***DATE:*** November 13, 2018

***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 Q3 Noise Monitoring Report*

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

---

## INTRODUCTION

The intent of this memorandum is to present the results of quarterly staffed sound level measurements conducted on September 26, September 29, and October 6, 2018. The intent of these measurements was to document sound levels from operations at the North Transfer Station 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[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) |

SMC 25.08.530 states that backup alarms are exempt from SMC sound level limits.

## SOUND LEVEL MEASUREMENTS

Staffed sound level monitoring took place between 8:00 AM and 5:30 PM on Wednesday September 26, 2018 and from 8:00 AM to 9:00 AM on Saturday September 29, 2018. Due to an equipment error at one of the measurement locations on September 29, 2018, additional data was collected on Saturday October 6, 2018. Measurements on September 26, 2018 were made for the duration of the station's operating hours and coincided with peak facility operating times based on information provided by SPU. The measurements on September 29, 2018 and October 6, 2018 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 all measurements, sound levels were monitored concurrently near two residential properties north and east of the Transfer Station. Wind speed on September 26, 2018 averaged 9 mile per hour from the west-southwest and temperatures ranged between 52 and 70-degrees Fahrenheit. On September 29, 2018 wind speed was 12 miles per hour and temperatures ranged between 52 and 66-degrees Fahrenheit and on October 6, 2018 wind speed was 7 miles per hour and temperatures ranged between 48 and 60-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

| Manufacturer and Model | Description | Serial |
|---|---|---|
| **Staffed Measured Equipment** | | |
| Brüel & Kjær Type 2250 | Sound level analyzer | 3006756 |
| PCB 426E01 (ICP) | Preamplifier | 47476 |
| Brüel & Kjær 4189 | Microphone | 2550228 |
| Brüel & Kjær 4231 | Acoustic calibrator | 2545696 |
| **Long Term Monitoring Equipment** | | |
| Svantek SV200 | Sound level analyzer | 39777 |
| Larson Davis CAL200 | Acoustic Calibrator | 9512 |
| MK250 | Microphone | 10978 |

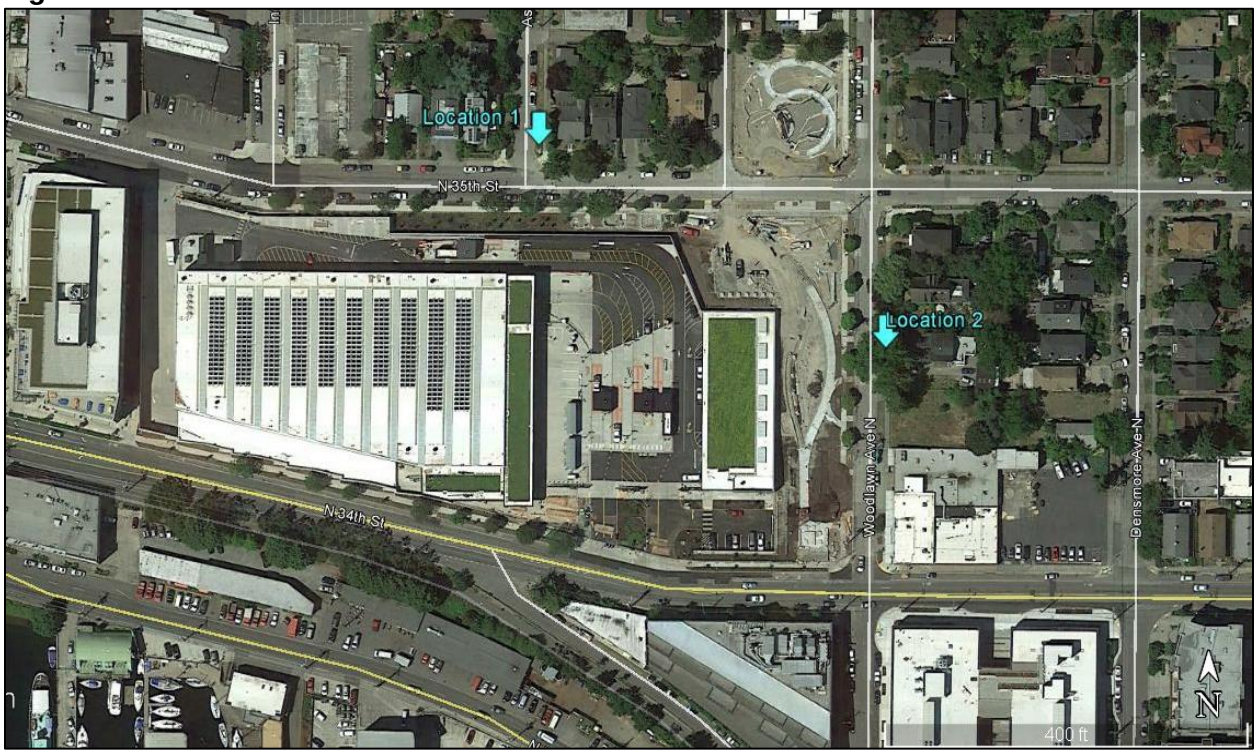
Field calibrations of monitoring equipment were performed before the measurements and verified after the measurements were completed. Audio recordings were made at both monitoring locations to allow for sound source identification after the measurements were completed. One-second and hourly average ($L_{eq}$) 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. Continuous staffed monitoring took place between 8:00 AM and 5:30 PM on September 26, 2018 and 8:00 AM and 9:00 AM on September 29, 2018. Staff did measurement again on October 6, 2018 at one of the locations because of an equipment error on September 29, 2018. Microphones were positioned 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

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 was restricted to maximum sound levels (hourly $L_{max}$) 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

Sound levels from Transfer Station operations exceeded SMC $L_{max}$ sound level limits twice on September 26, 2018. Once at Location 2 at 11:31 AM due to a backup alarm and the other at 3:39 PM at Location 1 which appeared to be the result of trash or metal being dumped or moved by a loader. Nighttime $L_{max}$ sound level limits were exceeded once the morning of September 29, 2018 at 8:39 AM due to a loader moving or dumping trash or metal. It is not known whether the residential haul doors were open during these exceedances. All exceedances results are summarized in Table 5 below.

**Table 5.** $L_{max}$ Sound Level Exceedances

| Date | Time | Measured Sound Level | SMC $L_{max}$ Limit | Event | Location |
|---|---|---|---|---|---|
| September 26, 2018 | 11:31 AM | 75 dBA | 72 dBA | Backup Alarm/Beeping Noise | Location 2 (East Pole) |
| | 3:39 PM | 73 dBA | | Dumping/moving debris | Location 1 (North pole) |
| September 29, 2018 | 8:39 AM | 64 dBA | 62 dBA | Dumping/moving debris | Location 2 (East Pole) |

During the measurements on September 26, 2018 monitoring staff noted that the residential haul doors remained open for extended periods of time. Monitoring staff noted two of the doors were open continuously from approximately 12:40 PM until 1:10 PM, but no exceedance was measured by sound level meters during that time. The commercial haul door was also open during the 4:00 PM hour; however, it is our understanding that commercial haul vehicles do not use the transfer station after 3:00 PM.

