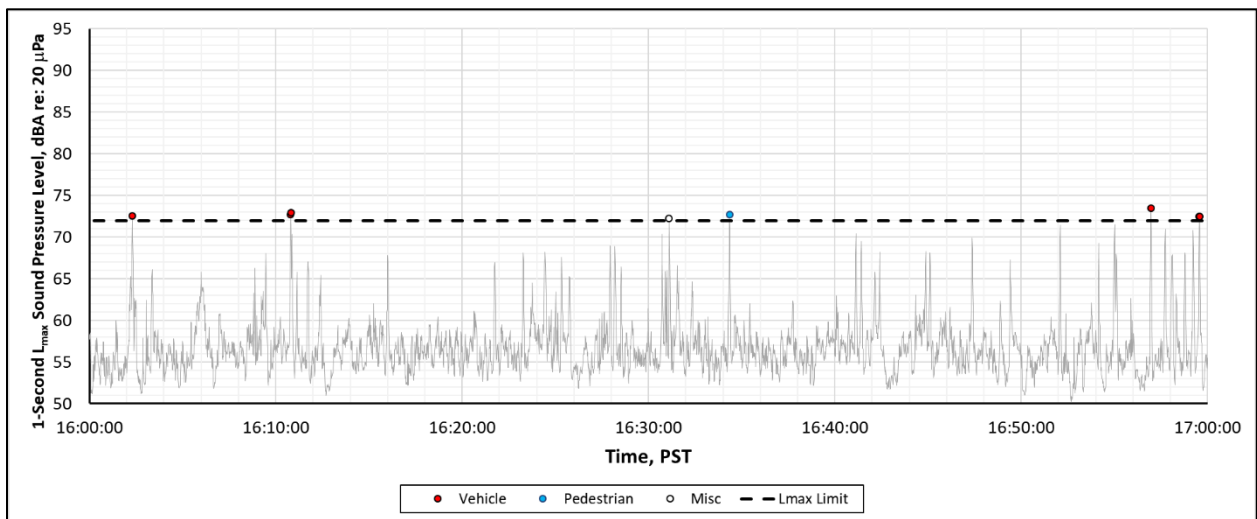
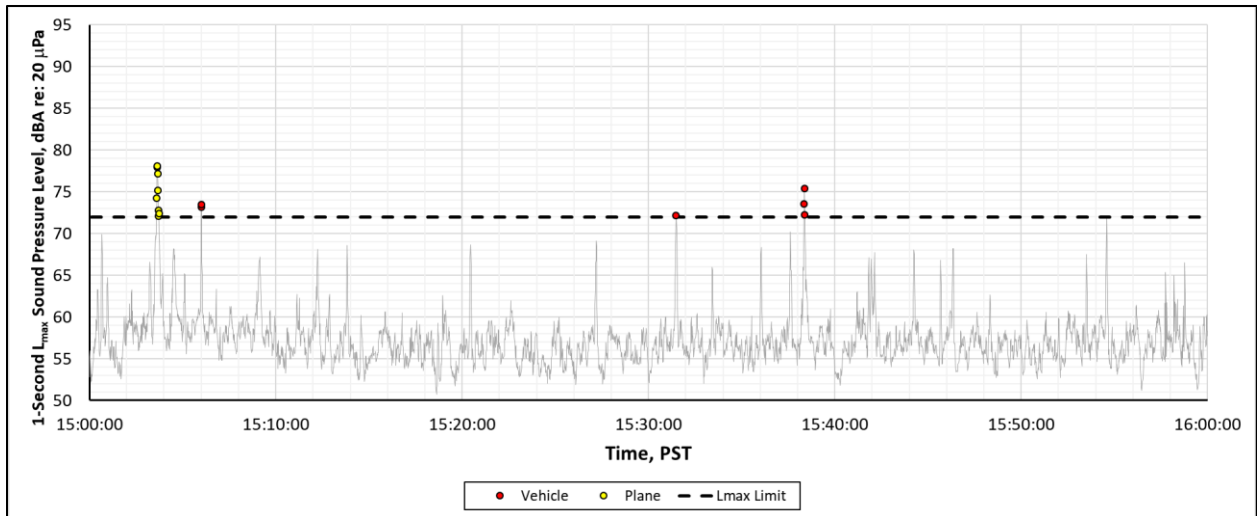
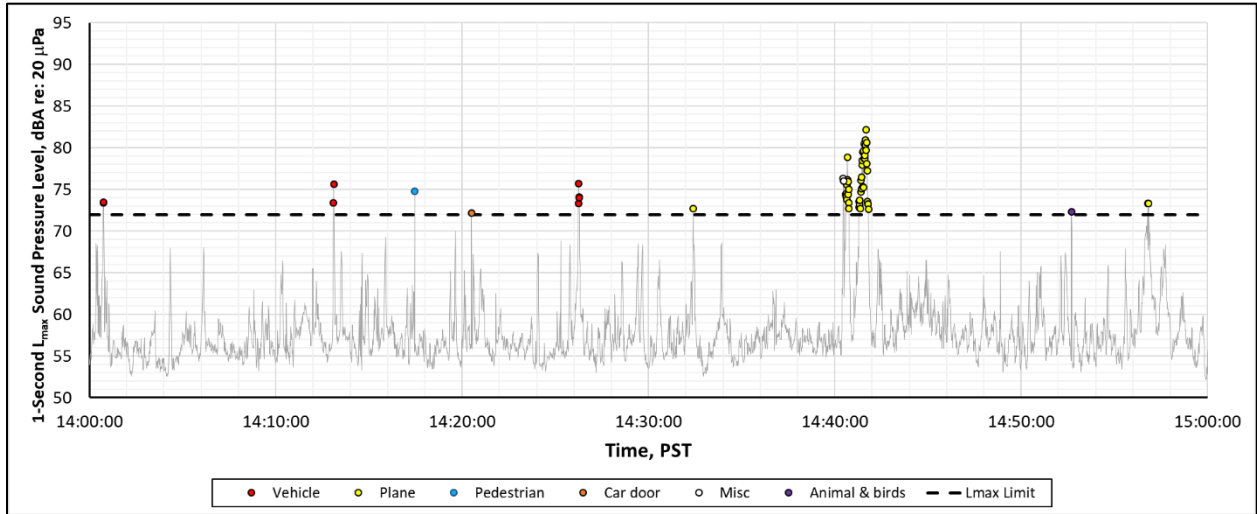
**Location 1 – December 15, 2018,  $L_{max}$  Sound Levels**

