Flying Cloud Airport (FCM)
Sound Study Report

October 2020

Community Relations Office

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1.0 Introduction

The Metropolitan Airports Commission (MAC) conducted a sound study near the Flying Cloud Airport (FCM) in support of the Flying Cloud Airport Advisory Commission (FCAAC) 2020 Work Plan. The study included two industry standard methods for assessing aircraft sound, field-measured data and modeled data.

This study was conducted by MAC Community Relations staff, using certified equipment and scientific guidelines. The results of this study are intended to enhance communication about aircraft noise associated with FCM aircraft activity. As such, the study captured sound data at the location of the sound monitoring equipment generated by aircraft that arrived to and/or departed from FCM or by community-related activity.

Sound level modeling for activity at FCM was conducted 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 FCAAC and airport stakeholders about aircraft activity and corresponding sound levels for a one-week study period.

Data not correlated to aircraft arriving to or departing from FCM are reported as community sound events in this report.

The sections below describe the FCM 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 of July 29 – August 4, 2020.

2.0 Operations

FCM 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 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.

An FAA air traffic control tower is located at FCM, and air traffic controllers direct aircraft into and out of FCM between 6:00 A.M. and 10:00 P.M. during times of the year when daylight savings is in effect; the hours are adjusted to 6:00 A.M. to 9:00 P.M. the remainder of the year. When the tower is closed, pilots communicate on a Common Traffic Advisory Frequency to announce their location and operational intentions to others operating in or near the airport.

There are three runways available for use at FCM while the air traffic control tower is staffed: Runway 28L/10R (south parallel runway), Runway 28R/10L (north parallel runway), and Runway 18/36. Runway

28R/10L is closed for use when the air traffic control tower is closed. Helicopters may land and depart from areas other than a runway.

According to FAA aircraft operations counts for FCM during July and August, the three-year average shows 1,490 flights use the airport during an average week during air traffic control tower hours. The FCM tower reported 4,164 operations at FCM during the study period. An operation is counted when an aircraft arrives to FCM or departs from FCM. Due to the existence of flight training at FCM, a single flight often will have multiple operations as pilots conduct touch and go operations for proficiency. This study period was a markedly busy week for FCM.

The 4,164 operations reported by the FAA tower is 77% higher than the 2020 weekly average for FCM, and 41% above the average week for July and August in 2020. It is normal and expected that the airport will be busier in the summer with increased flight training and recreational flying. However, the study period was well above even normal summertime activity.

The MAC Noise and Operations Monitoring System (MACNOMS) also collects flight tracking and operations data attributed to FCM. During the study period, MACNOMS recorded 2,008 arrivals and departures that used FCM. Of these, 441 flights performed touch and go operations. Table 2.1 shows the number of arrivals and departures on each FCM runway per day. The highest levels of operations occurred on Friday, July 31 with 338 flights, Wednesday, July 29 with 335 flights, and Tuesday, August 4 with 334 flights.

Table 2.1: FCM Aircraft Activity per Runway

Runway	Wednesday 29-Jul	Thursday 30-Jul	Friday 31-Jul	Saturday 1-Aug	Sunday 2-Aug	Monday 3-Aug	Tuesday 4-Aug	Runway Total
FCM Arrivals								
18			1	1		1	1	**4**
36	2		2	7	52	2		**65**
10L	13	67	11		15	57		**163**
10R	20	89	9	2	21	64		**205**
28L	67	1	76	52	10	3	85	**294**
28R	65		65	63		1	77	**271**
Unknown							1	**1**
FCM Departures								
18	1		1	1		7		**10**
36	1	2	1	1	40		2	**47**
10L	14	106	13	1	17	85		**236**
10R	6	42	9		8	30		**95**
28L	25	8	25	26	20	2	36	**142**
28R	121	4	125	88	3	2	132	**475**
Daily Total	335	319	338	242	186	254	334	**2,008**

Runway 28R/10L was used for 57% of the activity during the study period, Runway 28L/10R was used 37% and Runway 18/36 was 6%. Figures 2.1 and 2.2 show the arrivals and departures between 7 A.M.

and 10 P.M. There were 67 flights that operated between the hours of 10:00 P.M. and 7:00 A.M. Figures 2.3 and 2.4 show arrivals and departures during these nighttime periods.

The weather during the study week was desirable for flying with typical mid-summer wind and temperature patterns. Very little precipitation occurred. Weather conditions (e.g.; temperature, precipitation, wind, etc.) affect aircraft activity, runway use decisions and aircraft performance. In addition to operational factors, weather conditions also can 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: FCM Daytime Arrivals During Study Period