All other on-site activities, including dumping and moving of debris were below the SMC $L_{max}$ sound level limit.

### Backup Alarms

Backup alarms were the most frequent audible sound source from the Transfer Station at Location 2, but the noise measurement results show they were below the SMC $L_{max}$ limits. Though just one of the three events appeared to be the result of backup alarms on September 26. It should be noted that backup alarms are exempt from SMC limits under SMC 25.08.530. Monitoring staff noted that the backup alarms were noticeably louder at both measurement locations when the commercial or residential haul roll-up doors were open, however because backup alarm sound levels at the monitoring locations were below ambient conditions, the actual reduction in sound levels could not be quantified.

### Generator

The generator installed near the northwest corner of the Transfer Station property was exercised during the monitoring period on September 26, 2018. Monitoring staff noted it was running around 11:08 AM and turned off sometime around 11:28 AM. Sound levels measured at Location 2 did not significantly increase during periods the generator was operating. Monitoring staff observed the generator was only audible during periods when other off-site sound sources were not present. Review of audio recordings indicates sound produced by the generator is approximately 52 dBA at Location 1. Although sound produced by emergency equipment, including generator testing is exempt from SMC sound level limits, the generator at the Transfer Station appears to comply with SMC daytime limits at Location 1. A photo of the generator is provided below.

**Photo 3.** On-Site Generator


## Off-Site Sound Sources

During the measurements the two sound level meters recorded a combined total of 374 events above either the SMC daytime or nighttime $L_{max}$ sound level limit. Of the 374 events above the $L_{max}$ sound level limit, 3 events can be attributed to the operation of the Transfer Station. The remaining 371 events were the result of off-site sound sources including: vehicle traffic (cars, busses, delivery trucks and off-site haul trucks), car horns, aircraft, pedestrians, animals, birds and car doors. These off-site sound sources are summarized in Table 6 below and are presented graphically in the Appendix. **October 6, 2018**

**Table 6.** Sound Sources Exceeding SMC $L_{max}$ Limits

| Event | September 26, 2018 | | September 29, 2018 | October 6, 2018 | Total Events |
|---|---|---|---|---|---|
| | Location 1 | Location 2 | Location2 | Location1 | |
| Animal | 0 | 3 | 0 | 1 | 4 |
| Birds | 3 | 0 | 0 | 5 | 8 |
| Horn | 3 | 5 | 6 | 2 | 16 |
| Misc (not NTS) | 16 | 18 | 8 | 10 | 52 |
| Plane | 30 | 28 | 12 | 2 | 72 |
| Pedestrian | 8 | 5 | 3 | 3 | 19 |
| Vehicle | 104 | 35 | 23 | 38 | 200 |
| NTS | 1 | 1 | 1 | 0 | 3 |
| | | | | | 374 |

**CONCLUSION**

Operations at the Transfer Station exceeded daytime Seattle Municipal Code $L_{max}$ sound level limits for two events during daytime hours and once during nighttime hours. The exceedance measured at the Location 1, north of the Transfer Station was caused by dumping or moving of debris and at Location 2, which is east of the transfer station was due to back up alarms (which are exempt from SMC sound level limits) and dumping or moving debris. All other on-site activities during the measurement period complied with Seattle Municipal Code sound level limits.

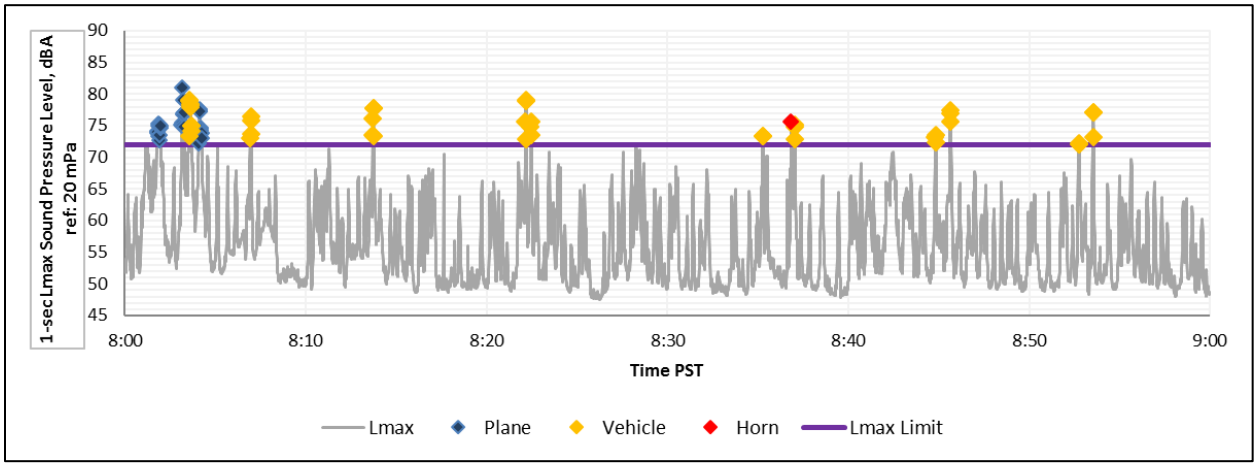
Respectfully submitted;

