Saint Paul Downtown Airport (STP)
Annual Sound Study Report

October 2021

Community Relations Office

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1.0 Introduction

The Metropolitan Airports Commission (MAC) completed the 2021 STP Annual Sound Study in support of the St. Paul Downtown Airport Advisory Council (DAAC) 2021 Work Plan and supplemental conditions of the flood wall erected in 2009. The study involved two industry standard methods for assessing aircraft sound: field-measurement analysis and modeled data. The results of this study are intended to enhance communication about sounds associated with St. Paul Downtown Airport (STP) aircraft activity.

Field sound measurements were conducted by MAC Community Relations staff using used certified equipment and best practices to measure and collect sound data at each of the six field locations. The results of this study are intended to enhance communication about sounds associated with St. Paul Downtown Airport (STP) aircraft activity. As such, field measurements captured aircraft sound events and community sounds events at six locations surrounding STP during a seven-day period: August 17-23, 2021. Sound data that are not correlated attributed to aircraft arriving to or departing from STP are included in this study as community sound events.

Sound level modeling for STP flight activity was performed using the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) modeling software to provide expanded sound data coverage as a tool to inform the DAAC and airport stakeholders about aircraft activity and corresponding sound levels for the same seven-day study period.

The sections below describe the STP runway use, aircraft operations, weather, field-measured data collection process and analysis, AEDT modeling data and analysis, a comparison of measured data and modeled data, and a summary of aircraft noise complaints received during the study period.

2.0 Operations

STP is a general aviation, public use airport owned and operated by the MAC. The airport is a primary reliever airport for Minneapolis-St. Paul International Airport (MSP) and accommodates personal use and recreational aircraft, business general aviation and air taxi aircraft, flight training and military aircraft. The aircraft operating at the airport currently include single and multi-engine propeller-driven aircraft, corporate jet aircraft, and helicopters.

The airport is open for aircraft operations 24 hours per day; however, FAA Air Traffic Controllers (ATC) are on site to help direct aircraft operations during the busiest operational periods. ATC directed aircraft into and out of STP between 6:00 AM and 10:00 PM, Monday through Friday and between 7:00 AM and 10:00 PM on Saturday and Sunday during the study period. There are three runways available for use at STP: Runway 14/32, Runway 13/31, and Runway 9/27. Helicopters may land and depart from areas other than a runway.

According to FAA aircraft operations counts for STP during August, the three-year average prior to 2021 shows 3,579 monthly operations, with 895 flights using the airport during an average week when the Air Traffic Control Tower is staffed. The three-year average is impacted by reduced operational levels at STP

in 2020 as a result of the impacts of COVID-19. Operational levels were only 50 percent of typical levels that historically occur in August at the airport in 2020. In August 2021, the FAA reported a total of 4,137 STP flight operations, with1,009 operations occurring during the study period. Flight training at STP generates multiple operations during a single flight as pilots practice their takeoffs and landing (called touch and go operations) for proficiency. It is normal and expected that the airport will be busier in the summer with increased flight training and recreational flying. The STP Sound Study is performed during this time of year to capture as much aircraft activity data as possible.

The MAC Noise and Operations Monitoring System (MACNOMS) collects flight tracking data and reports operations data. Until recently, MACNOMS counted an operation only when a flight began or ended, or arrived at the airport, or when the flight began, or departed the airport. This means that a single training flight that practiced numerous consecutive takeoffs and landings would only be counted for its initial takeoff and its final landing. Beginning on July 1, 2021, the MACNOMS methodology for counting operations was updated to more accurately reflect total aircraft departures or arrivals at MAC airports. The updated methodology were used for 2021 operations counts, while the historical data reflect the prior methodology.

During the study period, MACNOMS data show 834 total operations at STP with 414 arrivals and 420 departures. Table 2.1 shows the number of operations on each STP runway per day. The highest levels of STP runway use occurred on Runway 14 with 358 arrivals and 361 departures.

Table 2.1: STP Aircraft Activity per Runway each Day during the Study Period

Runway	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	**Runway Total**
STP Arrivals								
9	-	-	-	-	6	-	-	6
13	-	-	-	-	-	-	2	2
14	85	80	62	44	2	43	42	358
27	-	-	-	-	2	-	-	2
31	-	-	-	-	-	-	-	0
32	-	-	-	-	26	2	16	44
STP Departures								
9	-	-	-	-	-	1	-	1
13	2	1	-	-	-	1	3	7
14	84	77	64	51	-	45	40	361
27	-	-	-	-	1	-	1	2
31	-	-	-	-	2	-	-	2
32	2	2	1	-	24	1	17	47
Daily Total	**173**	**161**	**127**	**95**	**63**	**93**	**122**	**834**

Runway 14/32 was used for 97 percent of the activity during the study period, Runway 13/31 was used 1 percent and Runway 9/27 was used 1 percent. Figure 2.1 shows the STP flight tracks for daytime operations.

There were 52 flights that operated between the hours of 10:00 P.M. and 7:00 A.M.; 25 of those flights were arrivals and 27 were departures. Figures 2.2 depicts STP nighttime activity during the study period.

Weather during the study week was desirable for flying with typical mid-summer wind and temperature patterns, and very little precipitation occurred. Weather conditions (e.g.; temperature, precipitation,

wind, etc.) affect airport activity, runway use decisions and aircraft performance. In addition to operational factors, weather conditions can also affect the way sound is transmitted and observed. For these reasons, weather data are documented during the study period. A summary of daily weather conditions is provided in the Appendix.

Figure 2.1: STP Daytime (7:00 A.M to 10:00 P.M.) Operations During Study Period

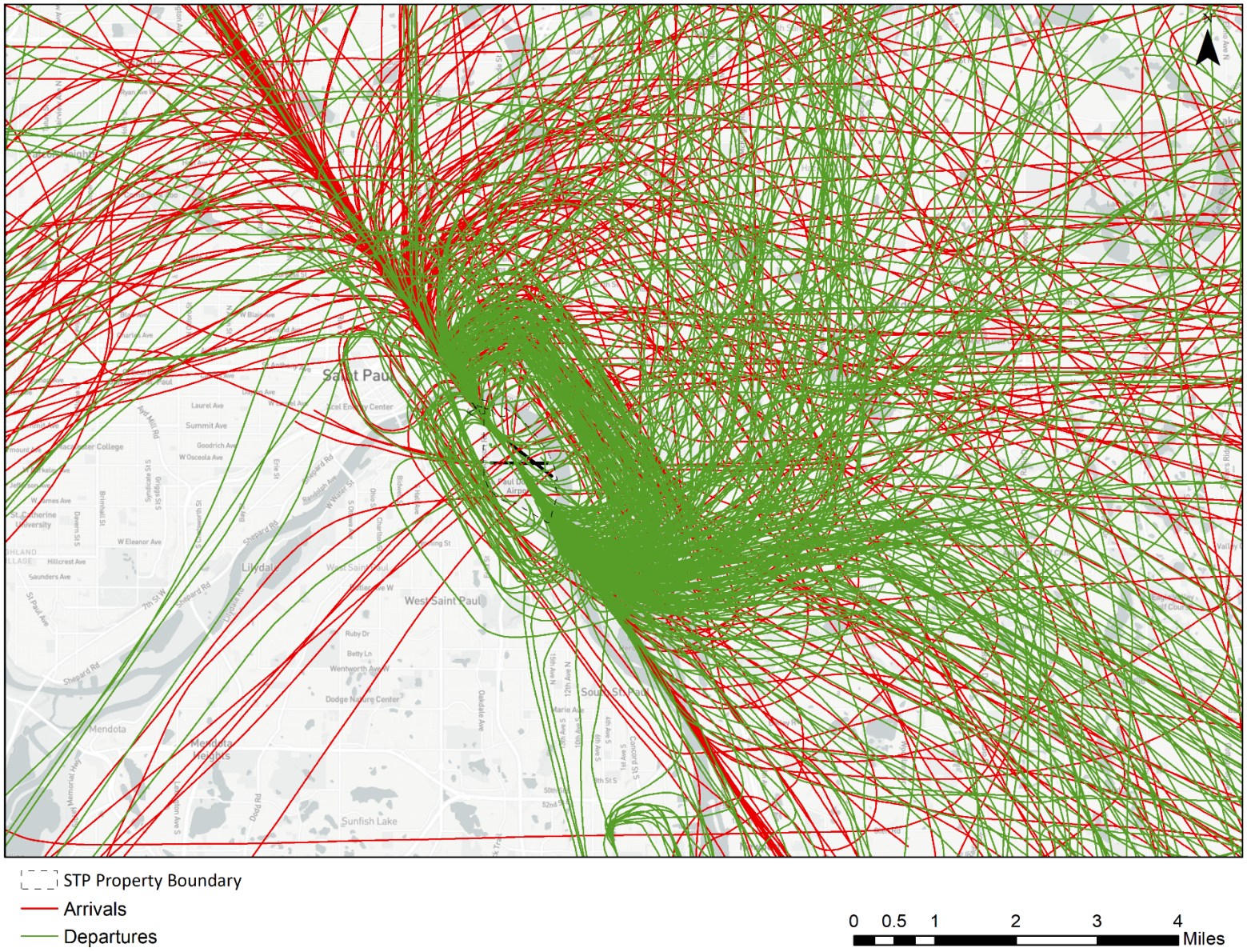
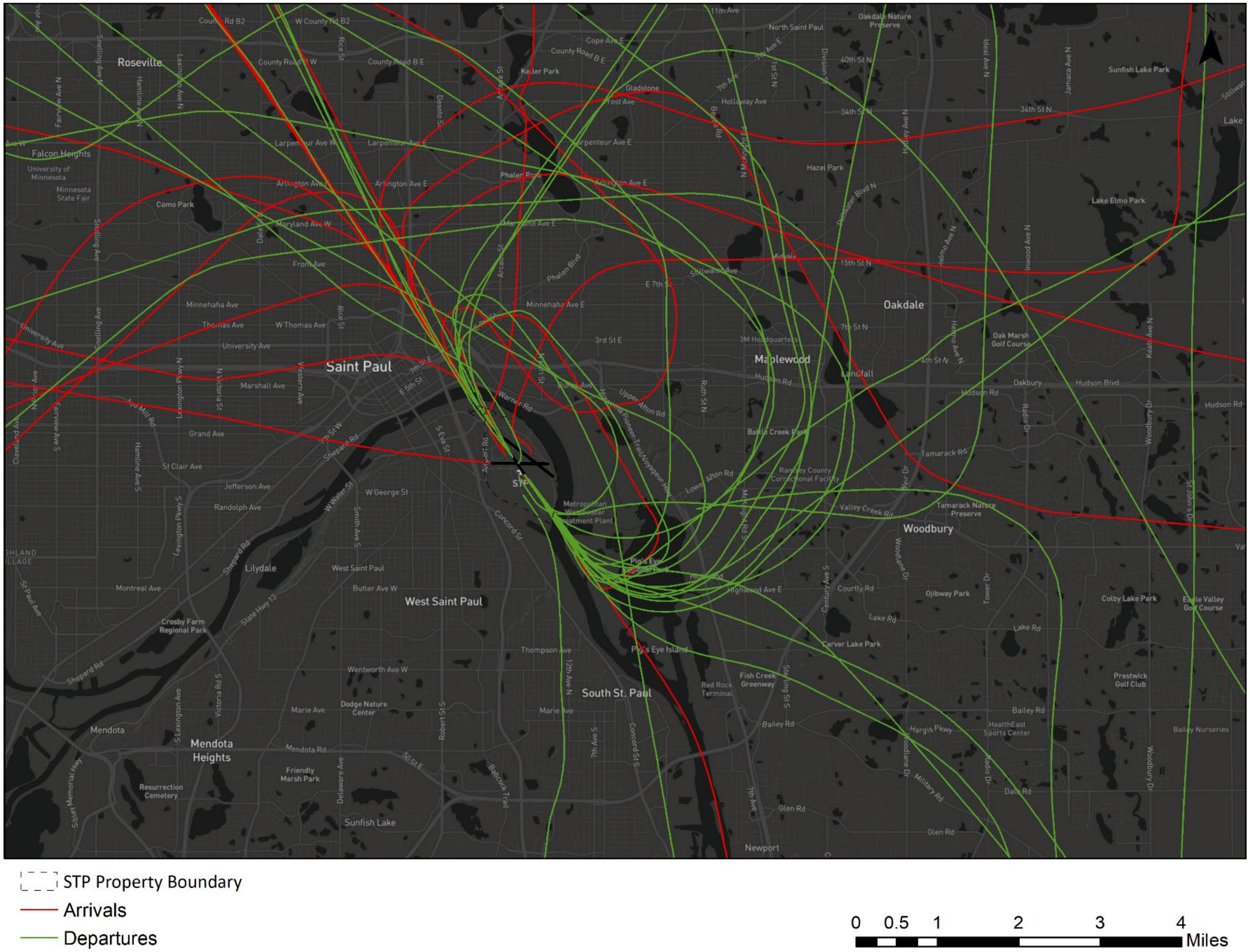


Figure 2.2: STP Nighttime (10:00 PM to 7:00 AM) Operations During Study Period



3.0 Field-Measured Sound Data

An STP Annual Sound Study, assessing field-measured sound data, has been conducted since 2007. The MAC has completed the annual study in accordance with Supplemental Conditions of Agreement (MAC action taken on June 19, 2006) related to the flood protection project at STP. A core element of the flood protection plan was the construction of the flood wall at STP in 2009 to mitigate flood events that historically have required the airport close. A copy of the Supplemental Conditions is provided in the Appendix.