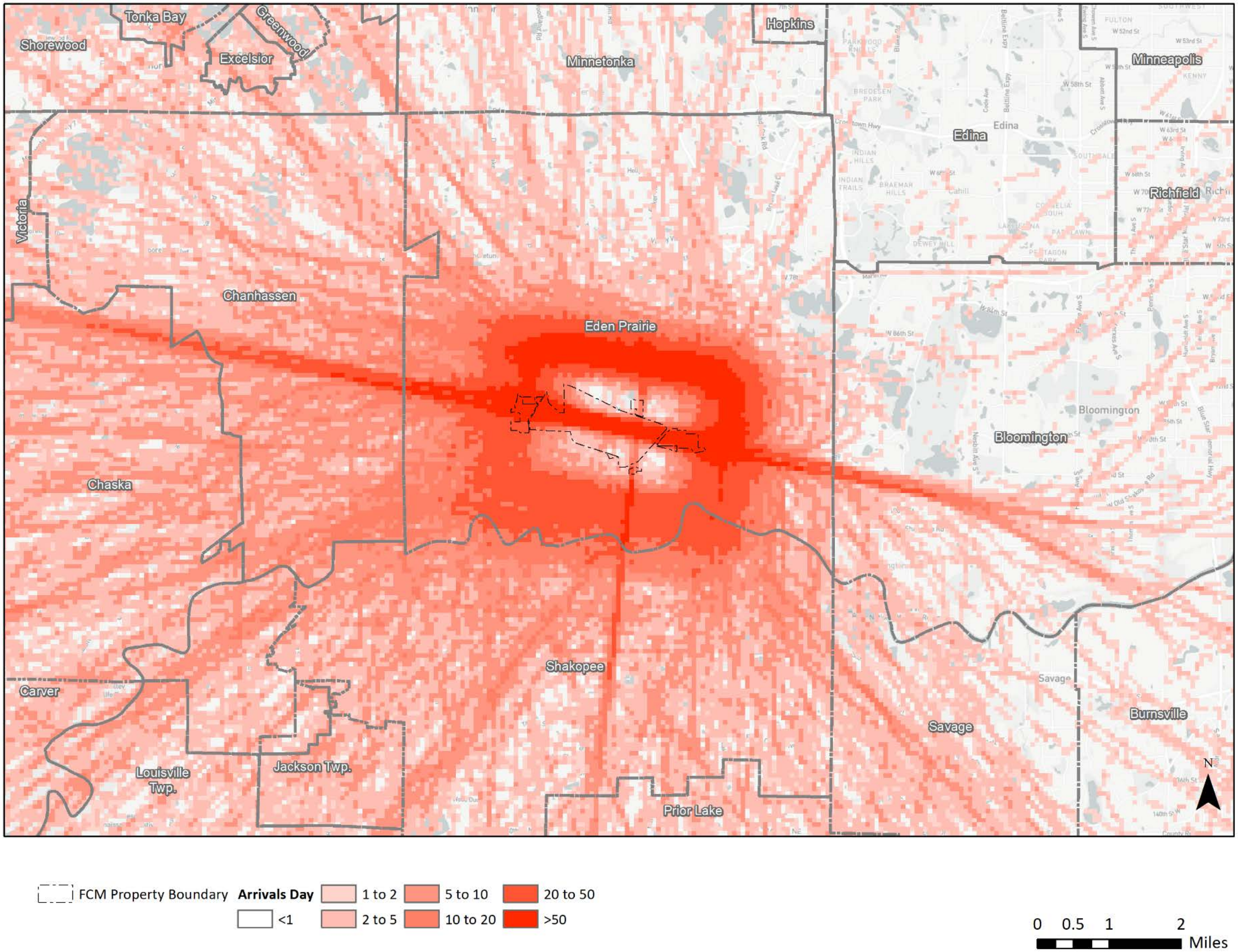


Figure 2.2: FCM Daytime Departures During Study Period

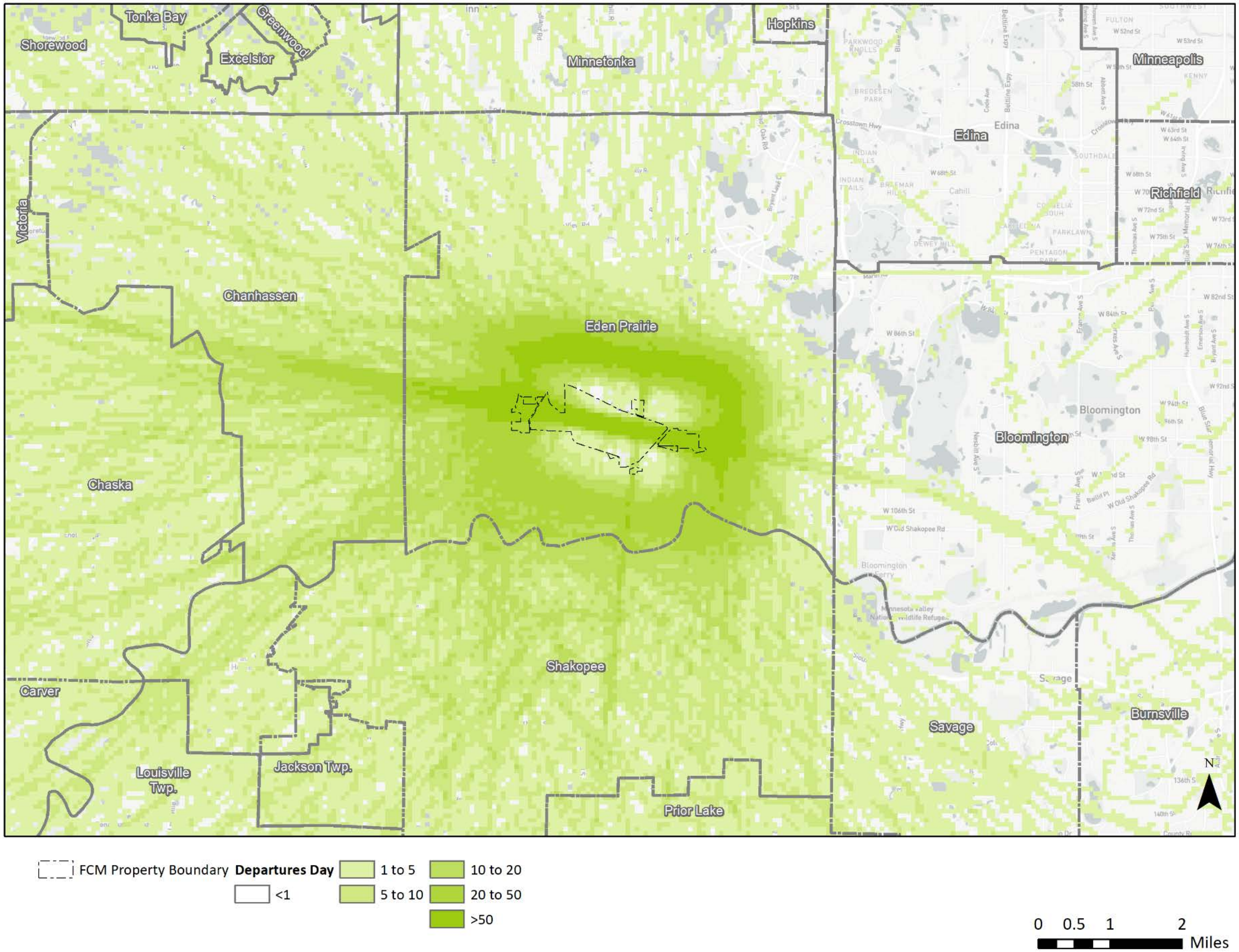
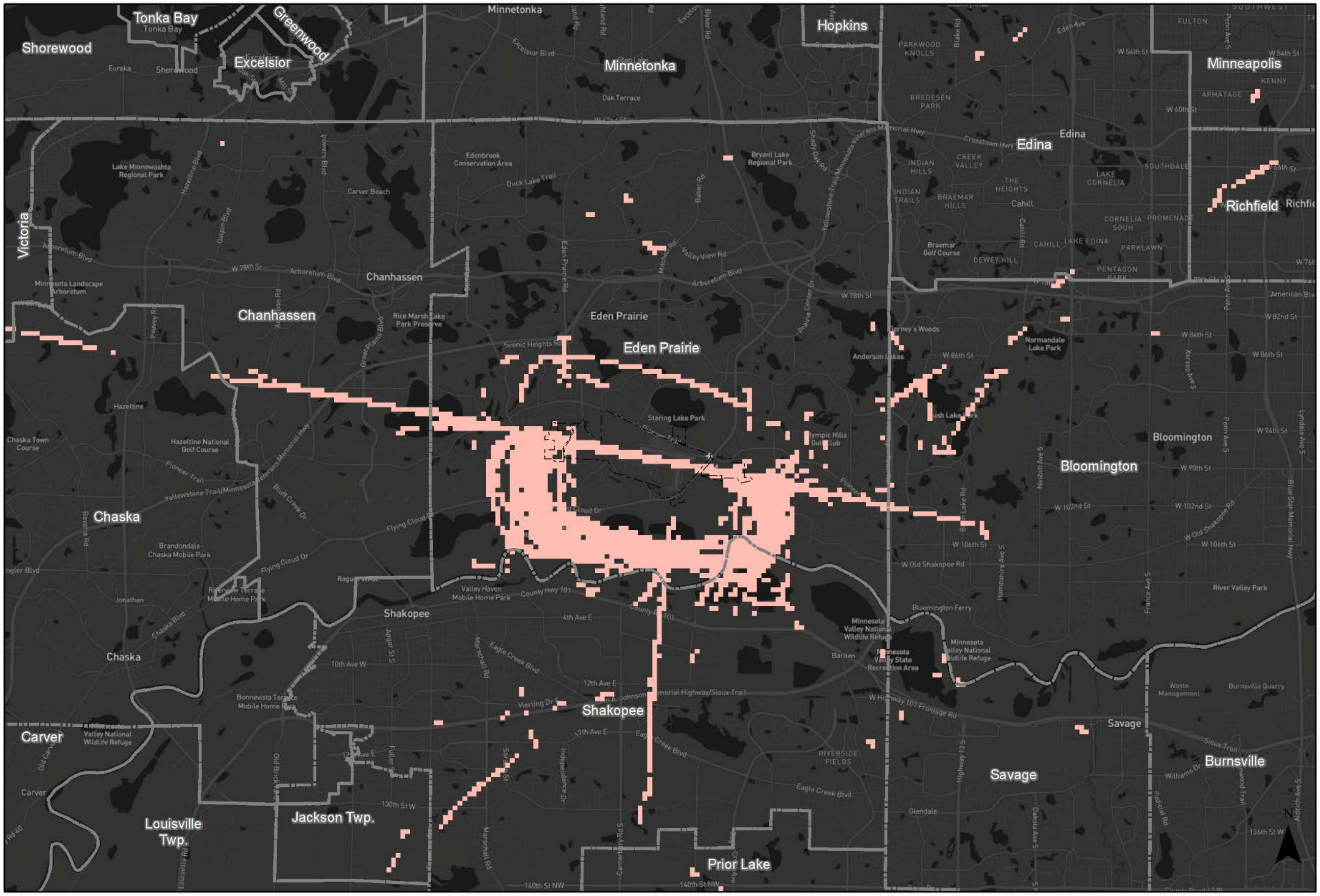


Figure 2.3: FCM Nighttime Arrivals During Study Period



FCM Property Boundary **Arrivals Night** <1 1 to 3

0 0.5 1 2 Miles

Figure 2.4: FCM Nighttime Departures During Study Period

3.0 Field-Measured Sound Data Collection

To identify areas with the greatest potential to collect data, MAC staff evaluated historical flight track data, observed aircraft in flight, and consulted with the FCM Airport Manager to determine the geographical areas with a high potential to obtain quality representative samples of aircraft sound data associated with FCM activity. Three capture areas were identified consistent with established Mobile Sound Monitoring Guidelines (see Appendix). Sound data collection equipment was positioned within each of those capture areas and data were collected in these areas continuously for the seven-day study period: July 29 – August 4, 2020.