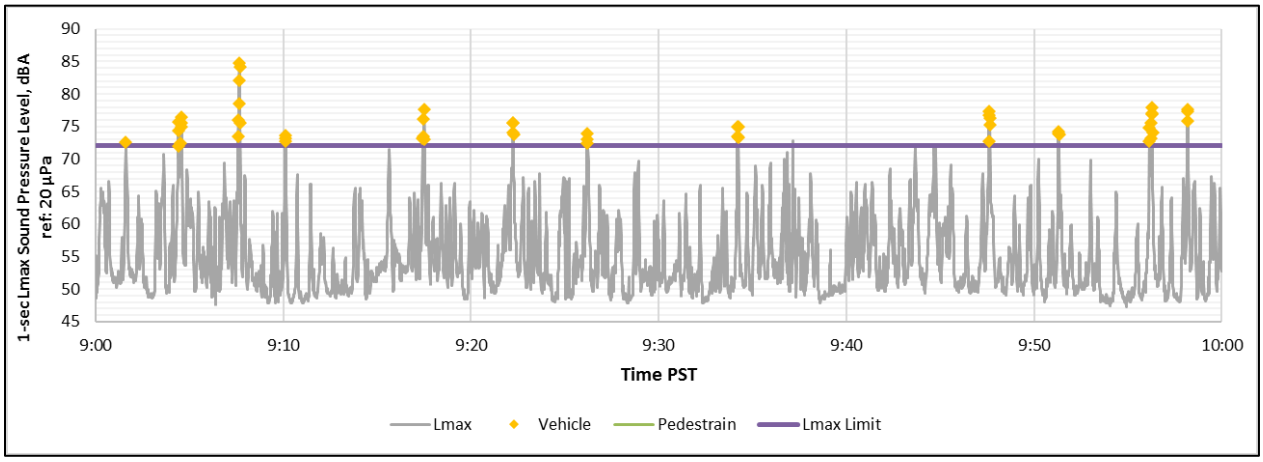
Justin B. Morgan, INCE

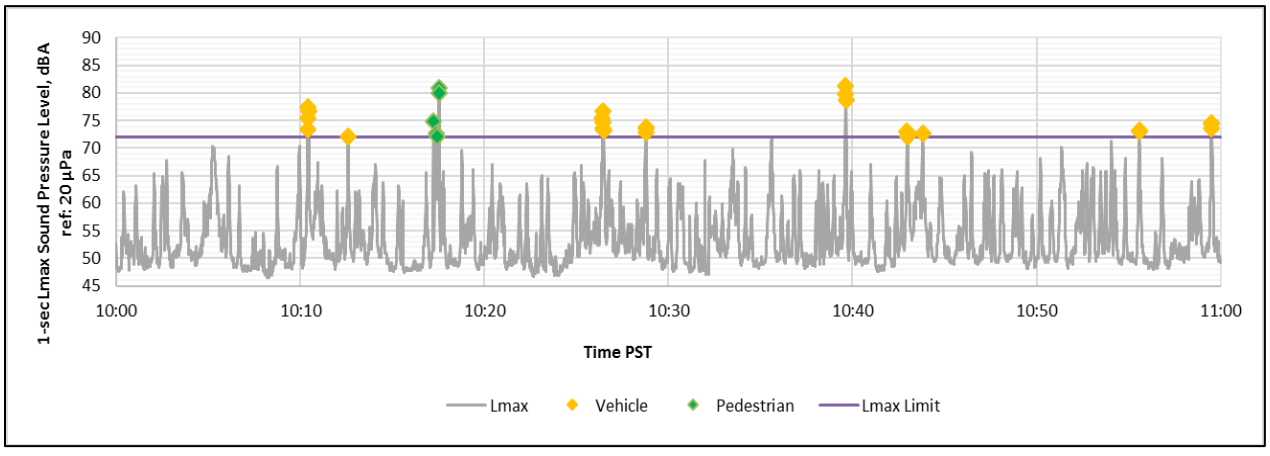
Bhawna Rathi

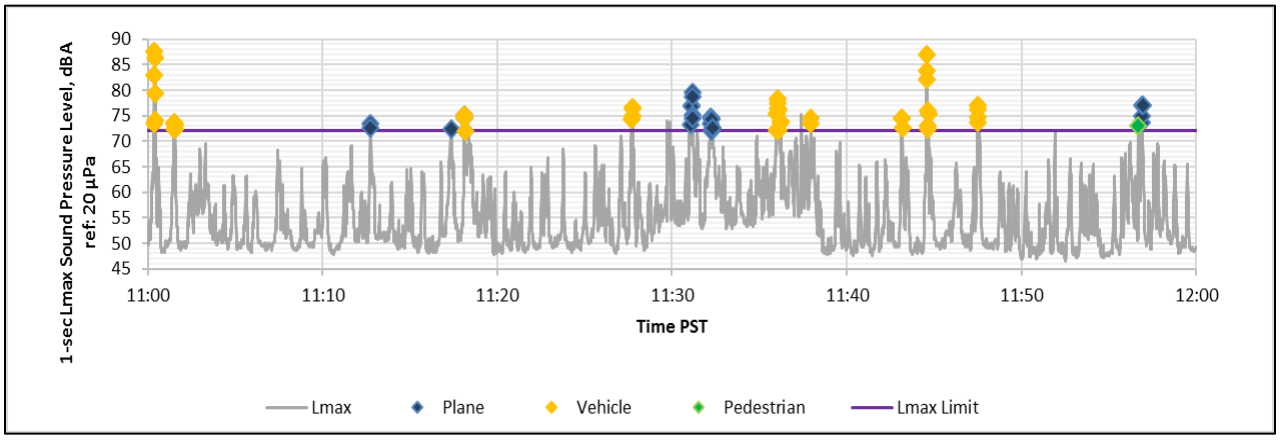
## APPENDIX

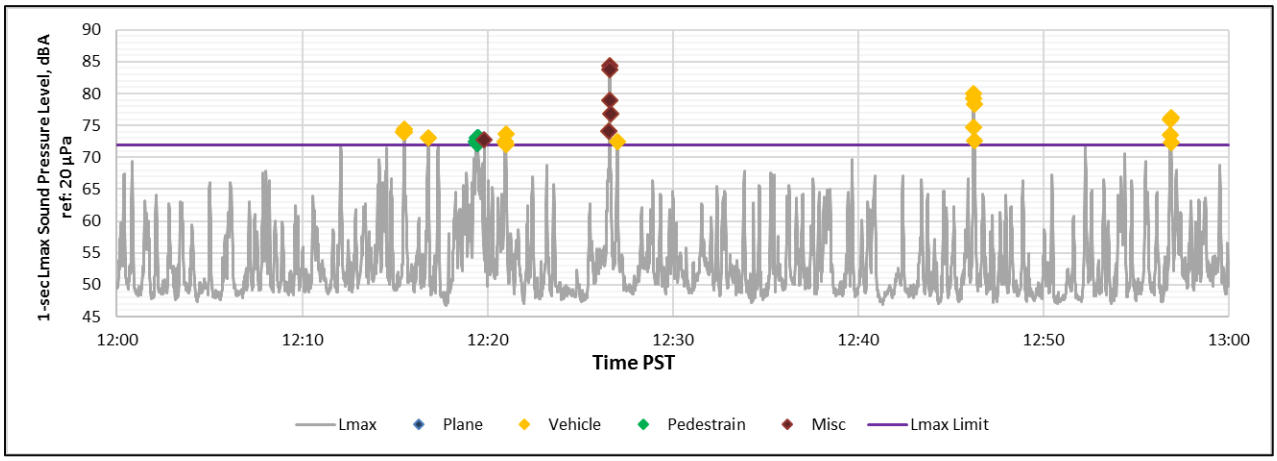
### Location 1 – September 26, 2018, $L_{max}$ Sound Levels