Since 2007, six field measurement sites have been positioned in coordination with DAAC District Council memberships, and consistent with MAC Mobile Sound Monitoring Guidelines. These guidelines, and a map of all Saint Paul Districts are provided in the Appendix.

Field measurement sites are positioned in the same or similar locations each year as much as possible to assist with comparing results. In 2021, all six sites were positioned in the same locations as the 2020 study.

The dates of this study period are August 17-23, 2021. This time frame was coordinated with the DAAC during its meeting on April 20, 2021. Figure 3.1 shows a map of the field measurement equipment locations, and Figure 3.2 shows a picture of each field measurement site.

Figure 3.1: Field Measurement Equipment Locations

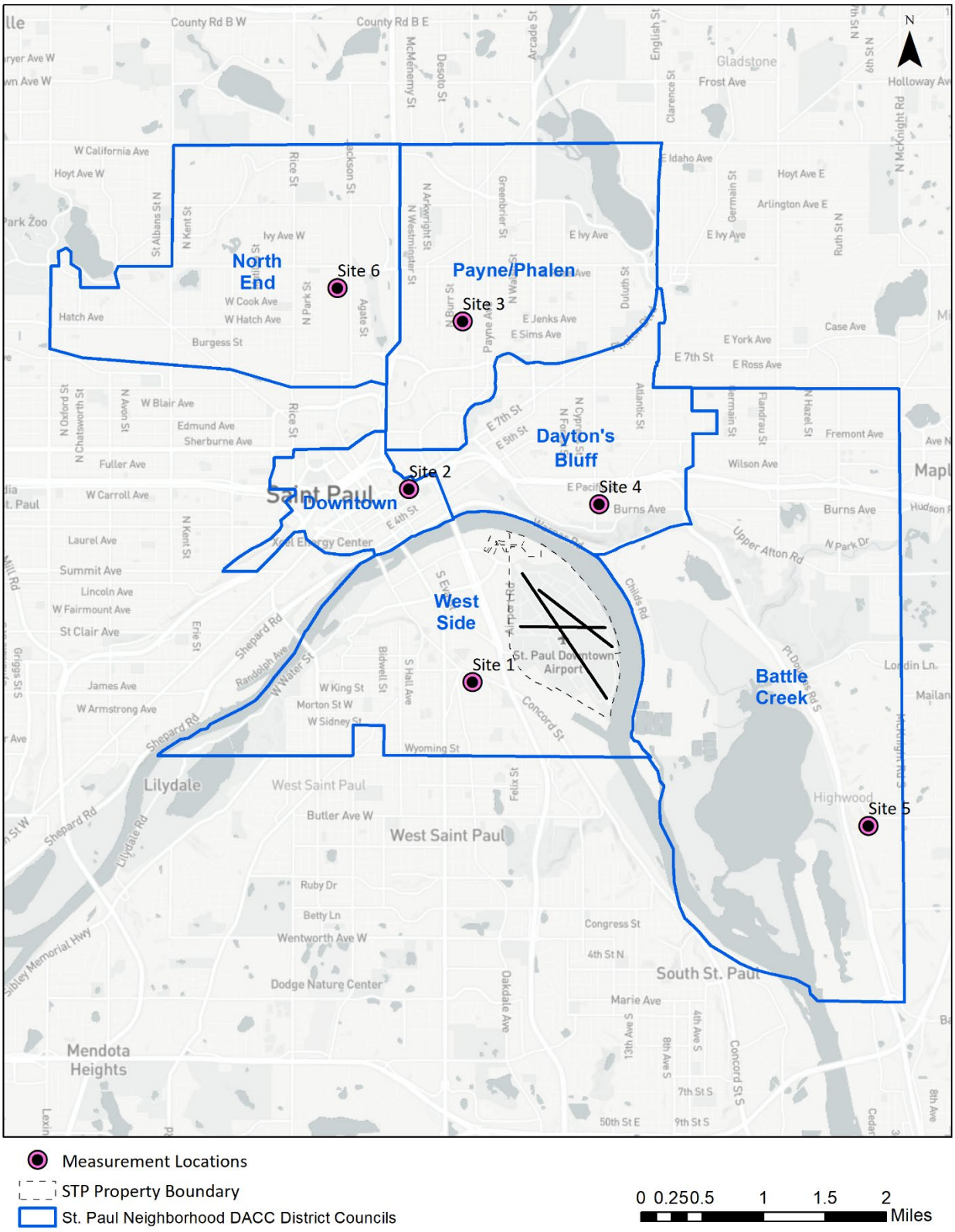
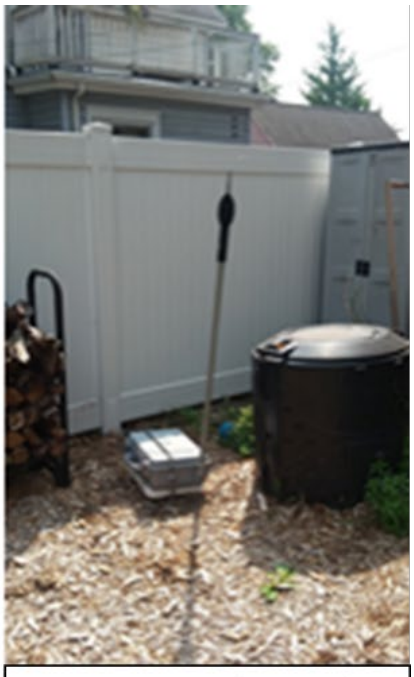


Figure 3.2: Field-Measurement Site Photos

Site 1 – District 3 (Mt. Hope Drive)

Site 2 – District 17 (Allen Building)



Site 3 – District 5 (Jenks Ave)

Site 4 – District 4 (Suburban Ave)

Site 5 – District 1 (Skyway Drive)

Site 6 – District 6 (Abell Drive)

3.2 Field Measurement Analysis and Parameters

One sound analyzer collected data at each of the field-measurement sites. Each site operated continuously measuring sound levels utilizing a slow response with A-weighting (dBA), as federally-prescribed by standards for collecting aircraft sounds in the FAA's 14 CFR Part 150. Sound events are identified and documented when the sound level exceeds 65 dBA for four seconds or longer. The parameters used by the sound monitoring instrumentation measure both community and aircraft sounds. The equipment and tolerances are set to be sensitive so that aircraft do not have to fly directly over the measurement site to be recorded.

In this study, sound events from aircraft and community sound sources were detected. Sound events were correlated with STP flight track data, collected by MACNOMS, using temporal and spatial parameters (time and distance). All uncorrelated sound events are referred to in this report as community events.

3.3 Field Measurement Results

There were 226 aircraft sound events and 1,220 community sound events measured at the six sites during the seven-day study period. This section summarizes information for both aircraft and community sound sources described in terms of sound event metrics (LA_{max}, SEL, Event Duration) and summary-based metrics (DNL, ADNL, CDNL and LA_{90}).

Single Sound Events Metrics

Table 3.1 shows the daily number of single aircraft sound events aircraft sounds that exceeded 65 dBA for four seconds. The largest number of aircraft sound events captured during the study period on a daily basis occurred on Tuesday, August 17 and Wednesday, August 18 with 46 events each day. The smallest number of aircraft sound events measured during the study period occurred on Saturday, August 21 with 17 events.

Table 3.1 also shows a total number of sound events captures for each site. Site 1 measured no aircraft sound events. The equipment was checked and determined to be operating properly. Site 6 measured the most aircraft sound events during the study period with 111 events. The second-highest number of aircraft sound events was 48 events at Site 5. Both sites measured aircraft using Runway 14/32, which is the most-heavily used runway during the study period. More detail about runway use was provided in Section 2.0.

Table 3.1: Number of Measured STP Aircraft Sound Events per Day

	Tue. August 17	Wed. August 18	Thur. August 19	Fri. August 20	Sat. August 21	Sun. August 22	Mon. August 23	Site Total
Site 1	-	-	-	-	-	-	-	0
Site 2	5	1	4	4	6	1	1	22
Site 3	9	4	4	4	5	2	6	34
Site 4	3	1	1	1	2	2	1	11
Site 5	3	12	5	4	2	8	14	48
Site 6	26	28	17	10	2	13	15	111
Daily Total	46	46	31	23	17	26	37	226

Figure 3.3 shows the number of aircraft sound events that were measured each hour during the study period. The highest number of aircraft sounds were captured during the 1:00 P.M., 2:00 P.M. and 3:00 P.M. hours with 24, 22, and 21 measured aircraft sound events, respectively. Site 6 measured the highest number of aircraft sound events during a one-hour period with 14 events. There were 27 aircraft sound events measured during the nighttime hours of 10:00 P.M. – 7:00 A.M.

Figure 3.3: Number of STP Aircraft Sound Events Above 65 dBA per Hour by Site

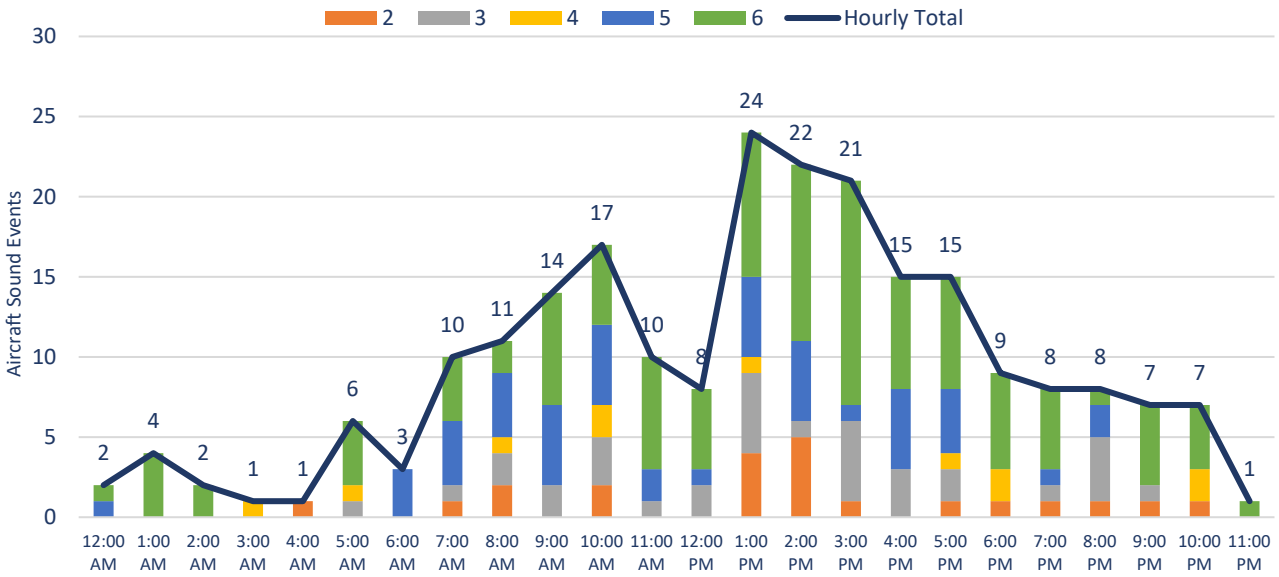


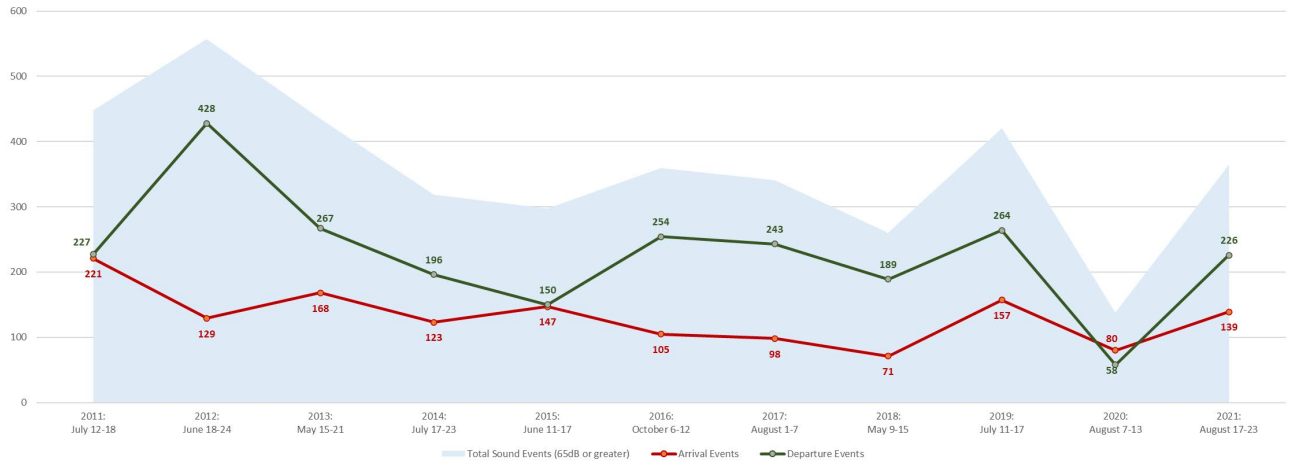
Table 3.2, below, shows the number of measured aircraft arrival and departure sound events with LA_{max} levels at or above 65 dBA, 80 dBA, 90 dBA, and 100 dBA at each site. A total of 226 aircraft sound events were measured at or above 65 dBA. Of those, one event was at or above 80 dBA and none were at or above 90 dBA. The loudest sound event was 81.3 dB generated by a Beech 36 Bonanza (BE36) arriving on STP Runway 14.