3.1 Capture Area Descriptions

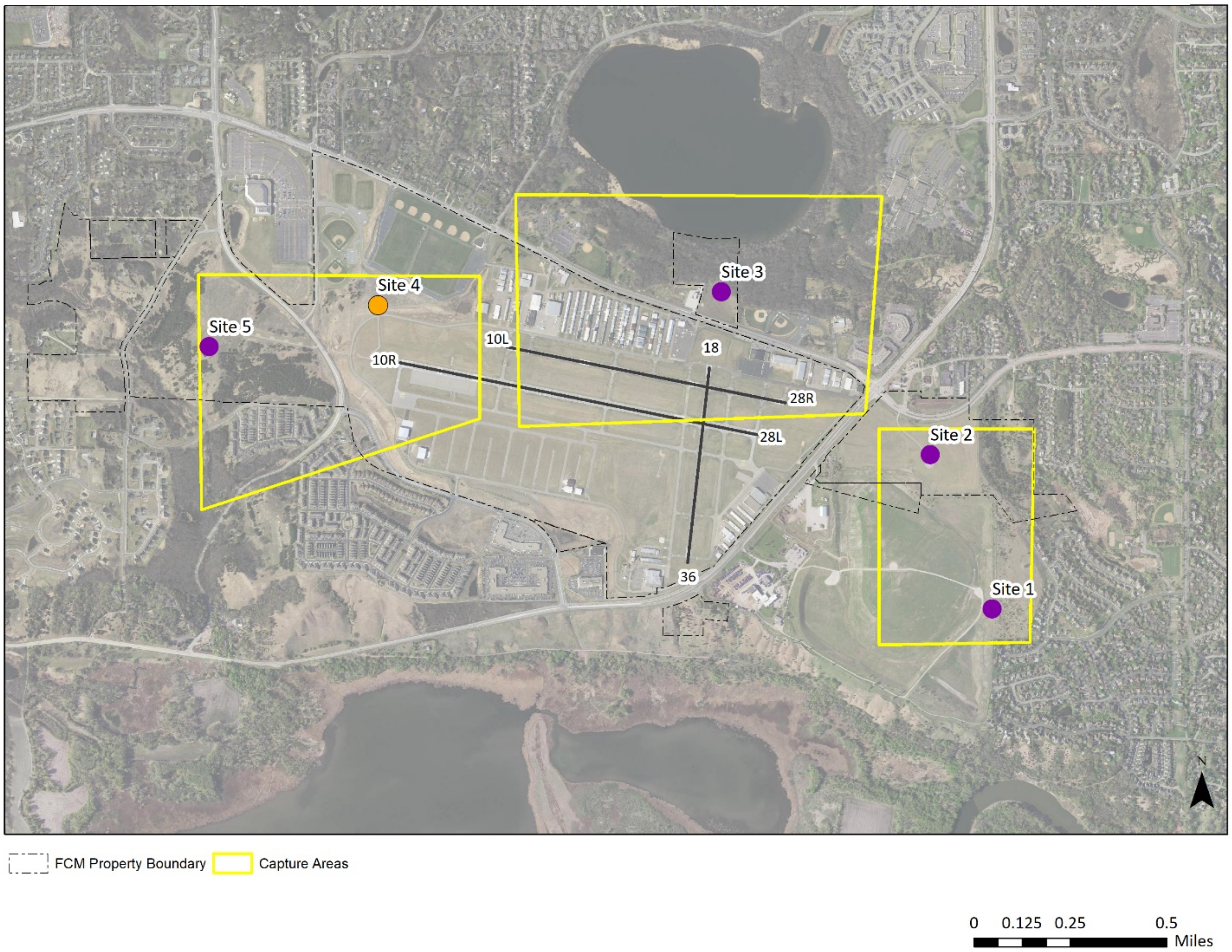
Each identified capture area was evaluated for its proximity to aircraft operating in a typical manner at FCM as well as ground conditions, environmental sounds, security, and accessibility. Figure 3.1 shows north, east, and west capture areas outlined in yellow. A southern capture area was not established because of challenges with security and accessibility. Additionally, there are no Eden Prairie residences south of FCM Runway 18/36.

East Capture Area: Sites 1 and 2 were positioned in the east capture area to measure aircraft sound events as flights arrived on Runways 28R or 28L or departed from Runways 10L or 10R, aircraft that remained in the traffic pattern, or aircraft that performed south turn departures. Site 1 was positioned on the nearby Minnesota Pollution Control Agency's (MPCA) landfill property, and Site 2 was positioned on airport property.

North Capture Area: Site 3 was positioned on airport property in the north capture area to measure aircraft sound events as flights arrived on Runway 18 or departed from Runway 36, or aircraft that remained in the traffic pattern performing touch and go operations north of FCM.

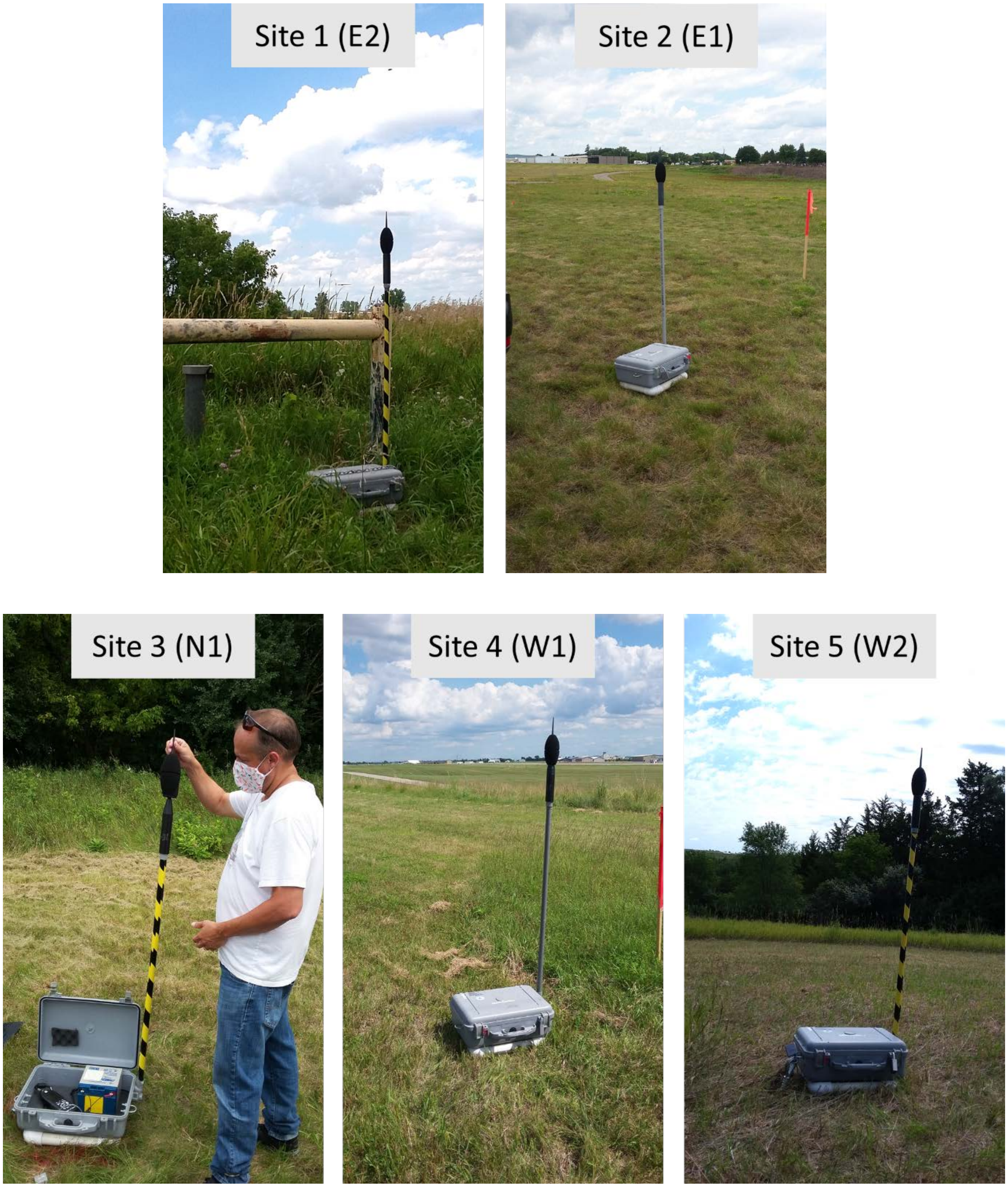
West Capture Area: Sites 4 and 5 were positioned in the west capture area to measure aircraft sound events as flights arrived on Runways 10L or 10R, aircraft that departed from Runways 28L or 28R, aircraft that remained in the traffic pattern, or aircraft that conducted south turn departures. Both Site 4 and Site 5 were positioned on airport property. Data collected at Site 4 were unable to be used for this study because the data were not retrievable at the conclusion of the study period.