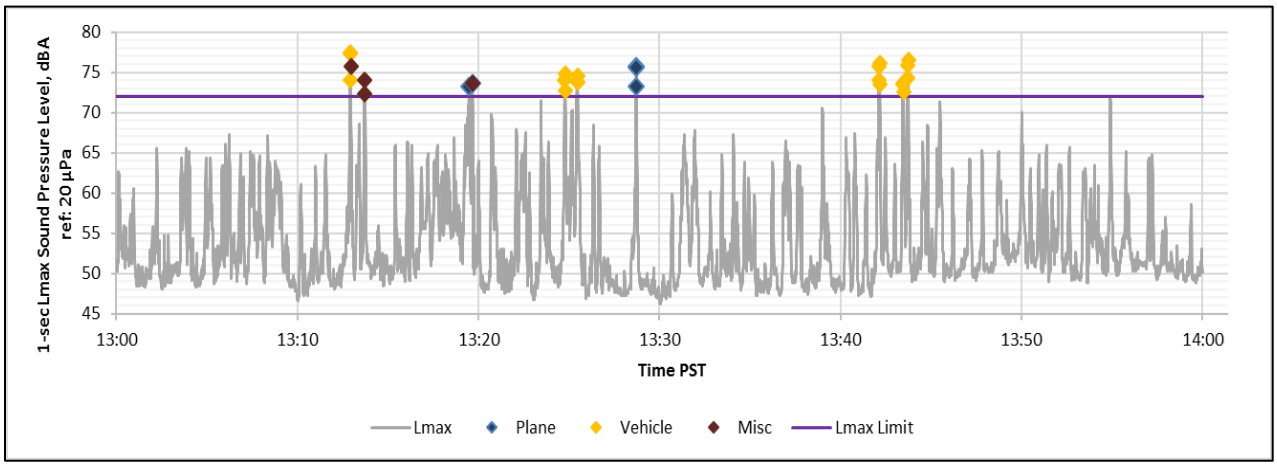


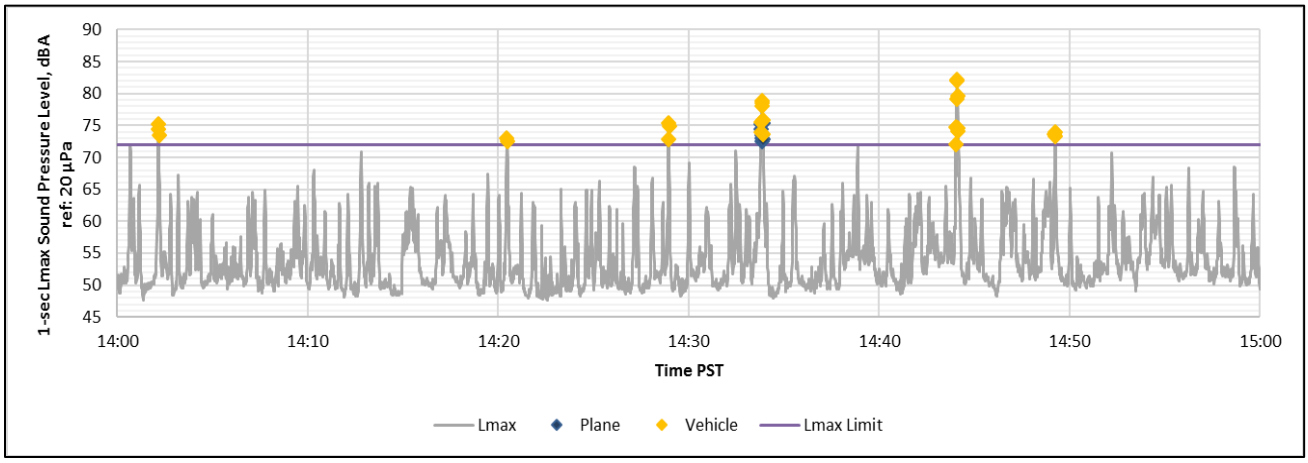



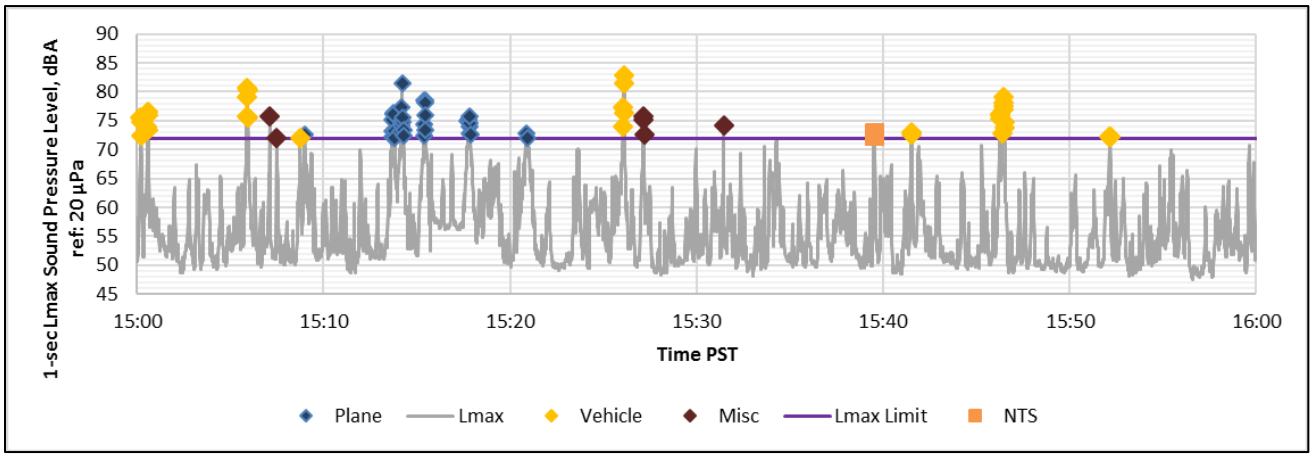



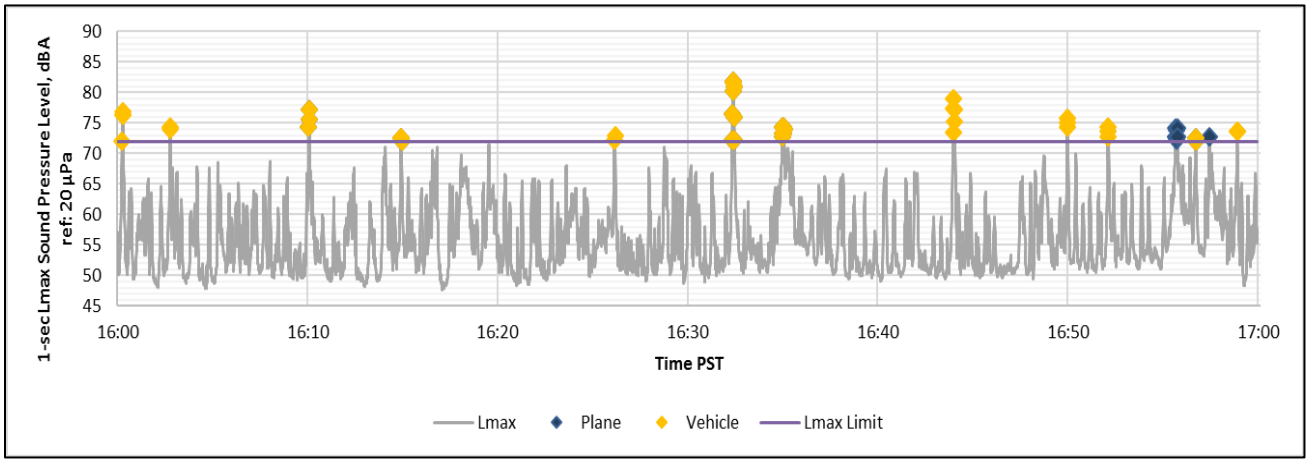

1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
11:00
11:10
11:20
11:30
11:40
11:50
12:00
Time PST
Lmax
Plane
Vehicle
Pedestrian
Lmax Limit