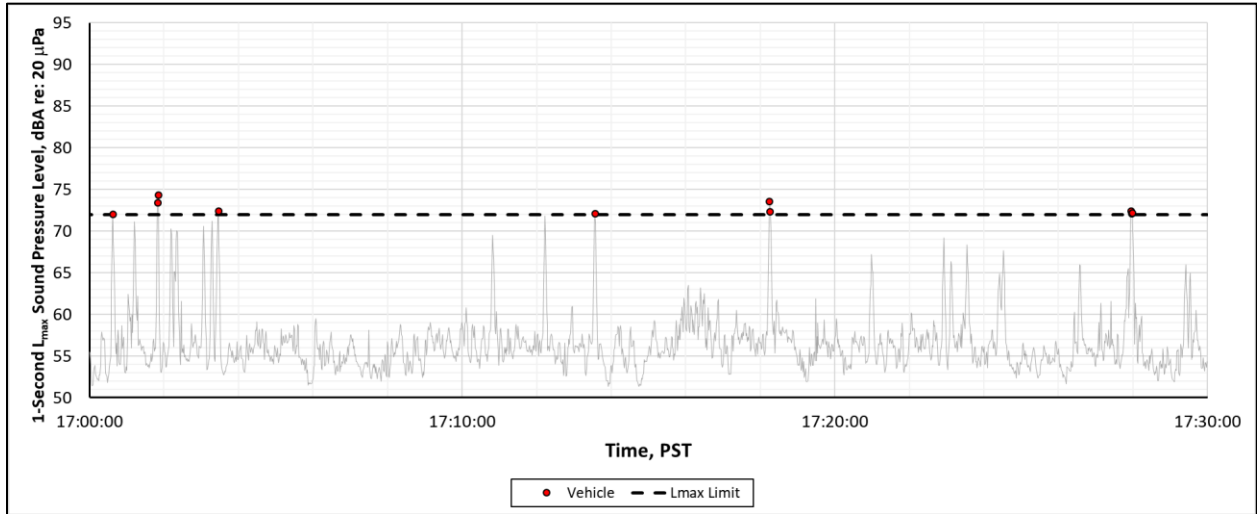


### Location 2 – December 5, 2018, L<sub>max</sub> Sound Levels









**Location 2 – December 15, 2018,  $L_{max}$  Sound Levels**