Figure 3.1: Field Measurement Capture Areas and Equipment Locations



A photo of each field measurement site is provided in Figure 3.2. Equipment specifications and are provided in the Appendix.

Figure 3.2: Field Measurement Site Photos



3.2 Field Measurement and Analysis Parameters

One sound analyzer operated 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. When these sound event thresholds are met, the distance of the sound source from the measurement equipment is irrelevant.

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

3.3 Field-Measurement Data Results

There were 1,919 aircraft sound events and 255 community sound events measured at the monitoring sites during the seven-day study period. This section summarizes information for both aircraft and community sound sources described in terms of single event metrics (LA_{max}, SEL, Event Duration) and summary-based metrics (DNL, ADNL, CDNL and LA_{90}).

Single Event Metrics (LA_{max} and SEL)

The single event LA_{max} metric indicates the maximum sound level measured during the event. Table 3.1 shows the daily number of single event aircraft sounds that exceeded 65 dBA for four seconds. Overall, Site 2 (located in East Capture Area) and Site 5 (located in West Capture Area) measured the largest number of sound events with 847 and 778 events, respectively. Both of these sites measured a high level of activity due to the proximity of these sites to the most frequently used runways at FCM, Runways 28L/10R and 28R/10L. More detail about runway use was provided in Section 2.0.

The largest number of sound events on a daily basis captured during the study period occurred on Thursday, July 30 with 424 events and Monday, August 3 with 339. The smallest number of sound events occurred on Sunday, August 2 with 184 events and Saturday, and August 1 with 191 events.

Table 3.1: Number of Measured Single Event FCM Aircraft Sounds per Day

	Wednesday 29-Jul	Thursday 30-Jul	Friday 31-Jul	Saturday 1-Aug	Sunday 2-Aug	Monday 3-Aug	Tuesday 4-Aug	Site Total
Site 1	24	54	10	2	10	49	8	157
Site 2	122	280	63	41	59	222	60	847
Site 3	7	23	7	2	71	18	9	137
Site 4*	-	-	-	-	-	-	-	-
Site 5	155	67	141	146	44	50	175	778
Daily Total	308	424	221	191	184	339	252	1,919

**Data from Site 4 are not available.*

Figure 3.3 shows the number of aircraft sound events that were measured each hour during the study period. The highest numbers of sound events were captured during the 11:00 A.M. and 12:00 P.M.

hours with 178 and 166 events, respectively. On an hourly basis, the highest number of sound events that were captured during a one-hour period occurred at Site 5 with 81 sound events during the 11:00 A.M. hour. Site 2 measured the second-highest number with 73 events during both the 11:00 A.M. and 12:00 P.M. hour. 87 aircraft sound events were measured during nighttime hours of 10:00 P.M. – 7:00 A.M. There were no aircraft sound events measured during the 1 A.M. or 2 A.M. hours.