The highest number of arrival sound events was 105, measured at Site 6. The highest number of departure sound events was 45 measured at Site 5.

Sound events measured during each study period between 2011 and 2021 are shown in Figure 3.4. This is provided for historical reference. Trends should not be inferred due to variations in study parameters.

Table 3.2: Number of Measured STP Aircraft Sound Events by Level (LA_{max})				
Site	# of Events > 65dBA	# of Events > 80dBA	# of Events > 90dBA	# of Events > 100dBA
Aircraft Arrivals				
1	0	0	0	0
2	11	0	0	0
3	17	0	0	0
4	3	0	0	0
5	3	0	0	0
6	105	1	0	0
Arrival Total	**139**	**1**	**0**	**0**
Aircraft Departures				
1	0	0	0	0
2	11	0	0	0
3	17	0	0	0
4	8	0	0	0
5	45	0	0	0
6	6	0	0	0
Departure Total	**87**	**0**	**0**	**0**
Total Aircraft Events	**226**	**0**	**0**	**0**

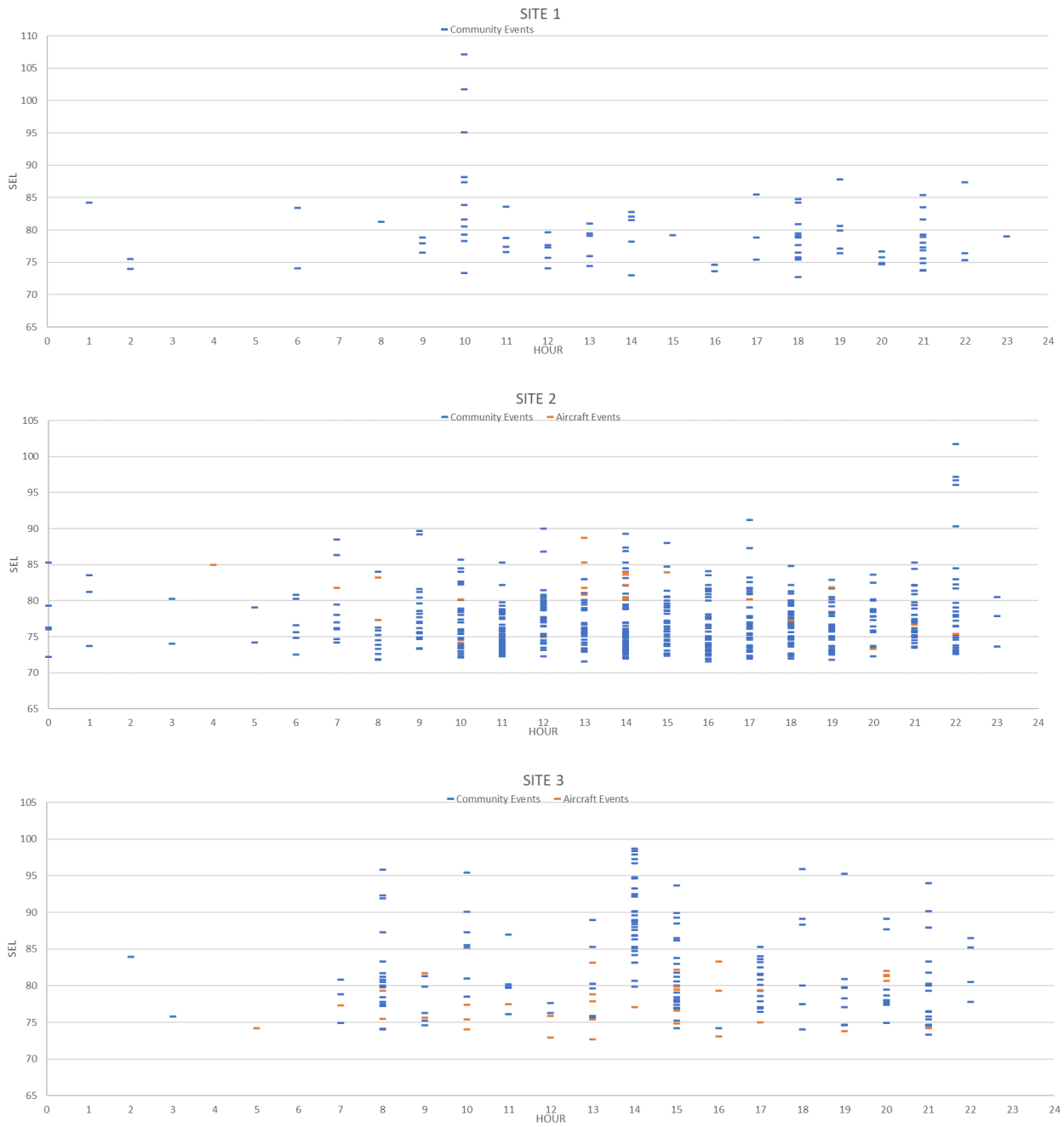
Figure 3.4 Sound Event Totals Measured during Study Periods in 2011 – 2021

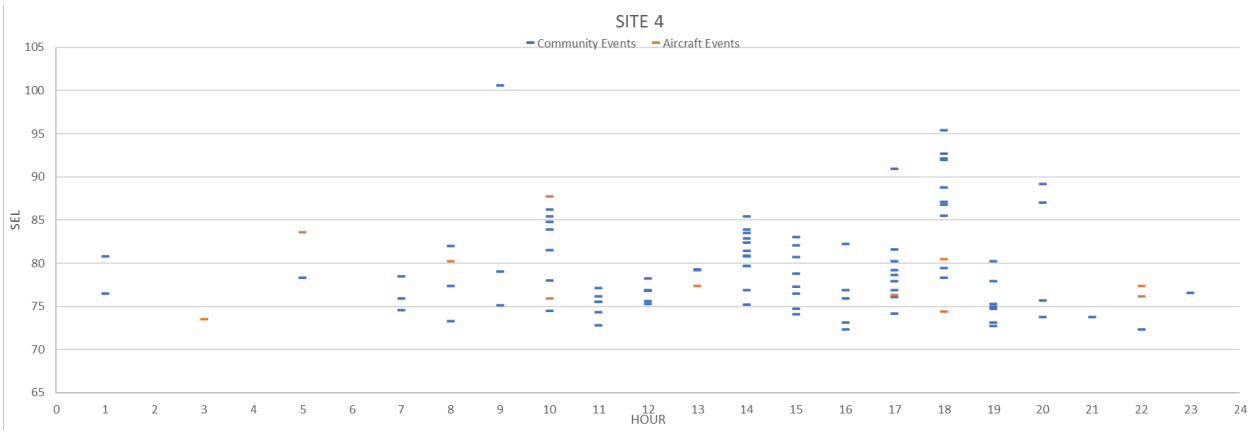


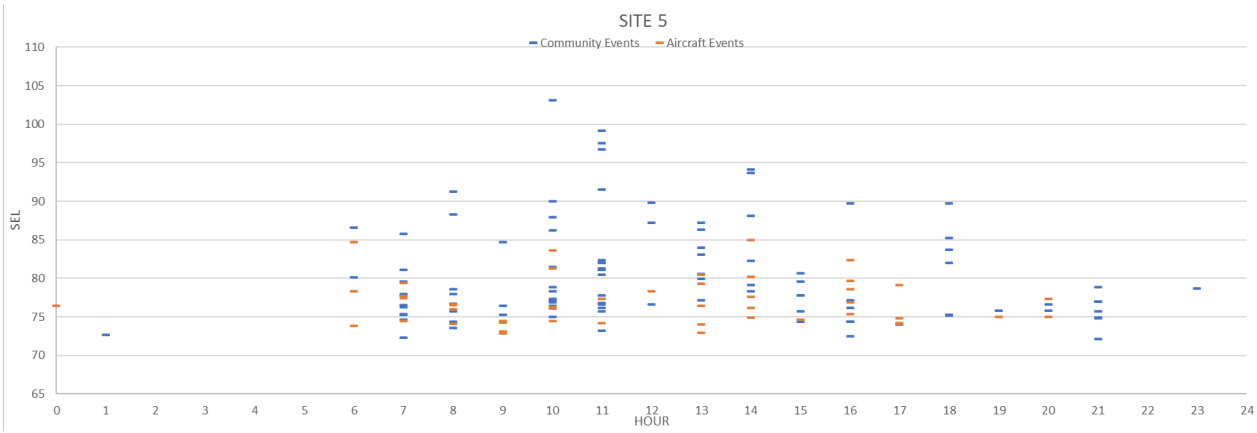
Sound events cannot be directly compared without normalization due to variations in sound levels and durations. The Sound Exposure Level (SEL) is a metric that provides a way to directly compare each event by expressing the sound energy of that event as a single second (1s) value, regardless of the actual event duration. The SEL and LA_{max} are not the same and in many cases and they rank differently.

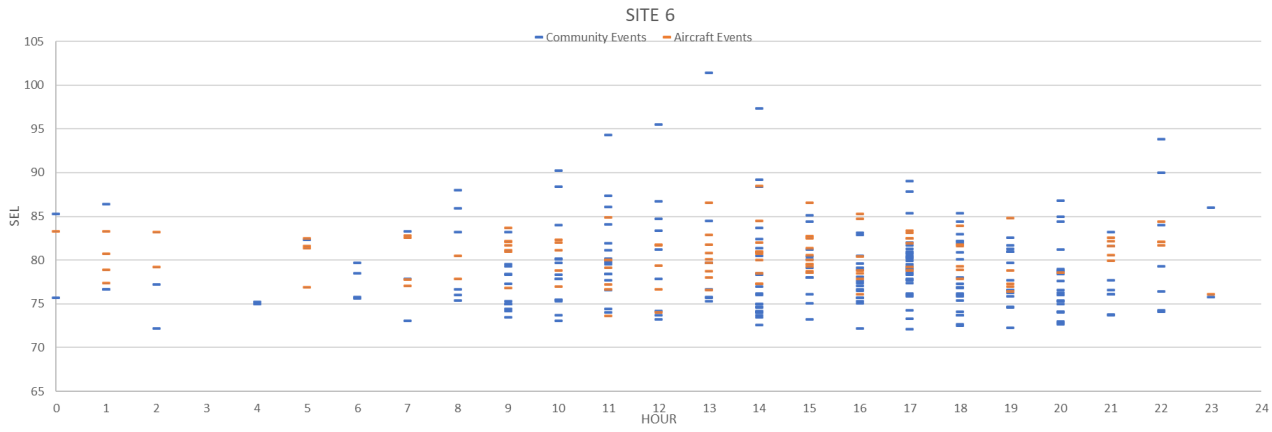
Figure 3.5 shows the measured hourly aircraft and community SEL events for each site.

Figure 3.5: Aircraft and Community Sound Events per Hour (SEL)









Sites 1 and 5 measured the highest SEL community events, and the highest SEL aircraft events occurred at Site 2 and Site 6. Table 3.3 shows the types of aircraft associated with highest LA_{max} and SEL at each site during the study period, ranked by LA_{max}.

The aircraft sound event with the longest duration was measured at 34 seconds and occurred at Site 4 by an unknown aircraft type on August 17, 2021 at 10:59 A.M. with a LA_{max} at 77.3 dB and a SEL of 87.7.

The loudest aircraft sound event during the study period occurred at Site 6 with a Beech 360 Bonanza piston aircraft measuring a maximum level at 81.3 dBA on August 20 at 3:11 P.M. The SEL for this aircraft sound event measured at 86.6.