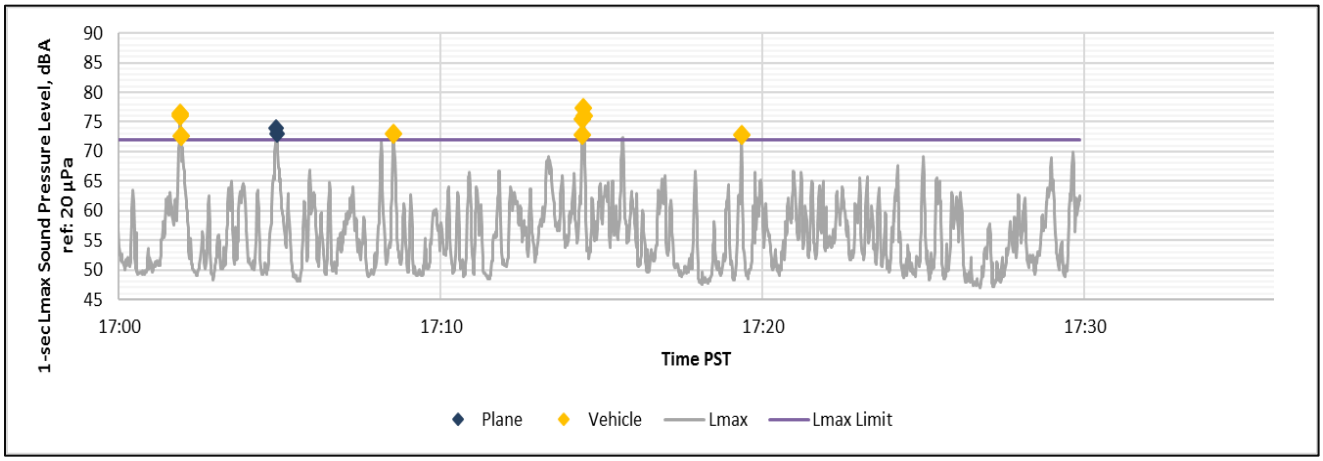

1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
12:00
12:10
12:20
12:30
12:40
12:50
13:00
Time PST
Lmax
Plane
Vehicle
Pedestrain
Misc
Lmax Limit


1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
80
75
70
65
60
55
50
45
13:00
13:10
13:20
13:30
13:40
13:50
14:00
Time PST
Lmax
Plane
Vehicle
Misc
Lmax Limit

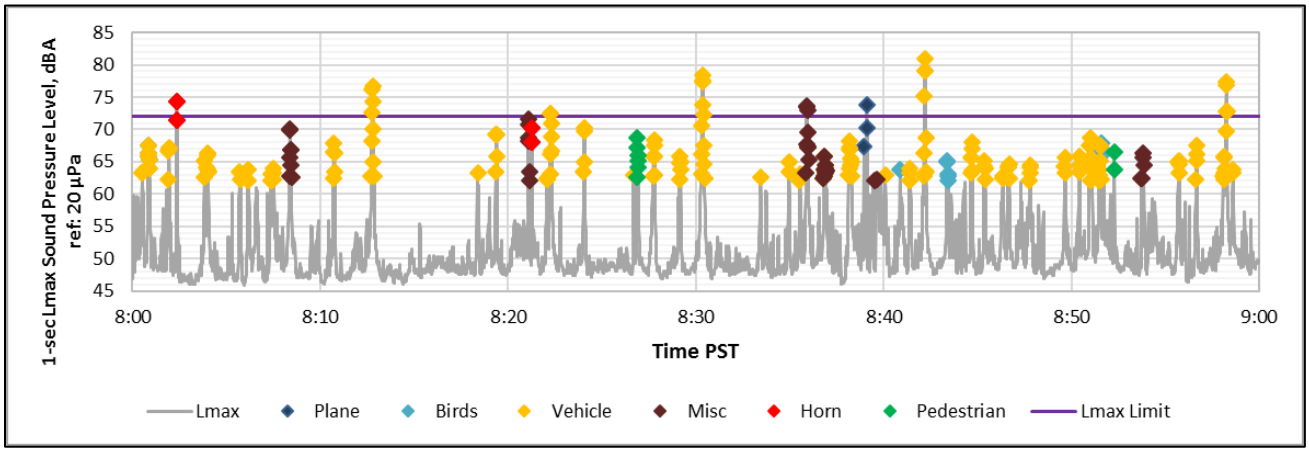

1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
14:00
14:10
14:20
14:30
14:40
14:50
15:00
Time PST
Lmax
Plane
Vehicle
Lmax Limit


1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
15:00
15:10
15:20
15:30
15:40
15:50
16:00
Time PST
Plane
Lmax
Vehicle
Misc
Lmax Limit
NTS

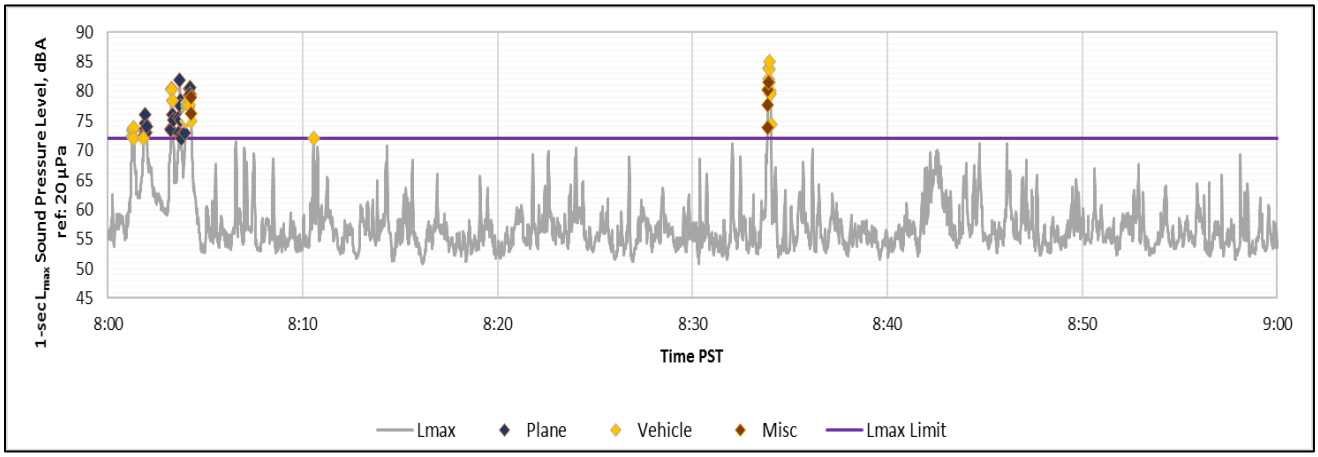

1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
16:00
16:10
16:20
16:30
16:40
16:50
17:00
Time PST
Lmax
Plane
Vehicle
Lmax Limit