Figure 3.3: Number of Single Event FCM Aircraft Sounds Above 65 dBA per Hour

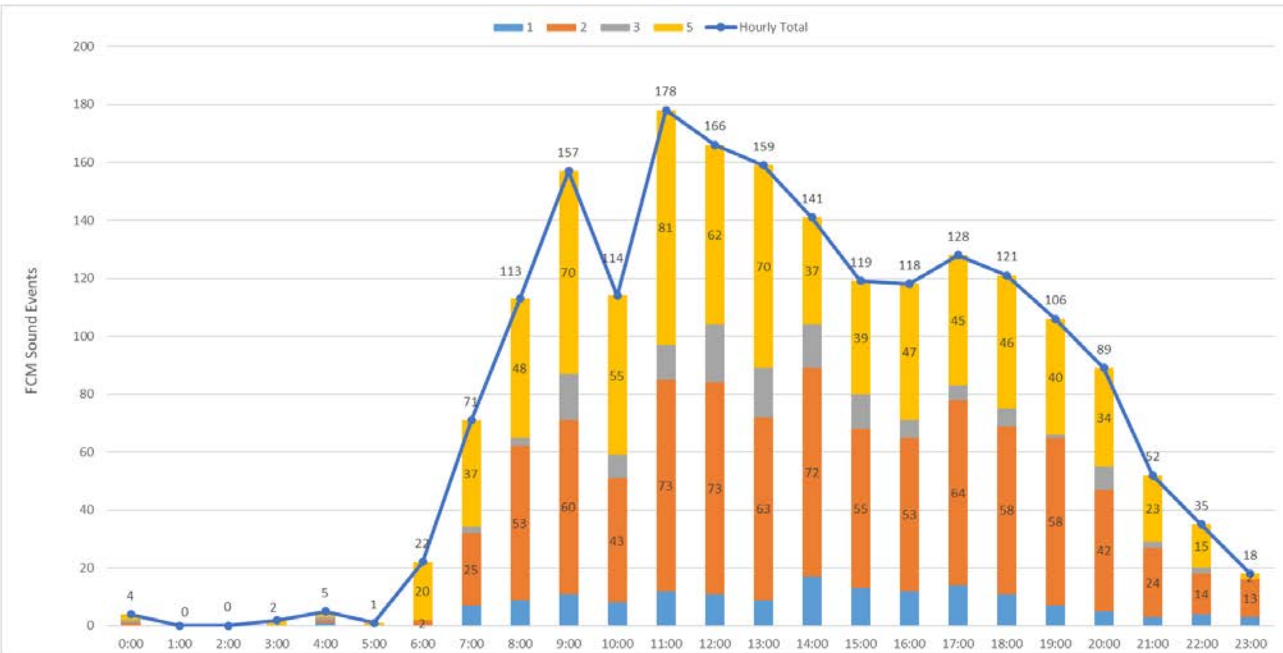


Table 3.2 shows the number of measured aircraft arrival and departure sound events with LA_{max} levels at or above 65 dBA, 80 dBA, 90 dBA, and 100 dBA at each site. A total of 1,919 sound events were measured at or above 65 dBA. Of those, 385 events were at or above 80 dBA and 18 were at or above 90 dBA. There were no aircraft sound events above 100 dBA.

The highest number of arrival sound events was 682, measured at Site 2, and the second highest number of arrival sound events was measured at Site 5 with 519 events. The highest number of departure sound events were measured at Site 5 with 259 events and Site 2 with 165 events. Fifty-four percent of the aircraft sounds over 65 dBA were attributed to touch and go operations.

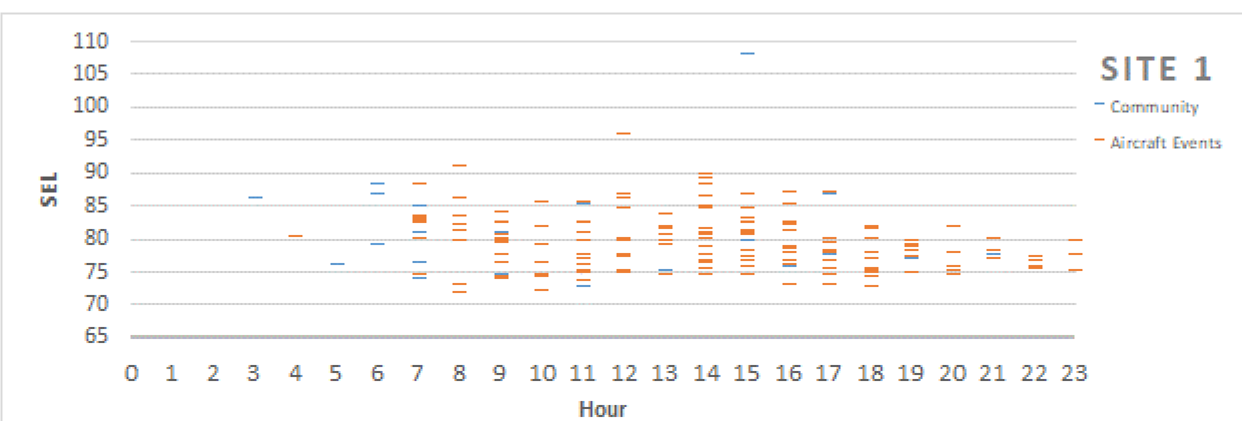
Table 3.2: Number of Single Event FCM Aircraft Sounds by Level				
Aircraft Arrival Events				
Site	**# of Events > 65dBA**	**# of Events > 80dBA**	**# of Events > 90dBA**	**# of Events > 100dBA**
1	83	1	0	0
2	682	119	3	0
3	92	31	0	0
4*	-	-	-	-
5	519	52	1	0
Arrival Total	**1,376**	**203**	**4**	**0**
Aircraft Departure Events				
Site	**# of Events > 65dBA**	**# of Events > 80dBA**	**# of Events > 90dBA**	**# of Events > 100dBA**
1	74	6	0	0
2	165	72	4	0
3	45	12	2	0
4*	-	-	-	-
5	259	92	8	0
Departure Total	**543**	**182**	**14**	**0**
Arrival & Departure Total	**1,919**	**385**	**18**	**0**