Table 3.3 Top-Ten Measured STP Aircraft Sound Events per Site

Site 1- District 3 (Mt. Hope Dr)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
--	--	--	--	--	--	--	--

Site 2- District 17 (Allen Building)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/22/2021 13:34	77.9	32	88.7	GLF4	CWG66	1	1
8/19/2021 13:09	77.3	23	85.3	UKN	Unknown	2	2
8/23/2021 15:26	75.5	20	83.9	GLF5	N19H	3	4
8/17/2021 4:50	75.2	23	85	EC45	N906SH	4	3
8/21/2021 13:53	74.6	18	81.8	CL30	DOW895	5	11
8/20/2021 14:06	74.6	29	83.9	UKN	Unknown	6	5
8/21/2021 7:59	74.4	14	81.8	H25B	RLJ523	7	10
8/19/2021 14:31	74	15	82.2	B429	N961BK	8	8
8/20/2021 8:57	73.7	20	83.2	UKN	Unknown	9	7
8/17/2021 17:54	72.9	11	80.2	C208	SWD8	10	15

Site 3- District 5 (Jenks Av)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/19/2021 9:25	75.5	9	81.7	F2TH	COL187	1	5
8/20/2021 20:11	75.3	9	81.5	CL35	LXJ589	2	6
8/18/2021 13:11	75	13	83.1	UKN	Unknown	3	2
8/23/2021 15:26	75	11	82.2	GLF5	N19H	4	3
8/17/2021 20:09	74.6	9	81.3	GLF5	N83M	5	7
8/17/2021 20:20	74.4	11	82	GLF5	N83M	6	4
8/23/2021 16:59	73.9	18	83.3	C560	N559SF	7	1
8/18/2021 17:17	73.7	7	79.4	C414	N1905B	8	11
8/17/2021 20:00	73.6	9	80.7	GLF5	N83M	9	8
8/23/2021 15:53	73.3	8	79.9	C56X	DOW885	10	9

Site 4- District 4 (Suburban Av)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/17/2021 10:59	77.3	34	87.7	UKN	Unknown	1	1
8/17/2021 5:22	75.4	14	83.6	EC45	N906SH	2	2
8/23/2021 18:48	73.9	10	80.5	PA32	N2899N	3	3
8/19/2021 13:32	72.6	6	77.4	UKN	Unknown	4	6
8/22/2021 8:53	72.1	12	80.2	B206	N555SJ	5	4
8/17/2021 22:49	71.1	6	76.2	PA28	N9594C	6	8
8/20/2021 10:44	70.1	6	75.9	PA28	N4325U	7	9
8/21/2021 17:48	69.8	7	76.3	F900	DOW890	8	7
8/21/2021 22:54	69.5	8	77.4	C172	N542TH	9	5
8/18/2021 18:49	68.4	5	74.4	PA44	NDU35T	10	10

Site 5- District 1 (Skyway Dr)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/22/2021 6:05	76.3	17	84.7	GLF6	N93M	1	2
8/20/2021 16:15	75.9	13	82.4	CL30	N971MC	2	4
8/22/2021 14:27	75.1	21	85	BE40	N731CM	3	1
8/22/2021 10:14	74.9	20	83.6	BE40	N598DR	4	3
8/21/2021 13:38	74	9	80.5	S22T	N55CQ	5	6
8/23/2021 7:59	73.4	7	79.4	BE20	N215HC	6	9
8/19/2021 10:57	72.7	12	81.3	C25C	N759R	7	5
8/18/2021 16:04	72.4	10	79.7	C525	N800CU	8	8
8/18/2021 17:09	72.3	9	79.1	CL30	N2428	9	11
8/23/2021 6:27	72	8	78.3	GLF5	N83M	10	14

Site 6- District 6 (Abell Dr)							
Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/20/2021 15:11	81.3	12	86.6	BE36	N16MN	1	3
8/20/2021 14:38	79.8	17	88.5	UKN		2	1
8/18/2021 13:24	78.6	17	86.6	C525	N8341C	3	2
8/17/2021 16:24	78.3	10	85.3	G150	N581SF	4	4
8/20/2021 22:09	77.8	11	84.4	F2TH	N132M	5	9
8/22/2021 11:21	77.6	16	84.9	PC12	N505P	6	5
8/21/2021 22:09	77.4	8	82.1	BE9L	N46CV	7	33
8/18/2021 16:57	77.3	10	84.7	GA5C	N575GD	8	7
8/22/2021 9:28	76.9	11	83.7	BE40	DPJ460	9	11
8/17/2021 17:45	76.6	10	83.1	C56X	N524BB	10	16

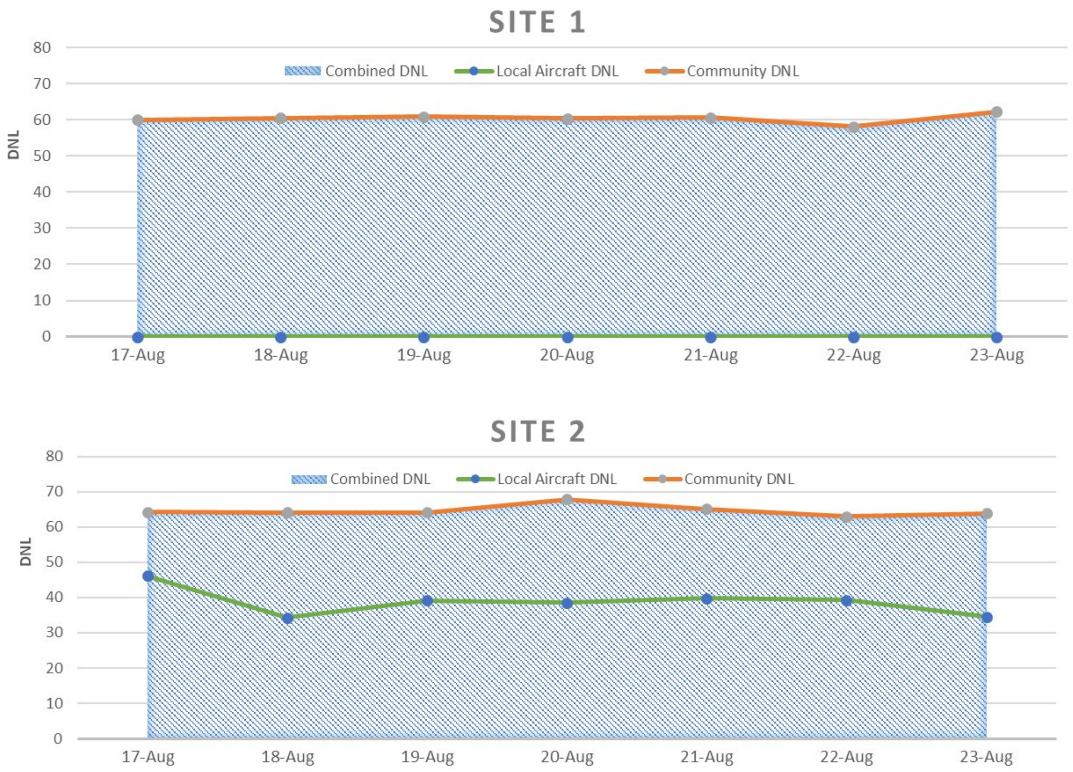
Summary Based Metrics

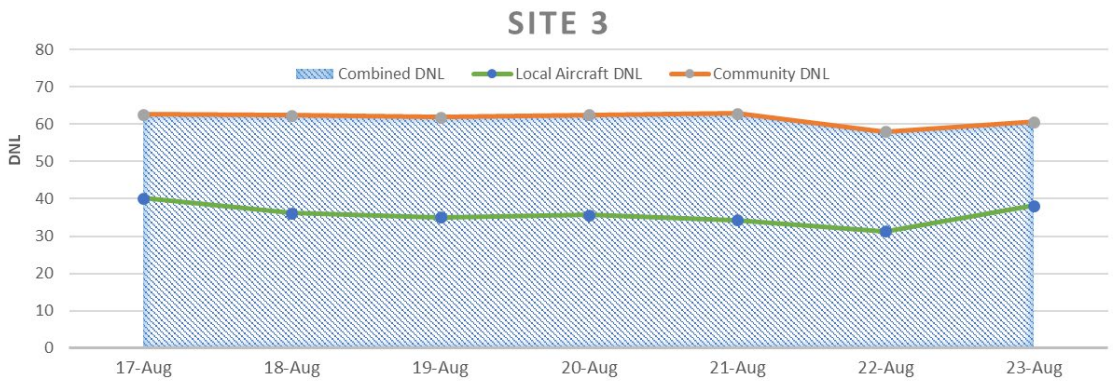
The Day-Night Average sound level (DNL) is an acoustic, summary-based metric that represents the total accumulation of all sound energy during a 24-hour day, including a 10 dB penalty applied to all sounds between 10:00 P.M. and 7:00 A.M. The FAA prescribes the use of DNL to establish a federal aviation threshold of significance of 65 dB DNL. DNL at or above 65 dB are considered incompatible for sensitive land uses such as residences and schools. The MAC distinguishes between aircraft and community using Aircraft DNL (ADNL) and Community DNL (CDNL) respectively.

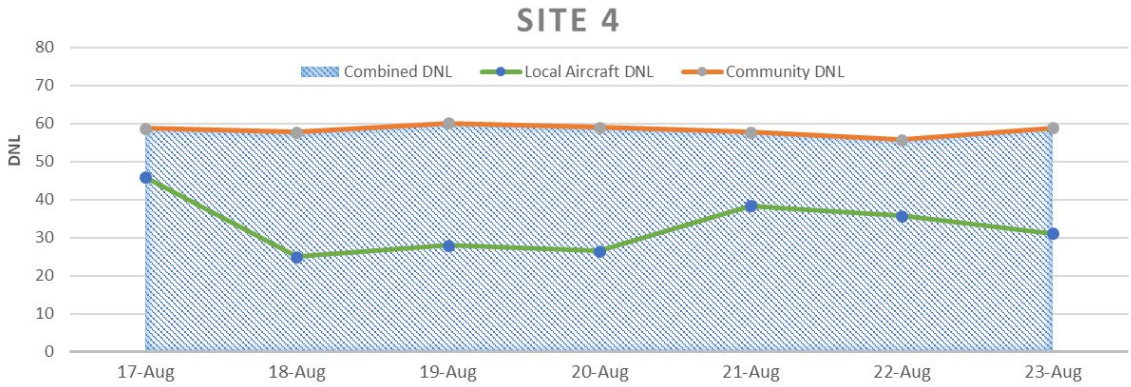
Figure 3.6 shows the ADNL and CDNL accumulations during the study period for each site. The highest ADNL occurred at Site 6 with 48.9 dB DNL on August 22, which is below the federal threshold of significance. The CDNL at Site 2 on the same date was 58.1 dB DNL and the combined DNL was 58.6 dB DNL.

The highest combined DNL was 67.9 dB DNL, which occurred at Site 2 on August 20. The CDNL of 67.9 and the ADNL of 38.5 dB DNL on this date are contributing to this high level combined DNL. More detail about the field-measured DNL can be found in the Appendix.

Figure 3.6: Aircraft and Community DNL Accumulations




SITE 3
Combined DNL
Local Aircraft DNL
Community DNL
DNL
80
70
60
50
40
30
20
10
0
17-Aug
18-Aug
19-Aug
20-Aug
21-Aug
22-Aug
23-Aug


SITE 4
Combined DNL
Local Aircraft DNL
Community DNL
DNL
80
70
60
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40
30
20
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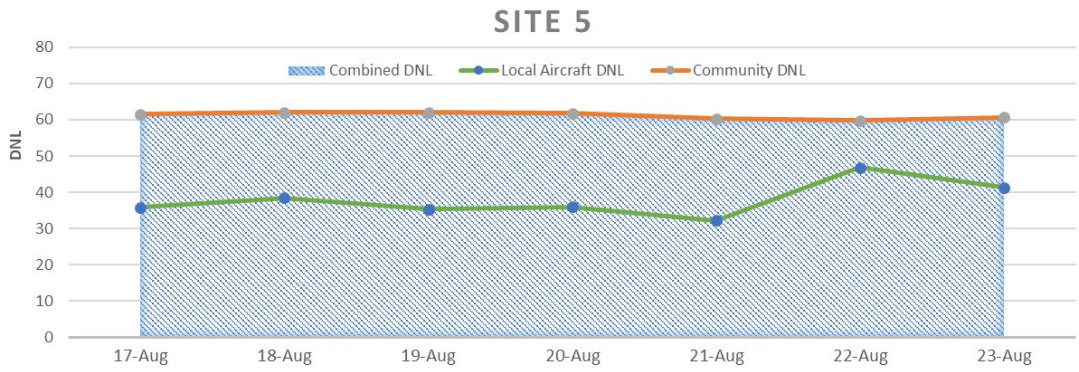
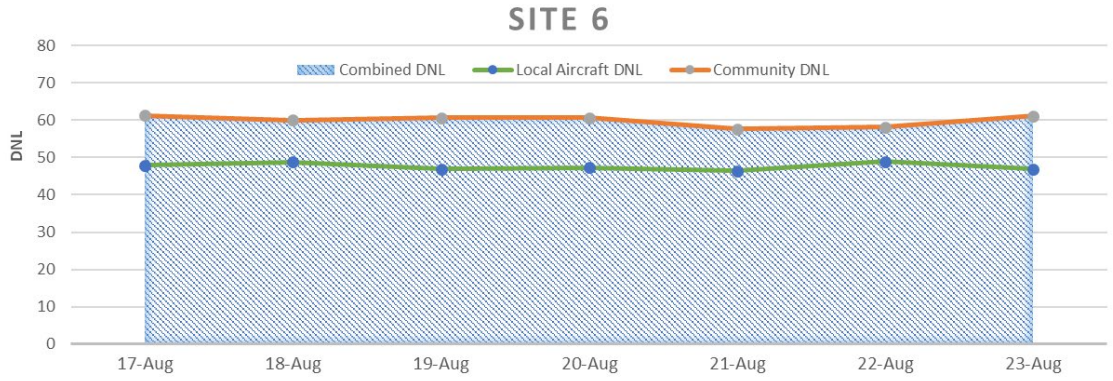
17-Aug
18-Aug
19-Aug
20-Aug
21-Aug
22-Aug
23-Aug