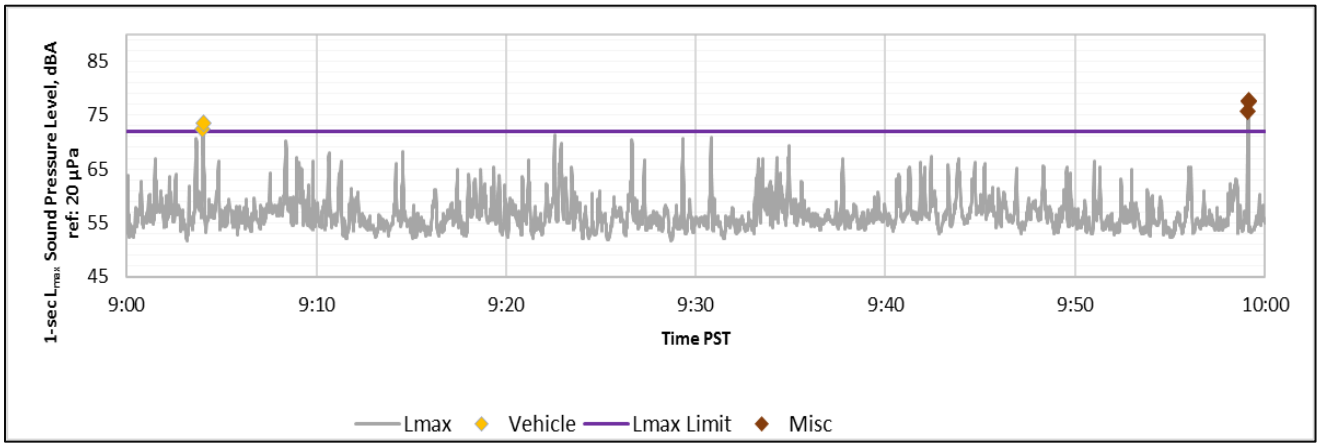


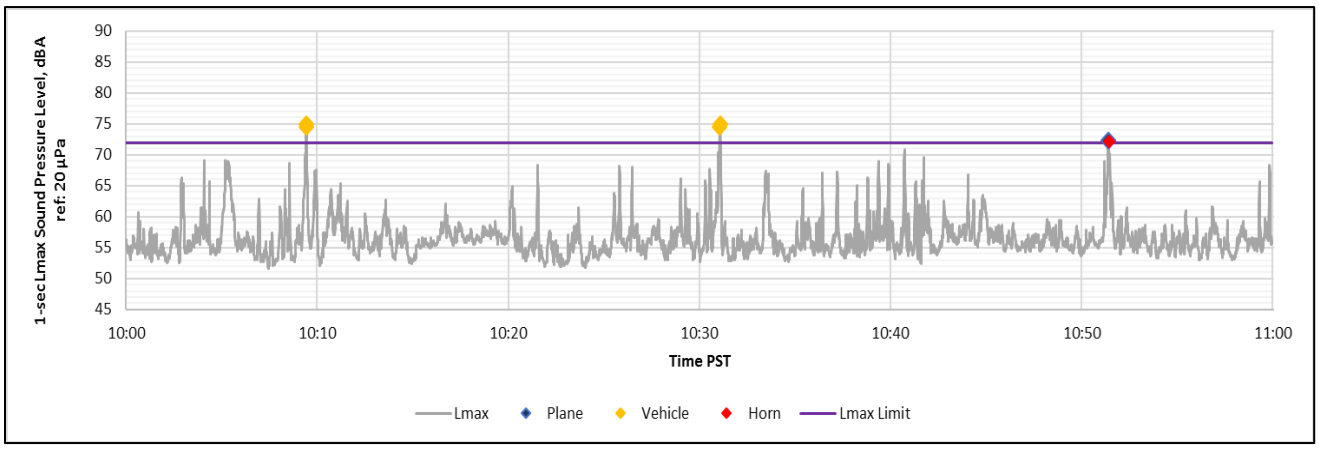

## Location 1 – October 6, 2018, $L_{max}$ Sound Levels

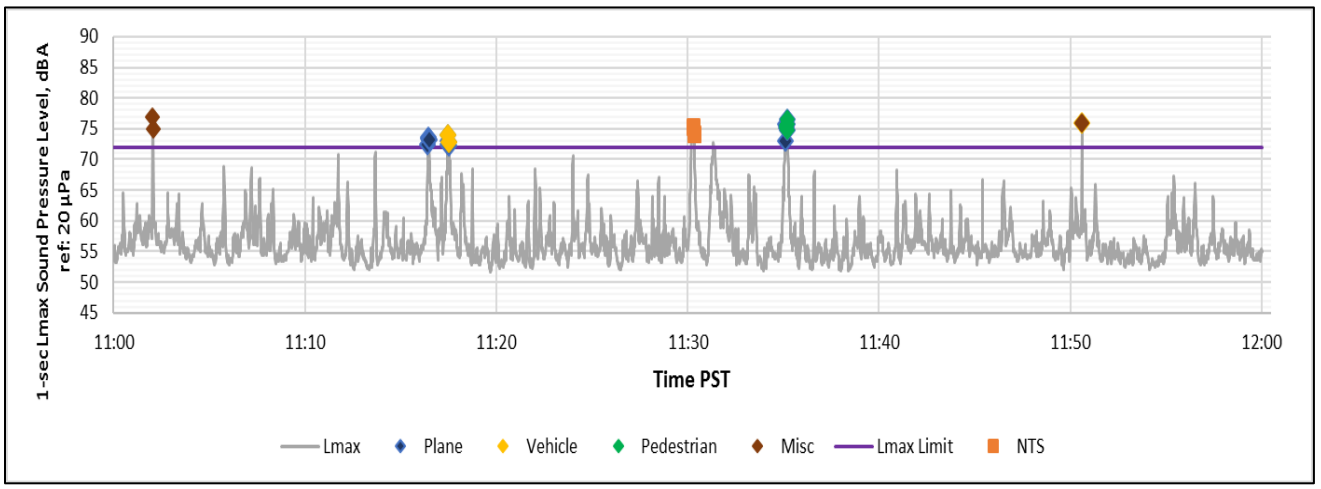


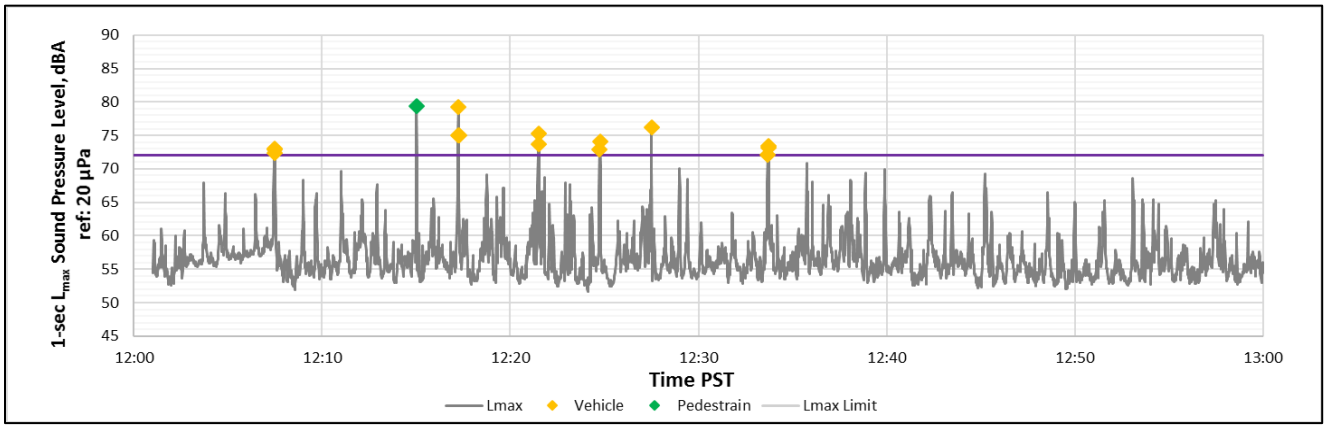