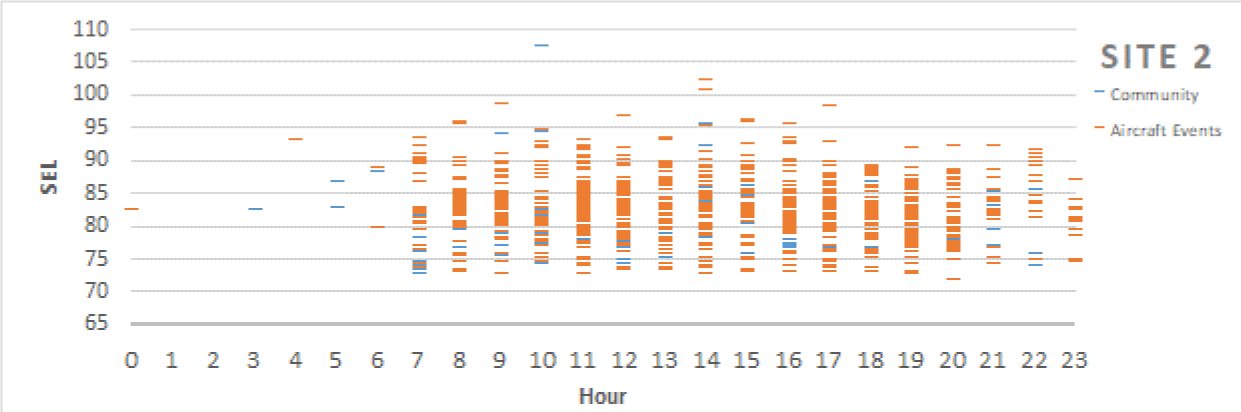
**Data from Site 4 are not available.*

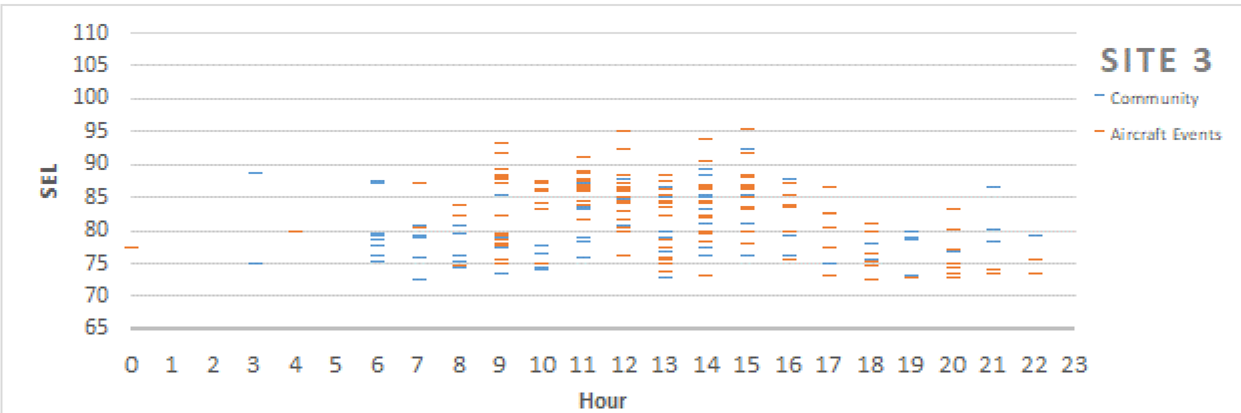
Single events cannot be directly compared without normalization due to variations in sound levels and durations. The Sound Exposure Level (SEL) metric provides us with a way to directly compare each event by expressing the sound energy of that event as a single second (1s) value, regardless of the actual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

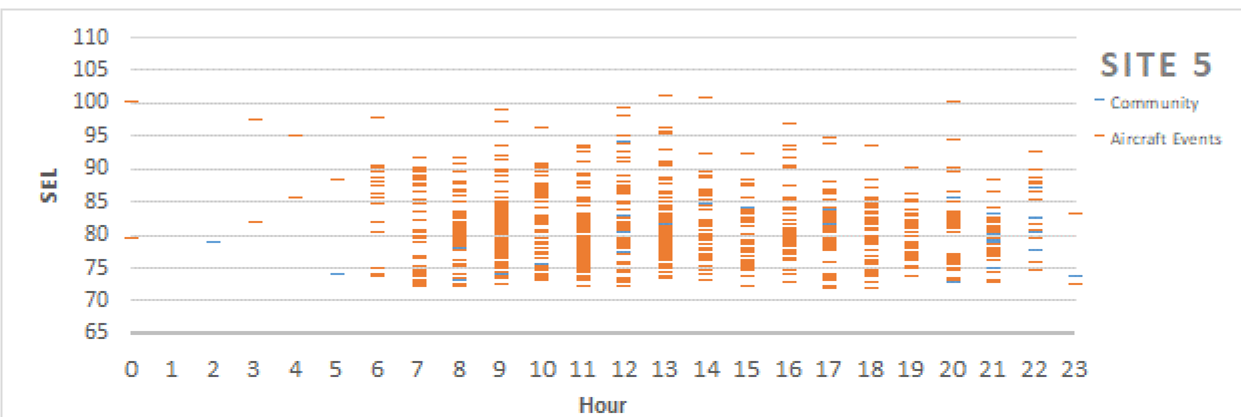
Figure 3.4 shows the measured hourly aircraft and community SEL events for each site.

Figure 3.4: Aircraft and Community Single Events per Hour (SEL)









Sites 1 and 2 measured the highest SEL community events, and the highest SEL aircraft events occurred at Site 5 and Site 2. 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 loudest aircraft, a Falcon 9000 jet (F900) departing at 2:01 P.M. August 2, 2020, was measured at Site 5 with an LA_{max} of 96.9 and SEL of 100.6. The next loudest aircraft, a Dassault Falcon 50 jet (FA50) departing at 2:03 P.M. on July 30, 2020, occurred at Site 2 with an LA_{max} of 96.3 and SEL of 102.1. Overall, jet aircraft and propeller-driven aircraft are each associated with half of the top-ten loudest sound events with 20 top-ten sound events each.

Table 3.3: Top-Ten Single Event FCM Aircraft Sounds per Site

Site 1- East Capture Area (E2)

Date and Time	LA_{max}	Duration (Seconds)	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
8/3/2020 12:34	89.2	21	95.9	BE40	N287LS	1	1
7/30/2020 8:46	86.7	12	91.1	BE58	N6024C	2	2
7/31/2020 14:24	84.9	15	89.9	BE36	N17669	3	3
7/29/2020 14:26	83.2	22	89.0	AT6G	N29931	4	4
8/3/2020 15:20	82.4	9	86.8	KODI	N565E	5	10
8/3/2020 7:39	80.8	16	88.1	CL35	N714F	6	6
7/30/2020 10:46	80.1	12	85.6	PA28	N279SR	7	15
8/3/2020 12:39	79.7	14	86.7	C25B	N925EM	8	11
7/30/2020 8:04	79.6	15	86.1	UNK	N/A	9	13
7/30/2020 16:30	79.5	17	86.9	PA27	N17WE	10	9

Site 2- East Capture Area (E1)

Date and Time	LA_{max}	Duration	SEL	Aircraft Type	Flight ID	Rank LA_{max}	Rank SEL
7/30/2020 14:03	96.3	23	102.1	FA50	N92CJ	1	1
7/30/2020 14:34	93.9	30	100.6	FA50	N92CJ	2	2
8/3/2020 9:59	91.7	20	98.5	BE40	N9WW	3	3
8/3/2020 8:53	91.3	15	96.0	CL30	N801PH	4	7
8/3/2020 16:45	91.2	17	95.5	AT6G	N29931	5	9
7/29/2020 14:26	91.1	27	95.3	NAVI	N645DS	6	11
8/3/2020 17:14	90.9	23	98.4	P28A	N71141	7	4
8/3/2020 12:34	89.9	19	96.8	BE40	N287LS	8	5
7/31/2020 15:14	89.0	21	96.3	C560	N567F	9	6
7/30/2020 15:12	88.9	18	95.8	BE40	N300RC	10	8