SITE 5
Combined DNL
Local Aircraft DNL
Community DNL
DNL
80
70
60
50
40
30
20
10
0
17-Aug
18-Aug
19-Aug
20-Aug
21-Aug
22-Aug
23-Aug


SITE 6
Combined DNL
Local Aircraft DNL
Community DNL
DNL
80
70
60
50
40
30
20
10
0
17-Aug
18-Aug
19-Aug
20-Aug
21-Aug
22-Aug
23-Aug

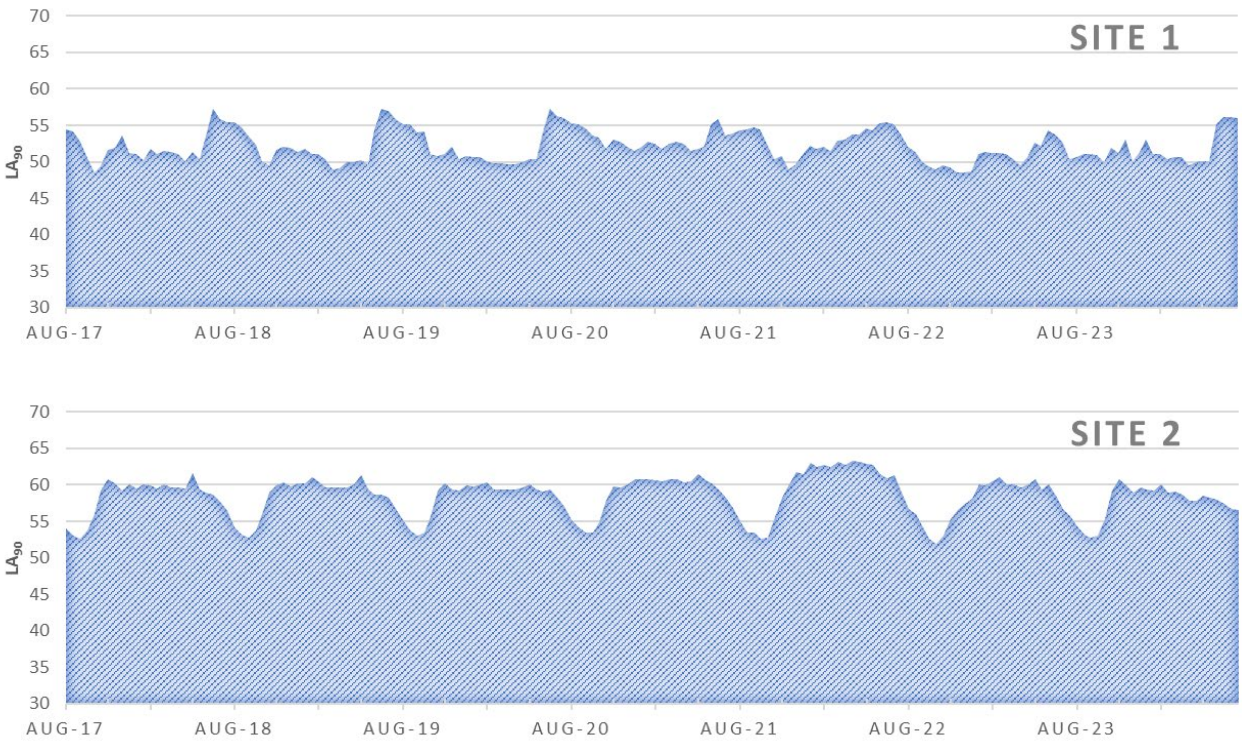
Ambient Sound Levels

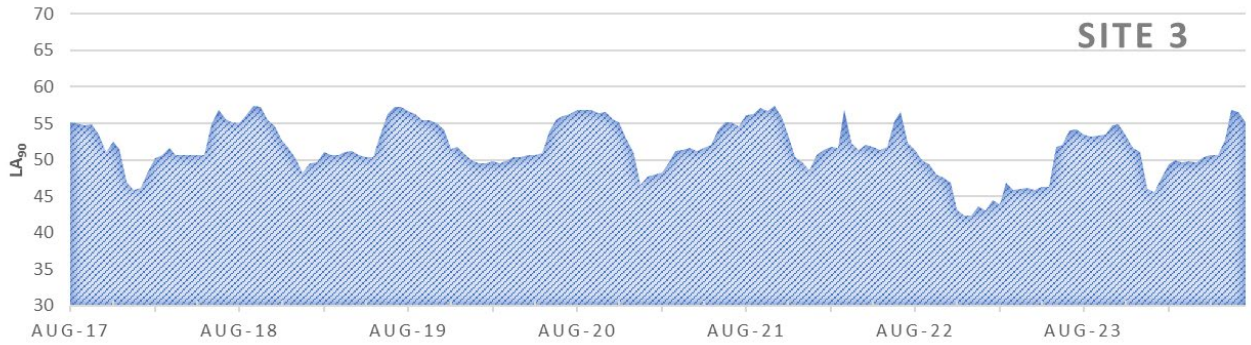
Ambient sounds are continuous; emitted around us by sources we cannot always see, such as wind, mechanical equipment, insects, freeways, etc. Many factors contribute to ambient sound levels (both intensity and frequency) and include natural and human made sounds. Sound events can be transient and/or cyclical (day/night, morning/afternoon/evening/night, weeks, months, seasons, holidays, etc.). Ambient sound levels are important when observing and comparing sound sources to achieve objectivity.

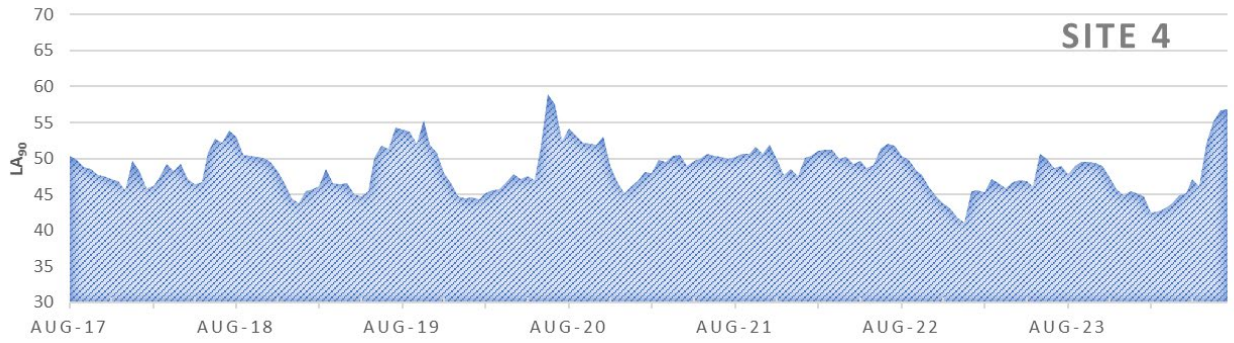
A common method to estimate ambient sound level is to use a statistical metric called the LA_{90}, which is the A-Weighted sound level that is exceeded 90 percent of the time. Figure 3.7 shows the LA_{90} levels measured at each site during the study period.

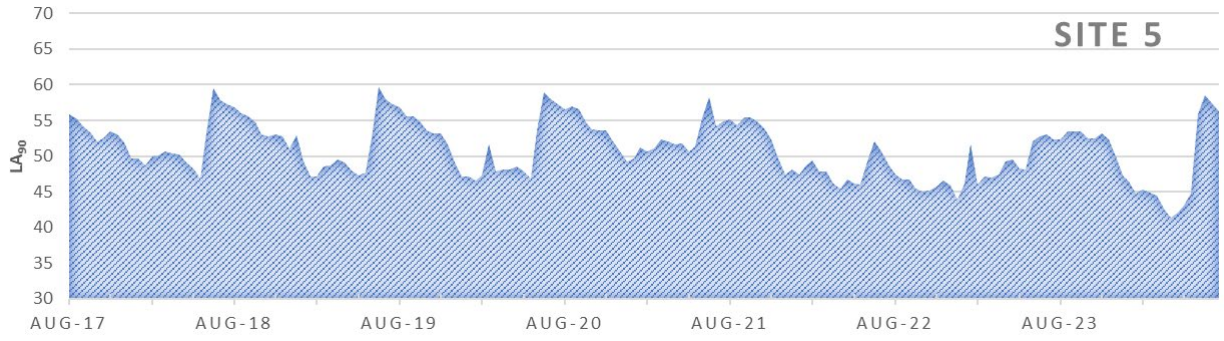
The LA_{90} levels were highest in the vicinity of Site 2 on August 10 with 63.7 dB during the 6 A.M. hour and 63.4 dB during the 1:00 P.M. hour. Site 2 also had an LA_{90} level of 63.4 dB on August 12 during the 5 P.M. hour. As represented by valleys in the charts below, nighttime ambient sound levels are typically lower. Because Site 2 is located in the downtown St. Paul urban area, the ambient sound levels recorded at this location make sense.

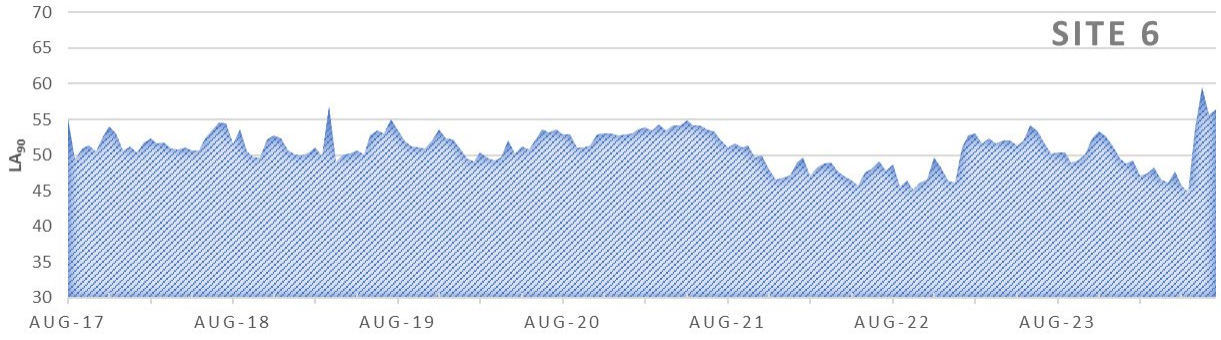
Figure 3.7: Hourly Average Ambient Sound Levels




SITE 3
70
65
60
55
50
45
40
35
30
LA90
AUG-17
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23


SITE 4
70
65
60
55
50
45
40
35
30
LA90
AUG-17
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23


SITE 5
70
65
60
55
50
45
40
35
30
LA90
AUG-17
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23


SITE 6
70
65
60
55
50
45
40
35
30
LA90
AUG-17
AUG-18
AUG-19
AUG-20
AUG-21
AUG-22
AUG-23

4.0 Sound Modeling

In addition to field monitoring, STP aircraft activity from August 17-23, 2021 was modeled using the FAA's modeling tool, AEDT, Version 3d. The FAA notes in a recent report to Congress,

> "… while the DNL metric is FAA's decision-making metric, other supplementary metrics can be used to support further disclosure and aid in the public understanding of community noise effects."

With actual monitoring, as noted above, events are documented when the analyzer detects a sound level over 65 dBA for four seconds or longer. Due to the nature of environmental monitoring, MACNOMS must take measures to attempt to filter out community and other ambient sounds before assigning aircraft sound events to a specific operation. The AEDT model does not have community ambient sounds to consider.

Conversely, AEDT must make assumptions about aircraft performance, flap configurations, engine settings, aircraft model types, weight, and weather. AEDT uses standard aircraft thrust settings, standard departure climb-rates as well as standard arrival descent rates, which may not represent actual flight operating characteristics. Additionally, certificated sound data are available for many aircraft types in the model, however all aircraft operating at STP are not represented. In those situations, modeling requires aircraft substitutions be used to represent missing aircraft types.

The goal of conducting field measurement studies and producing modeling results are similar and will often time produce the same sound metric results; however, differences between field measurements and sound modeling will result in variances between the data due to community sounds, measurement parameters, and necessary model assumptions.

The AEDT model can produce various sounds metrics. Two metric options available are the Number Above Noise Level and Time Above Noise Level. For this analysis, MAC staff evaluated the number of operations at or above 65 dB at a specific grid point and their duration.

This modeled sound analysis depicts aircraft sound events from actual aircraft activity at STP from August 17, 2021 through August 23, 2021 using model inputs such as runway use, aircraft fleet mix, aircraft performance and thrust settings, topography, and atmospheric conditions. Quantifying aircraft-specific sound characteristics in AEDT is accomplished using a comprehensive database developed by the FAA under 14 CFR Part 36. As part of the airworthiness certification process, aircraft manufacturers are required to subject aircraft to a battery of sound tests. Using federally-adopted and endorsed algorithms, this aircraft-specific sound information is used in the generation of model outputs. Justification for such an approach is rooted in national standardization of sound quantification at airports. Appendix A.4 includes the fleet mix and Appendix A.5 includes weather data utilized in the AEDT model for this analysis.