## Location 2 – September 26, 2018, $L_{max}$ Sound Levels

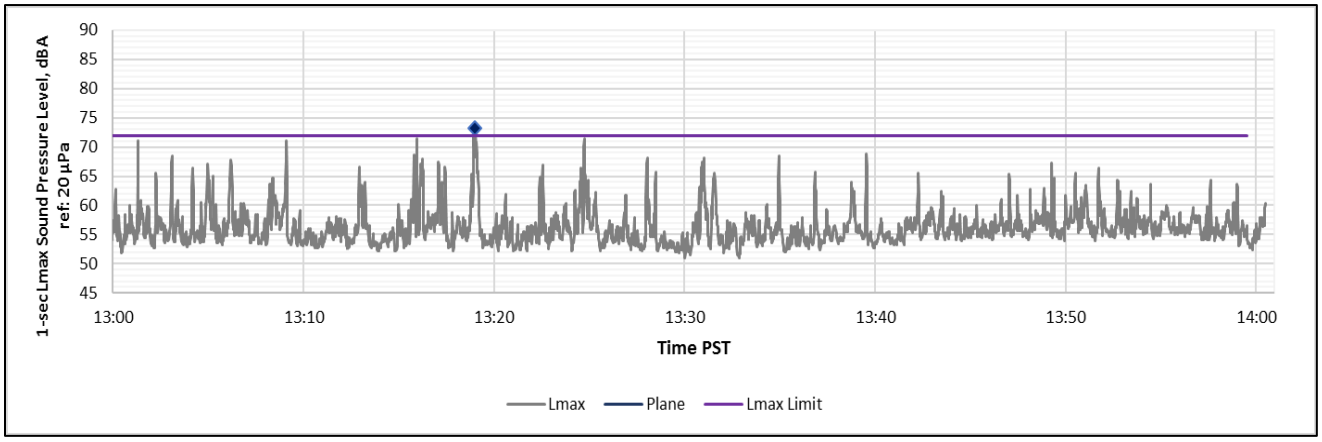


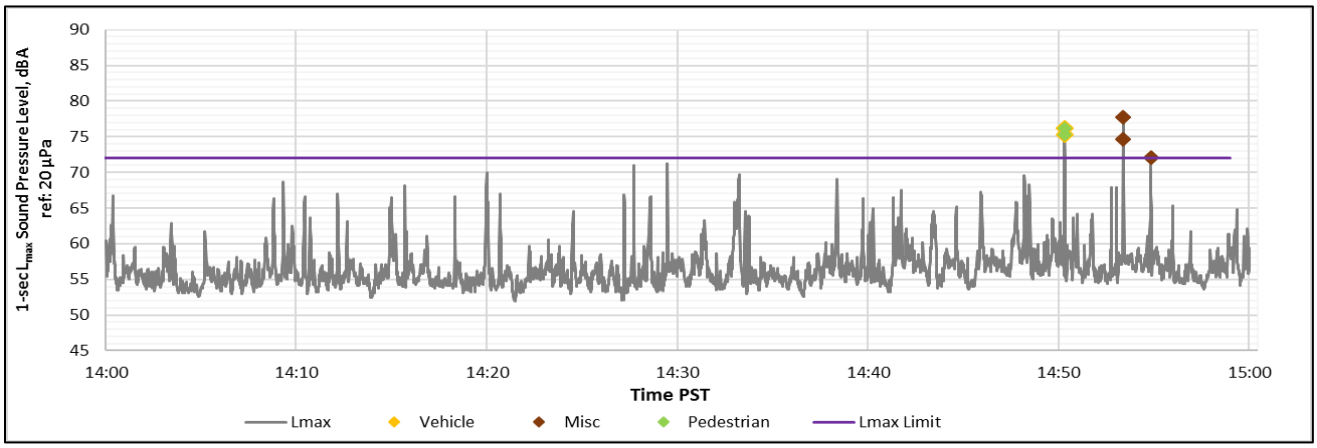

1-sec $L_{max}$ Sound Pressure Level, dBA ref: 20 µPa
85
75
65
55
45
9:00
9:10
9:20
9:30
9:40
9:50
10:00
Time PST
Lmax
Vehicle
Lmax Limit
Misc