AEDT uses a grid pattern of individual noise measurement points, known as receptors, and calculates sound at each of these points. The grid pattern for this study included 22,500 unique points spaced 0.1 nautical miles apart for a range of 15 miles.

Additionally, AEDT uses standard weather inputs that are typically available for a study comprising a full year of data. For this study, standard weather inputs were changed to represent the average weather conditions for the study period. These inputs are available in Appendix A.5, Table A.1.

Figure 4.1 shows the modeled grid points by average number of events per day during the study period. Grid points with the highest number of events per day are all located within airport property.

Table 4.1 below provides the total number of sound events above 65 dBA modeled to occur at a field measurement location during the STP study period. The table also provides the number of measured sounds events above 65 dBA correlated to aircraft during the study period for comparison.

Table 4.1 Measured Vs Modeled Number Above Sound Levels			
Site	N^{65} Measured	N^{65} Modeled	Difference
1	0	22	22
2	22	67	45
3	34	48	14
4	11	25	14
5	48	121	73
6	111	147	36

Figure 4.2 shows the modeled grid points by average time spent above 65 dBA per day during the study period.

Table 4.2 below provides the total amount of time sound levels were above 65 dBA modeled to occur at a measurement location during the study period. The table also provides the total monitored time above 65 dBA correlated to aircraft during the study period for comparison.

Table 4.2 Measured Vs Modeled Time Above Sound Level			
Site	TA^{65} Measured (min)	TA^{65} Modeled (min)	Difference (min)
1	0.0	2.3	2.3
2	6.5	8.8	2.4
3	4.7	9.8	5.1
4	1.9	4.8	2.9
5	6.7	24.7	18.1
6	20.7	34.3	13.6

Figure 4.1: Number of Events Above 65 dB per Day

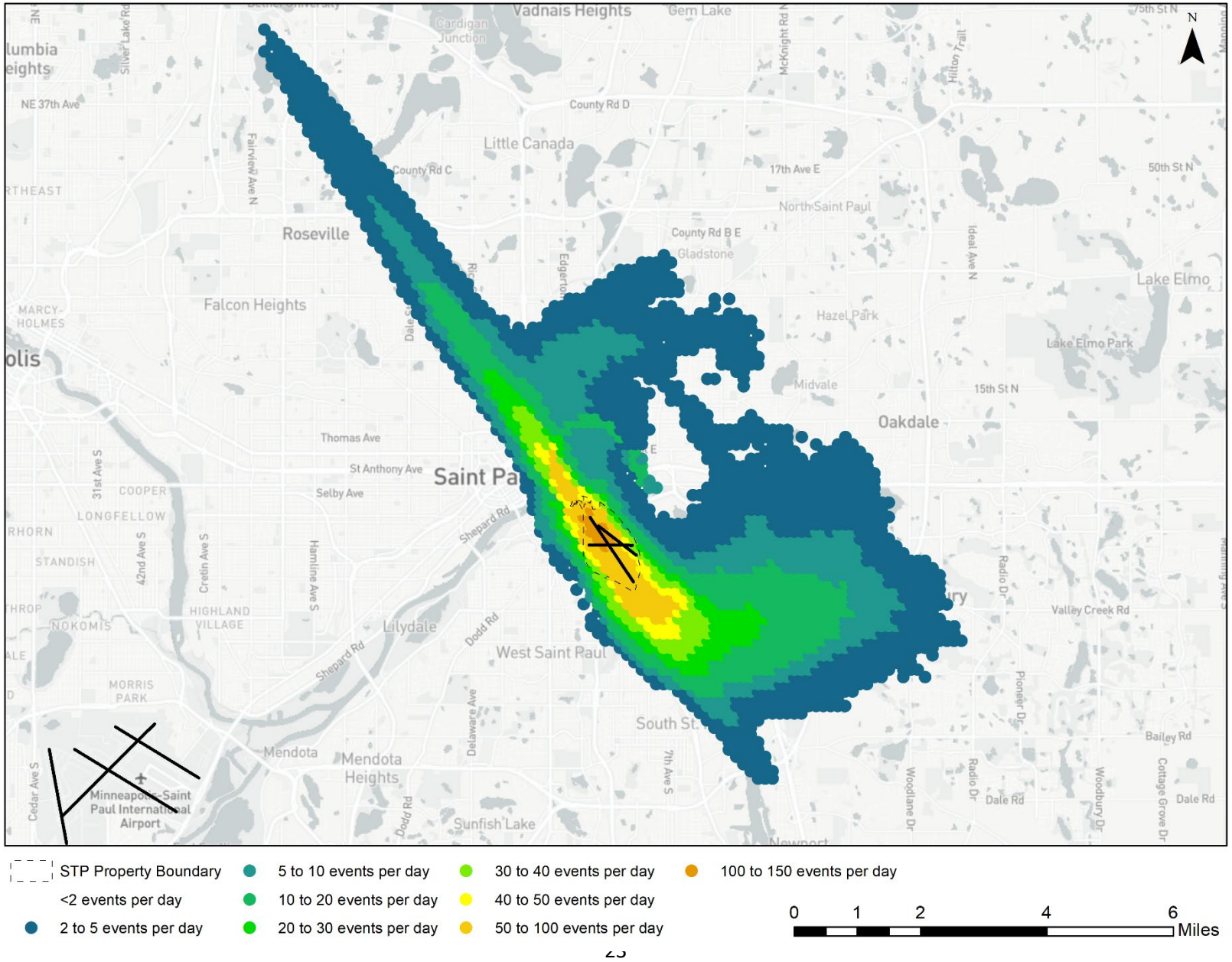
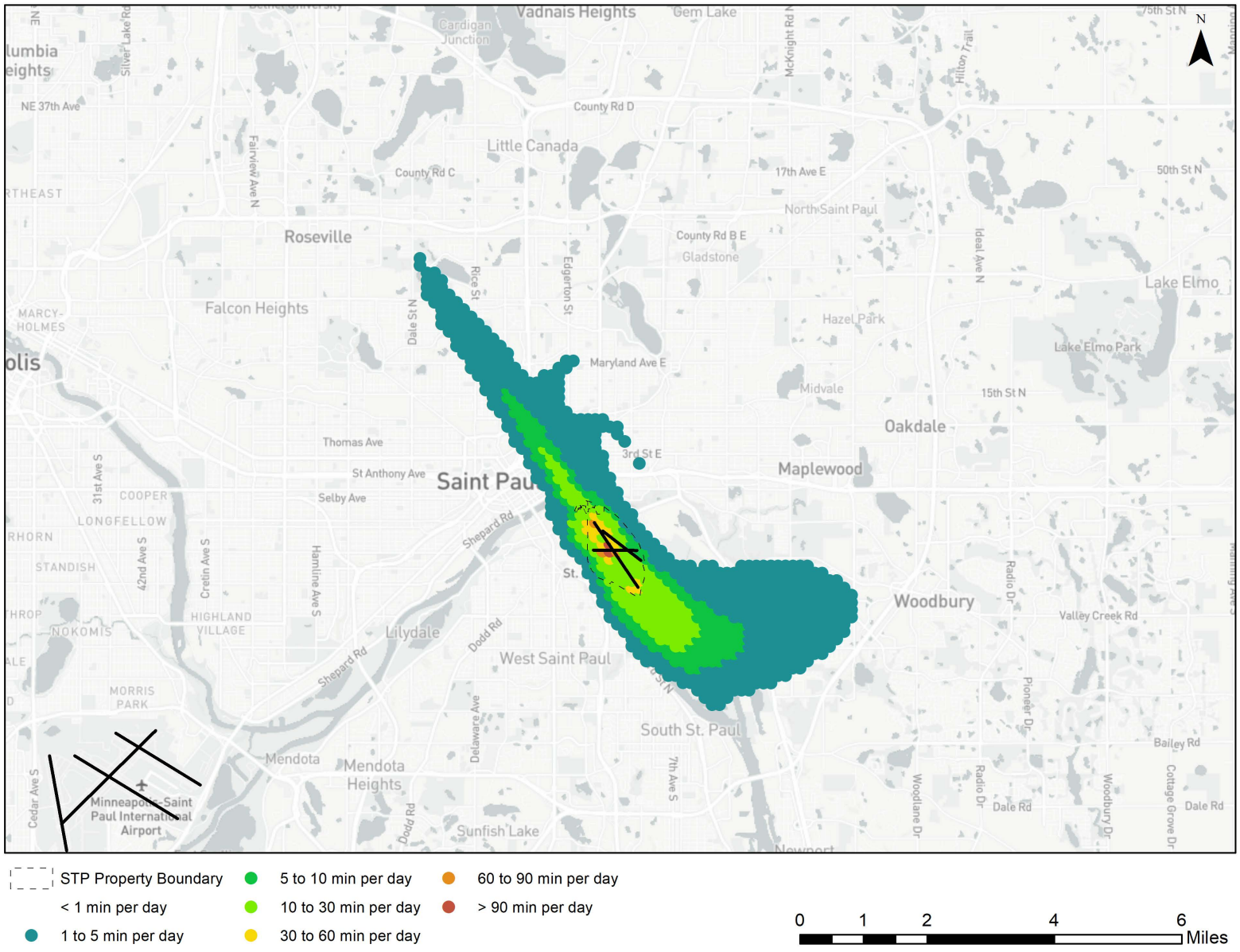


Figure 4.2: Time Above 65 dB (minutes per day)



5.0 Noise Complaints

During the study period, fourteen complaints were received from five Saint Paul households, and two complaints were received from two households in other cities. Five complaints were received during nighttime hours, between 10:00 P.M. and 7:00 A.M. Table 4.2 illustrates the complaints with correlated operations by aircraft type. Piston aircraft operated the most flights during the study period and received the greatest number of complaints.

Table 5.1 Complaints and Operations

Aircraft Type	Operations	Complaints
Helicopter	18	1
Jet	269	7
Piston	380	3
Turbo-Prop	82	5
Unknown	85	-
Total	**834**	**16**

Figure 5.1 shows a complaint heat map representing the number of complaints within a grid square. Figure 5.2 shows complaints and the number of events above 65 dB.