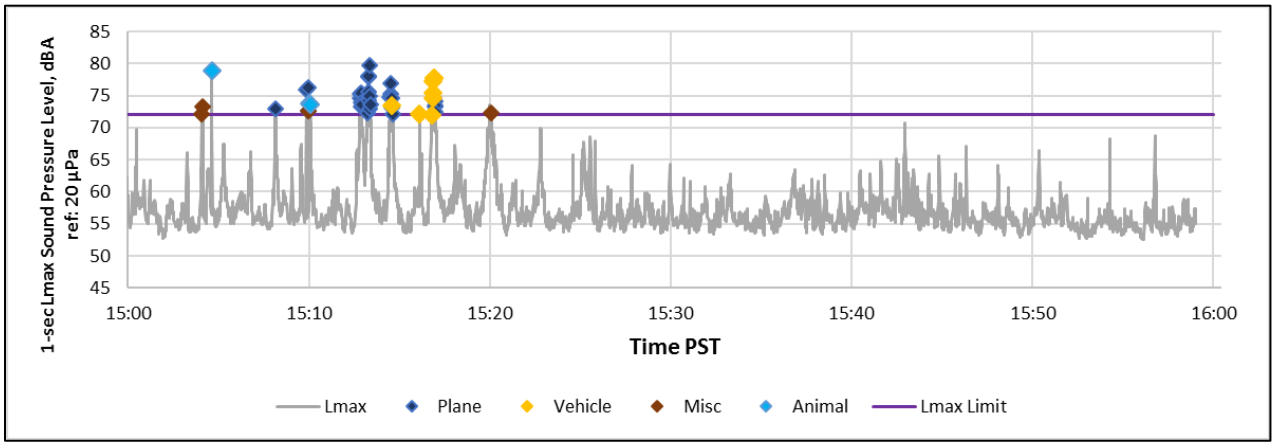

1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
10:00
10:10
10:20
10:30
10:40
10:50
11:00
Time PST
Lmax
Plane
Vehicle
Horn
Lmax Limit

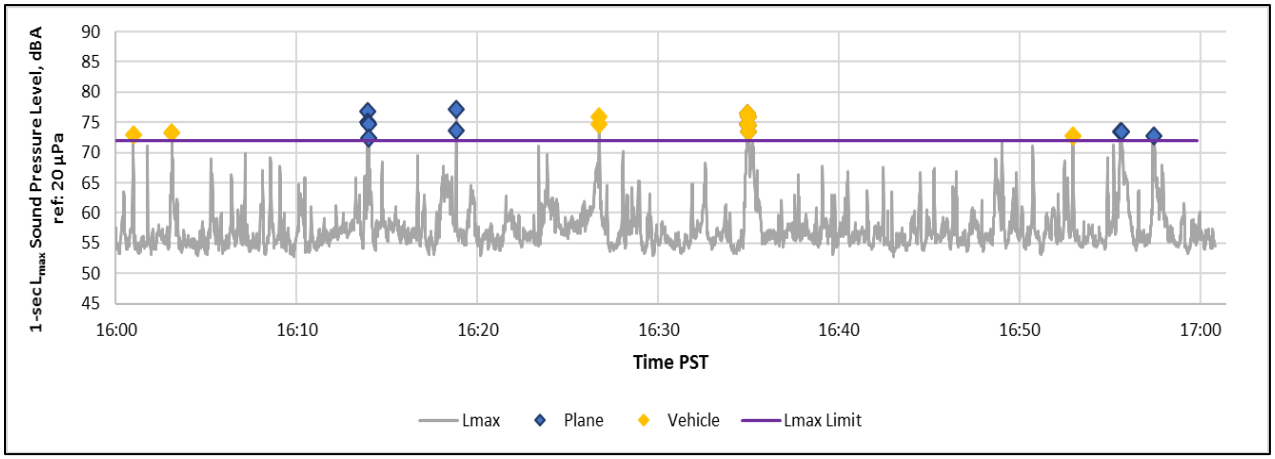

1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
11:00
11:10
11:20
11:30
11:40
11:50
12:00
Time PST
Lmax
Plane
Vehicle
Pedestrian
Misc
Lmax Limit
NTS

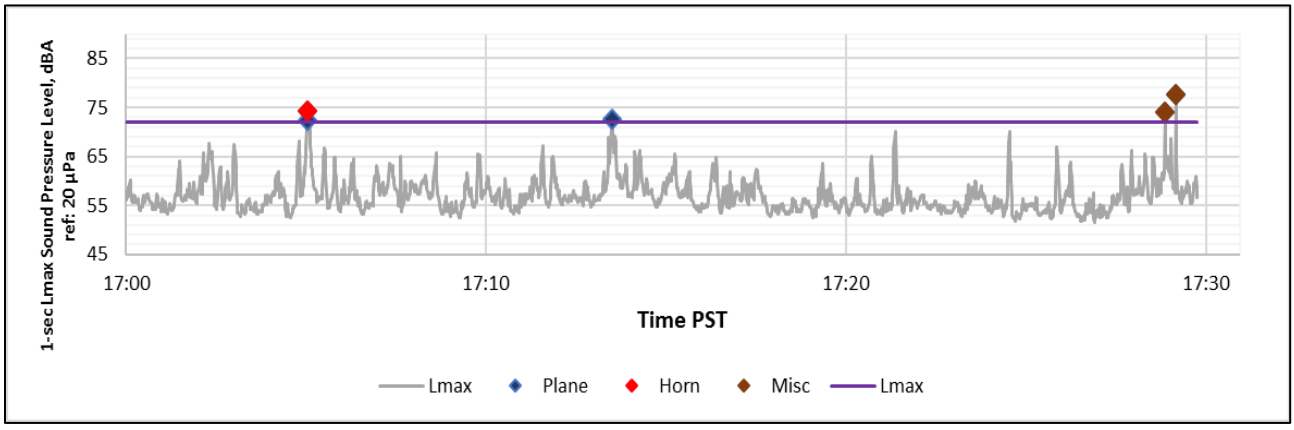

1-sec $L_{max}$ Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
12:00
12:10
12:20
12:30
12:40
12:50
13:00
Time PST
Lmax
Vehicle
Pedestrain
Lmax Limit


1-sec Lmax Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
13:00
13:10
13:20
13:30
13:40
13:50
14:00
Time PST
Lmax
Plane
Lmax Limit


1-sec $L_{max}$ Sound Pressure Level, dBA ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
14:00
14:10
14:20
14:30
14:40
14:50
15:00
Time PST
Lmax
Vehicle
Misc
Pedestrian
Lmax Limit


1-sec Lmax Sound Pressure Level, dBA
ref: 20 µPa
85
80
75
70
65
60
55
50
45
15:00
15:10
15:20
15:30
15:40
15:50
16:00
Time PST
Lmax
Plane
Vehicle
Misc
Animal
Lmax Limit


1-sec Lmax Sound Pressure Level, dBA
ref: 20 µPa
90
85
80
75
70
65
60
55
50
45
16:00
16:10
16:20
16:30
16:40
16:50
17:00
Time PST
Lmax
Plane
Vehicle
Lmax Limit


1-sec Lmax Sound Pressure Level, dBA
ref: 20 µPa
85
75
65
55
45
17:00
17:10
17:20
17:30
Time PST
Lmax
Plane
Horn
Misc
Lmax

## Location 2 – September 29, 2018, $L_{max}$ Sound Levels