Figure 5.1: STP Study Period Complaint Heat Map

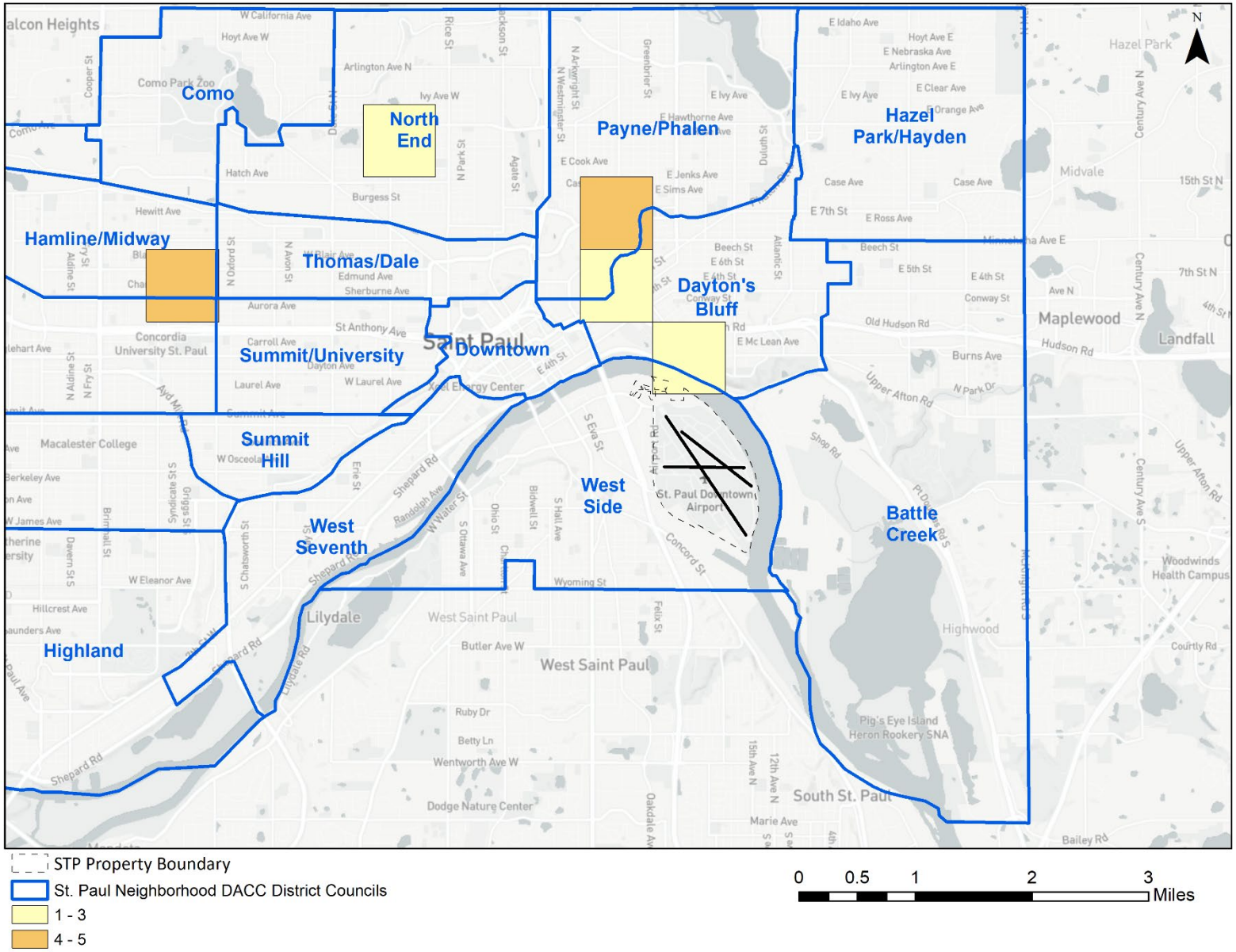
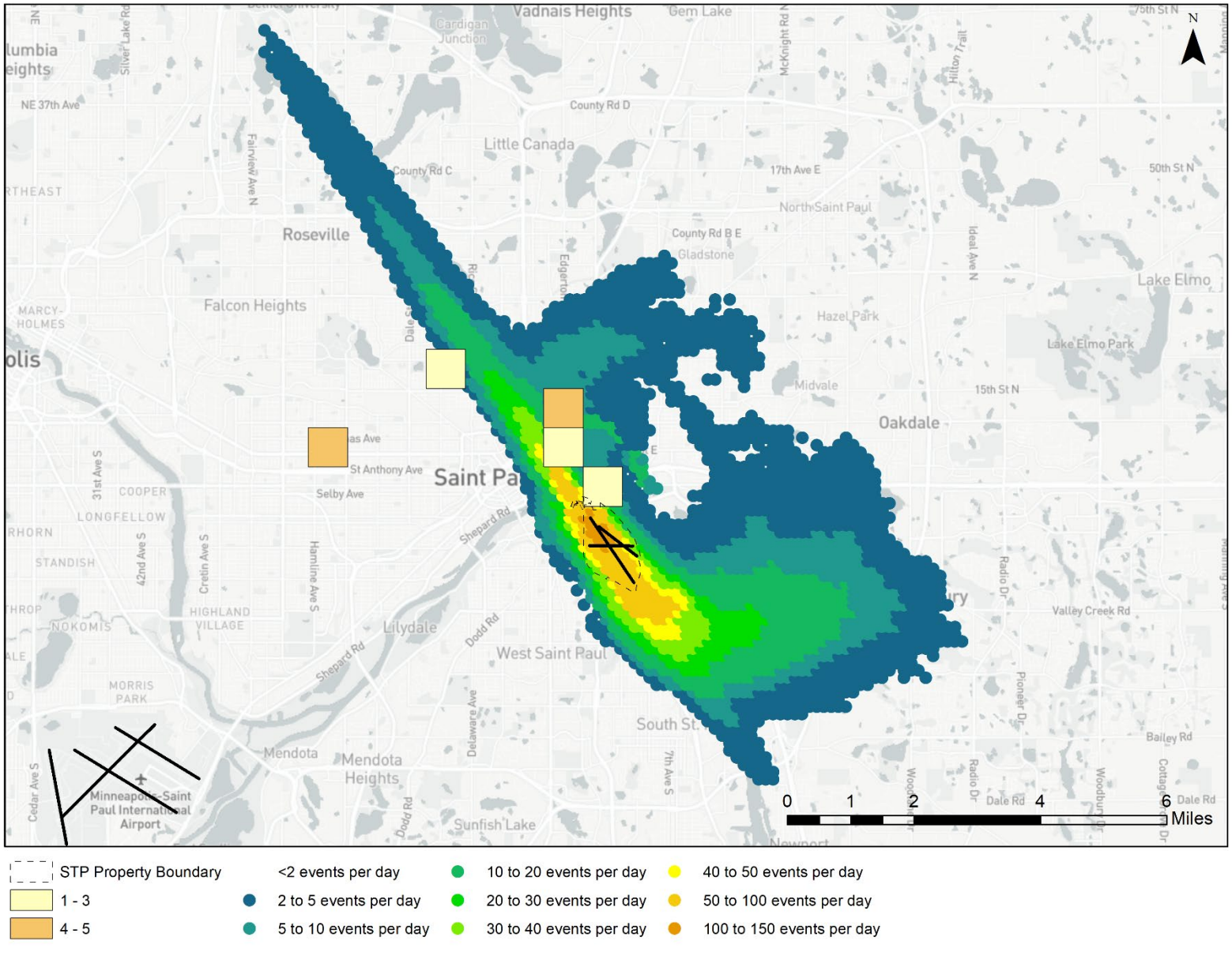


Figure 5.2: STP Study Period Complaint Heat Map with Number of Events Above 65 dB



Appendix

A.1 MAC Mobile Sound Monitoring Request Guidelines

Mobile equipment sites are located to measure sounds near known aircraft flight paths:

- Located where flight operations are at altitudes, concentrations, and configurations creating aircraft sound levels above community sound levels.
- Away from known community sound sources (such as large arterial roads, train tracks, factories, transit centers, natural and other gathering spots) that may interfere with gathering aircraft sound data.
- Availability of power source(s).
- On MAC or public owned property (preferred).

A.2 Field-Measured Sound Data: Aircraft and Community DNL

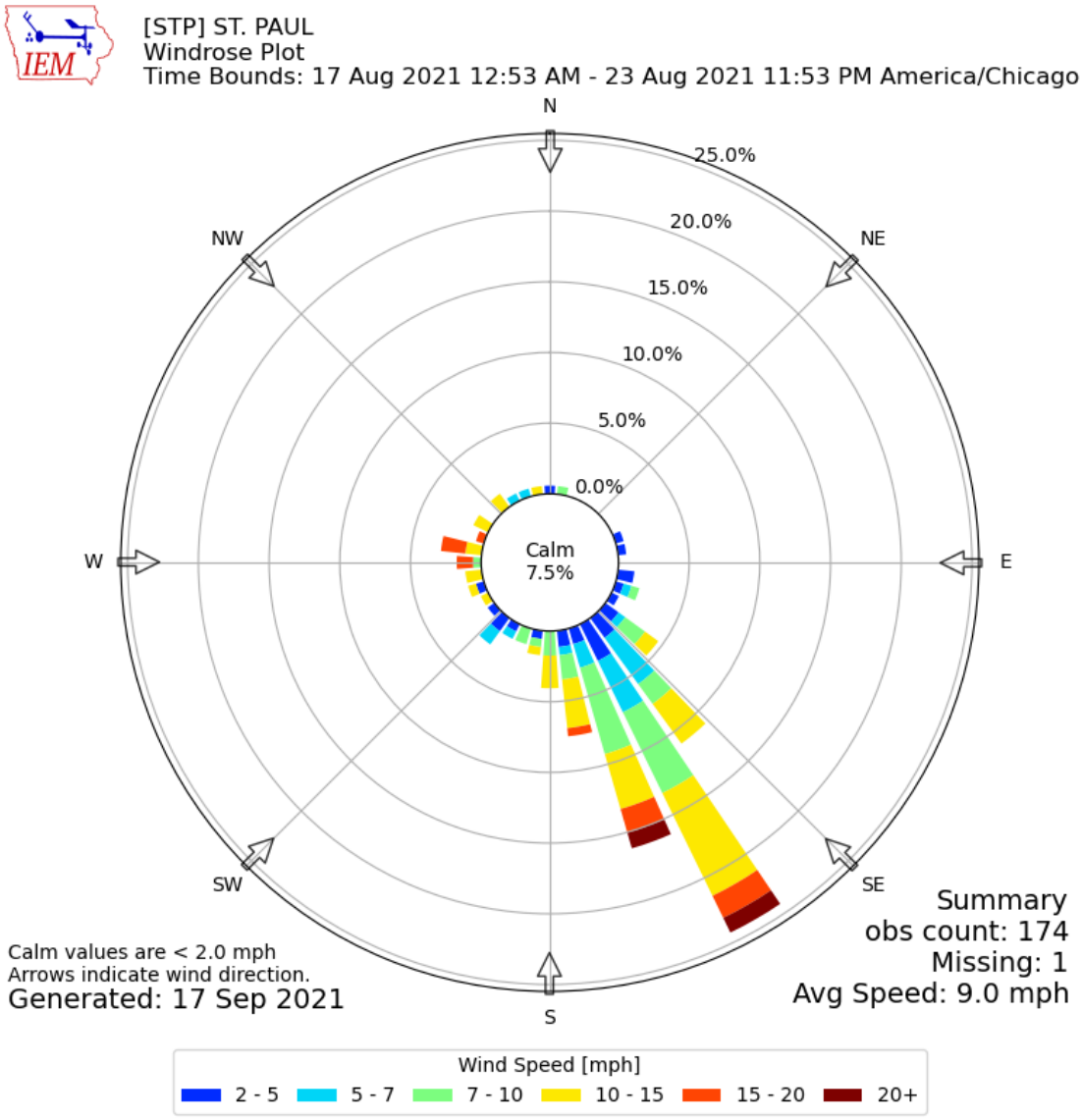
Site	Date	ADNL	CDNL	Combined DNL
1	17-Aug	0.0	60.0	60.0
1	18-Aug	0.0	60.5	60.5
1	19-Aug	0.0	60.9	60.9
1	20-Aug	0.0	60.4	60.4
1	21-Aug	0.0	60.6	60.6
1	22-Aug	0.0	58.2	58.2
1	23-Aug	0.0	62.3	62.3
2	17-Aug	46.1	64.2	64.3
2	18-Aug	34.2	64.1	64.1
2	19-Aug	39.2	64.2	64.2
2	20-Aug	38.5	67.9	67.9
2	21-Aug	39.8	65.2	65.2
2	22-Aug	39.3	63.0	63.0
2	23-Aug	34.5	63.9	63.9
3	17-Aug	40.1	62.7	62.7
3	18-Aug	36.2	62.4	62.4
3	19-Aug	35.1	61.9	61.9
3	20-Aug	35.7	62.5	62.5
3	21-Aug	34.4	62.9	62.9
3	22-Aug	31.3	58.0	58.0
3	23-Aug	38.2	60.7	60.7
4	17-Aug	45.8	58.8	59.0
4	18-Aug	25.0	57.7	57.7
4	19-Aug	28.0	60.1	60.1
4	20-Aug	26.5	59.0	59.0
4	21-Aug	38.4	57.8	57.8
4	22-Aug	35.8	55.8	55.8
4	23-Aug	31.1	58.8	58.8
5	17-Aug	35.9	61.6	61.6
5	18-Aug	38.4	62.1	62.1
5	19-Aug	35.3	62.1	62.1
5	20-Aug	36.0	61.8	61.8
5	21-Aug	32.2	60.3	60.3
5	22-Aug	46.8	59.8	60.0
5	23-Aug	41.3	60.7	60.7
6	17-Aug	47.9	61.3	61.5
6	18-Aug	48.8	60.0	60.3
6	19-Aug	46.9	60.7	60.9
6	20-Aug	47.3	60.6	60.8
6	21-Aug	46.4	57.7	58.0
6	22-Aug	48.9	58.1	58.6
6	23-Aug	47.0	61.1	61.3

A.4 Modeled Aircraft Distribution

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Jet	**175.5**	**174.2**	**11.7**	**361.3**
Bombardier Challenger 300	14.4	13.1	0.0	27.5
Bombardier Challenger 350	1.3	2.6	0.0	3.9
Bombardier Challenger 601	1.3	2.6	0.0	3.9
Bombardier Global 6000	0.0	1.3	0.0	1.3
Bombardier Learjet 35	1.3	1.3	0.0	2.6
Bombardier Learjet 45	2.6	2.6	0.0	5.2
Bombardier Learjet 60	1.3	0.0	0.0	1.3
Bombardier Learjet 70	1.3	1.3	0.0	2.6
Cessna 500 Citation Jet I	1.3	1.3	0.0	2.6
Cessna 501 Citation Jet ISP	1.3	1.3	0.0	2.6
Cessna 525 Citation Jet	3.9	2.6	0.0	6.5
Cessna 525A Citation Jet (CJ2)	1.3	1.3	0.0	2.6
Cessna 525B Citation Jet (CJ3)	1.3	1.3	0.0	2.6
Cessna 525C Citation Jet	3.9	3.9	0.0	7.9
Cessna 550 Citation II	2.6	2.6	0.0	5.2
Cessna 560 Citation Encore	5.1	6.8	0.0	11.8
Cessna 560 Citation Ultra	2.8	3.7	0.0	6.5
Cessna 560 Citation XLS	10.5	10.5	0.0	21.0
Cessna 650 Citation III	0.0	1.3	0.0	1.3
Cessna 680 Citation Sovereign	10.5	7.9	0.0	18.3
Cessna 750 Citation X	2.6	3.9	0.0	6.5
CESSNA CITATION 510	2.6	2.6	0.0	5.2
Dassault Falcon 2000	15.7	17.0	0.0	32.7
Dassault Falcon 50	2.6	2.6	0.0	5.2
Dassault Falcon 900	7.9	5.2	0.0	13.1
Eclipse 500 / PW610F	1.3	1.3	0.0	2.6
Embraer 500	15.7	15.7	0.0	31.4
Embraer Legacy 550 (EMB-550)	3.9	3.9	0.0	7.9
Falcon 7X	1.3	1.3	0.0	2.6
Gulfstream G150	2.6	2.6	0.0	5.2
Gulfstream G280	1.3	0.0	0.0	1.3
Gulfstream G400	5.2	3.9	0.0	9.2
Gulfstream G500	19.6	21.0	11.7	52.3
Gulfstream II	1.3	1.3	0.0	2.6
Israel IAI-1125 Astra	0.0	1.3	0.0	1.3
Raytheon Beechjet 400	18.3	17.0	0.0	35.4
Raytheon Hawker 800	5.2	3.9	0.0	9.2
Piston	**136.2**	**144.1**	**242.4**	**522.6**
Single Engine	**129.6**	**136.2**	**242.4**	**508.2**
Beech 23 Musketeer Sundowner (FAS)	2.6	2.6	0.0	5.2
Beechcraft Bonanza 33 (FAS)	0.0	1.3	0.0	1.3
Beechcraft Bonanza 35 (FAS)	2.6	2.6	0.0	5.2
Cessna 150 Series	10.5	10.5	84.7	105.6
Cessna 152 (FAS)	3.9	5.2	17.5	26.7
Cessna 172 Skyhawk	38.0	39.3	81.8	159.0
Cessna 177 (FAS)	2.6	2.6	0.0	5.2
Cessna 182	9.2	10.5	8.8	28.4
Cessna 206	2.6	2.6	0.0	5.2
Cirrus SR20	1.3	1.3	0.0	2.6

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Cirrus SR22	5.2	6.5	0.0	11.8
Cirrus SR22 Turbo (FAS)	9.2	7.9	0.0	17.0
Lancair Evolution (FAS)	0.0	1.3	0.0	1.3
Piper PA-28 Cherokee Series	27.5	26.2	43.8	97.5
Piper PA-32 Cherokee Six	2.6	3.9	0.0	6.5
Piper PA44 (FAS)	5.2	5.2	5.8	16.3
Raytheon Beech Bonanza 36	6.5	6.5	0.0	13.1
Multi Engine	**6.5**	**7.9**	**0.0**	**14.4**
Cessna 414	2.6	2.6	0.0	5.2
Cessna 421	1.3	1.3	0.0	2.6
Cessna 425 Conquest I	1.3	1.3	0.0	2.6
Piper PA-30 Twin Commanche	0.0	1.3	0.0	1.3
Piper PA-34 Seneca	1.3	1.3	0.0	2.6
Turboprop	**51.7**	**49.8**	**0.0**	**101.5**
Single Engine	**16.4**	**13.1**	**0.0**	**29.5**
Cessna 208 Caravan	3.9	2.6	0.0	6.5
EADS Socata TBM-700	2.0	2.6	0.0	4.6
Pilatus PC-12	9.2	6.5	0.0	15.7
Socata TBM-9 (FAS)	1.3	1.3	0.0	2.6
Multi Engine	**35.4**	**36.7**	**0.0**	**72.0**
Raytheon Beech 99	1.3	1.3	0.0	2.6
Raytheon King Air 90	3.9	3.9	0.0	7.9
Raytheon Super King Air 200	19.6	21.0	0.0	40.6
Raytheon Super King Air 300	10.5	10.5	0.0	21.0
Helicopter	**10.5**	**13.1**	**0.0**	**23.6**
Single Engine	**1.3**	**1.3**	**0.0**	**2.6**
Bell 206B-3	1.3	1.3	0.0	2.6
Multi Engine	**9.2**	**11.8**	**0.0**	**21.0**
Agusta A-109	1.3	1.3	0.0	2.6
Bell 407 / Rolls-Royce 250-C47B	3.9	5.2	0.0	9.2
Bell 429	1.3	1.3	0.0	2.6
Eurocopter EC-155B1	2.6	2.6	0.0	5.2
Robinson R44 Raven / Lycoming O-540-F1B5	0.0	1.3	0.0	1.3
Grand Total	**373.8**	**381.1**	**254.1**	**1,009.0**

A.5 STP Weather Details

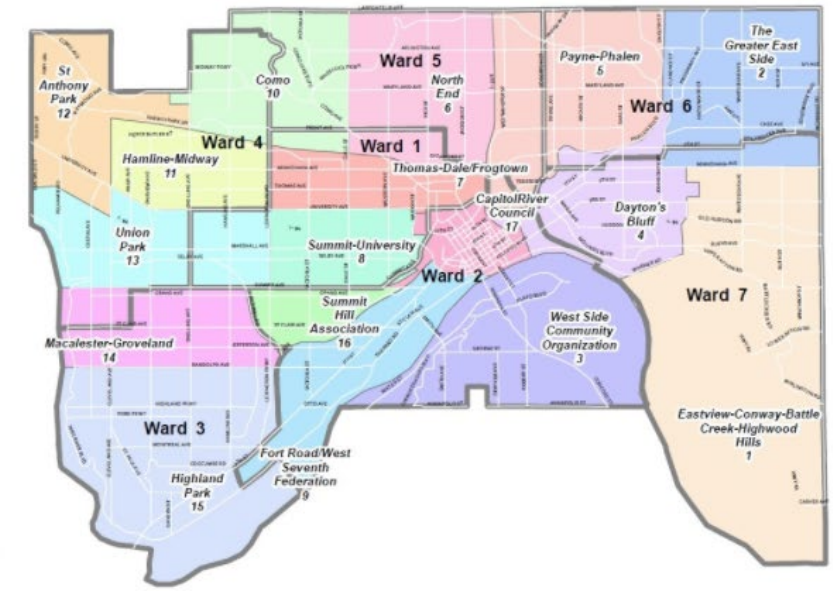


Source: [Mesonet Iowa State]

Table A.1: Model Weather Inputs	
Average Temp	74.5
Average Wind Speed	9.0
Average Dew Point	62.3
Average Sea Level Pressure (SLP)	29.1
Average Relative Humidity	64.3
Average SLP (millibar)	986.1

A.6 Saint Paul District Council Map and Details

District Council Directory



District	Neighborhood	District Council
1	Eastview - Conway - Battle Creek - Highwood Hills	District 1 Community Council
2	Greater East Side	District 2 Community Council
3	West Side	West Side Community Organization
4	Dayton's Bluff	Dayton's Bluff Community Council
5	Payne-Phalen	Payne Phalen Community Council
6	North End	North End Neighborhood Organization
7	Thomas-Dale/Frogtown	Frogtown Neighborhood Association
8	Summit-University	Summit-University Community Council
9	West 7th/Fort Road	Fort Road Federation
10	Como	District 10 Como Community Council
11	Hamline-Midway	Hamline Midway Coalition
12	St. Anthony Park	St. Anthony Park Community Council
13	Union Park	Union Park District Council
14	Macalaster-Groveland	Macalester Groveland Community Council
15	Highland	Highland District Council
16	Summit Hill	Summit Hill Association
17	Downtown	Capitol River Council

Source: www.stpaul.gov/residents/live-saint-paul/neighborhoods/district-councils/district-council-directory

A.7 Supplemental Conditions of Agreement

METROPOLITAN AIRPORTS COMMISSION

Minneapolis-Saint Paul International Airport
6040 - 28th Avenue South • Minneapolis, MN 55450-2799
Phone (612) 726-8100

TO WHOM IT MAY CONCERN:

On June 19, 2006 the following action took place at the Metropolitan Airports Commission full Commisson meeting regarding the St. Paul Downtown Airport – Flood Protection Update:

COMMISSIONER MARS MOVED AND COMMISSIONER LANNERS SECONDED TO INCREASE THE AMOUNT FOR THE PROJECT IN THE CAPITAL IMPROVEMENT PROGRAM FROM $28.5 MILLION TO $29.3 MILLION AND AUTHORIZE STAFF TO INCLUDE THE CONDITIONS THAT WERE PRESENTED TO THE COMMITTEE IN THE ZONING APPLICATION WHEN RESUBMITTED TO THE CITY. FURTHER THAT STAFF WORK WITH PUBLIC AND PRIVATE PARTIES THAT WILL DIRECTLY BENEFIT FROM THE FLOOD PROTECTION PROJECT TO RAISE REVENUES TO OFFSET THE COST INCREASE.

The Motion passed unanimously by the following roll call vote:

Commissioners: **Berman, Boivin, Harris, Landy, Lanners, Mars, McGee, Rehkamp, Sigel, Warner, Williams and Chair McKasy**

Absent: **Commissioners Foley and Stenerson**

Sallye Douma, Commission Secretary

Runway Length MAC will not take any action to increase the length of the runways at the Airport in excess of the current length, unless required to do so by State law, provided that MAC will not initiate, promote or otherwise support enactment of such law.

Pavement Strength MAC will not take any action to increase the Runway Pavement Weight-Bearing Capacity at the Airport beyond the maximum presently available, unless required to do so by State law, provided that MAC will not initiate, promote or otherwise support enactment of such law.

Cargo Operations MAC represents that, based on operational and space limitations, major air cargo transfer/sortation operations (such as Federal Express, UPS and other similar companies) are not able to use the Airport, nor will MAC take action to accommodate such activity.

Airport Noise Abatement Plan MAC will, in consultation and collaboration with the City and other interested parties (agreed to by MAC and the City), immediately initiate an update of the St. Paul Downtown Airport Noise Abatement Plan to include the following elements:

- Use of the runways at the Airport.
- Appropriate flight tracks for aircraft arriving at, or departing from, the Airport.
- Voluntary restraint on night-time aircraft operations and recommended procedures for any such operations that must occur.
- Voluntary restraint on night-time aircraft engine runups.
- Implementation of a pilot/FBO information and education program designed to inform Airport Users and Fixed Base operators of the elements contained in the Noise Abatement Plan.
- Completion of an annual study of aircraft noise in the areas surrounding the Airport.
- Incorporation of limitations regarding runway length, runway strength and cargo operations.
- Public Input.

As necessary, MAC will seek Federal Aviation Administration approval of the updated noise abatement plan. MAC shall use its best efforts to secure federal approval of the plan or any portion of the proposed plan.

Endangered/Threatened Species MAC will coordinate with the City of St. Paul and other appropriate agencies to complete an updated survey of threatened/endangered species within the project area.

Vegetation/Revegetation Plan MAC will coordinate with the City of St. Paul and other interested parties to review and make recommendations regarding a vegetation/revegetation plan for the project area. MAC will implement these recommendations if they are determined to be compatible with Airport operations.

Treatment of Contaminated Soils MAC will complete additional soil sampling and testing in the area proposed for compensatory excavation, including testing for PAH's and inorganics. MAC will also monitor excavated material from the compensatory excavation per a Testing and Disposal Plan. Any contaminated soils will be properly disposed of in a licensed facility approved for such disposal.

Stormwater Discharge MAC will complete a sampling/testing protocol for subdrain discharge, as may be required by the Minnesota Pollution Control Agency.

A.8 Glossary

Aircraft Operation

Aircraft arriving or departing from STP, or an aircraft that performed both an arrival and departure (touch and go).

A-Weighting

A-Weighting is a standard filter used by acoustic measurement devices and can be applied to acoustic measurements. It is frequency filter that attempts to emulate the way human hear.

Day-Night Level (DNL)

The FAA established DNL as the primary metric for aircraft noise analysis and expressing aircraft noise exposure in the United States. "DNL" is the acronym for Day-Night Average Sound Level, which represents the total accumulation of all sound energy, with a 10-decibel penalty applied for each sound event between 10:00 P.M. and 7:00 A.M. DNL has been widely accepted as the best available method to describe aircraft noise exposure and is the industry standard for use in aircraft noise exposure analyses and noise compatibility planning. It also has been identified by the U.S. Environmental Protection Agency as the principal metric for airport noise analyses.

Decibel (dB/dBA)

Sound levels are measured in Decibels, a logarithmic scale of energy referenced to human hearing. Sound levels are reported in dB; dBA is the Decibel value after the A-Weighting filter is applied.

LA_{eq} (Equivalent Sound Level) Equivalent sound level

The representation of a time-varying sound as an equivalent steady state A-weighted sound level for the period or interval of interest.

LA_{max} (Maximum A-weighted Sound Level)

This is maximum A-Weighted Sound Level observed for the period, event, or interval of interest.

LA_{90} (Sound Level Exceeded 90 Percent of the Time)

The LA90 is a common and typical method to estimate ambient sound levels or background sound levels seen most of the time. It is a statistical based metric which provides us with which A-Weighted sound level that is exceeded 90 percent of the time.

Number Above

The "Number Above", also referred to as N-level sound metric or Count Above, is the total number of aircraft sound events that exceeded a specified sound level threshold (LA_{max}). This report contains a count

of departure events and arrival events recorded with field-measurement equipment when the maximum sound level of those events exceeds 65, 80, 90, and 100 dB levels.

SEL (Sound Exposure Level)

Sound Exposure Level is the total sound energy expressed in one second. Numerically, the energy is equivalent but allows for the comparison of sound events with varying durations.

Time Above Metric

The "Time Above" noise metric measures the total time or percentage of time that the A-weighted aircraft noise level exceeds an indicated level. Time Above data are summarized for arrival and departure events based on one-second intervals.

Metropolitan Airports Commission

6040 28th Avenue South, Minneapolis, MN 55450

MetroAirports.org

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