Site 3- North Capture Area (N1)							
Date and Time	**LA_{max}**	**Duration**	**SEL**	**Aircraft Type**	**Flight ID**	**Rank LA_{max}**	**Rank SEL**
8/2/2020 12:17	90.5	16	94.8	M20P	N1067W	1	2
8/2/2020 15:26	90.5	16	95.2	SR22	N8ZP	2	1
8/2/2020 14:36	88.2	16	93.6	SR22	N505PG	3	3
8/2/2020 15:30	86.9	16	91.7	C177	N16185	4	6
8/2/2020 9:30	86.3	18	91.6	SR20	N933JB	5	7
8/2/2020 9:34	86.1	19	93.2	SR22	N711FF	6	4
7/30/2020 12:18	86.1	15	92.3	WACO	N23JL	7	5
8/2/2020 11:11	85.4	14	91.1	LANC	N350RP	8	8
8/2/2020 14:31	84.8	14	90.4	SR20	N933JB	9	9
8/2/2020 9:19	83.9	14	89.0	C172	N6301D	10	10

Site 5- West Capture Area (W2)							
Date and Time	**LA_{max}**	**Duration**	**SEL**	**Aircraft Type**	**Flight ID**	**Rank LA_{max}**	**Rank SEL**
8/2/2020 14:01	96.9	16	100.6	F900	N382KU	1	2
7/31/2020 12:55	94.8	18	99.2	F900	N115RL	2	5
7/29/2020 13:34	94.7	38	101.0	AT6G	N29931	3	1
8/1/2020 20:12	94.0	22	100.2	BE40	N287LS	4	3
7/30/2020 0:52	93.3	20	100.0	BE40	N287LS	5	4
8/2/2020 9:04	92.6	17	97.1	H25B	CJE684	6	10
8/1/2020 9:29	92.2	21	98.8	C560	LAK307	7	6
7/29/2020 12:25	90.6	32	98.0	BE40	N287LS	8	7
7/31/2020 13:18	90.0	15	95.3	C25A	N970ZG	9	15
7/29/2020 13:30	89.8	16	96.2	C560	N86CV	10	12

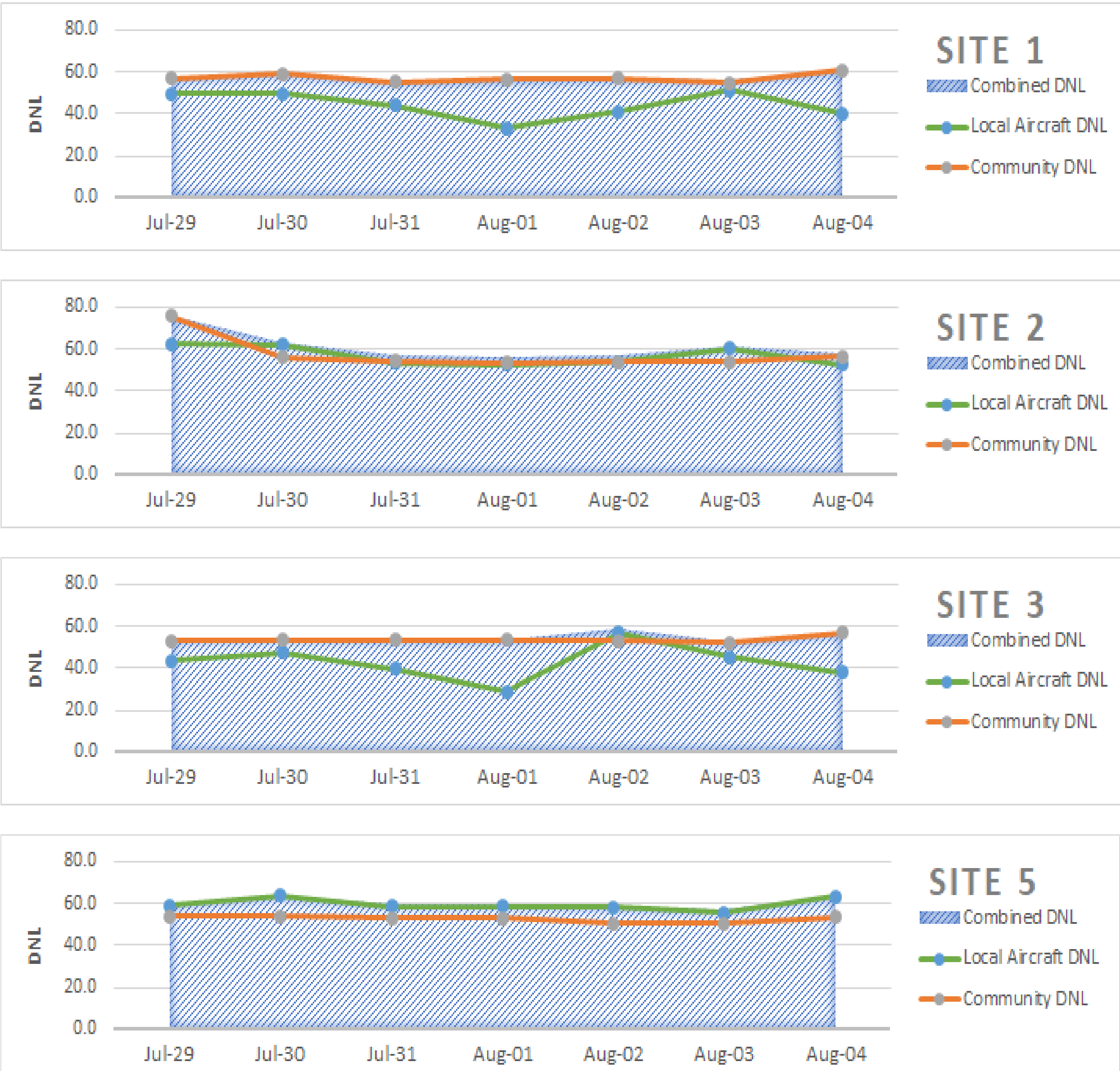
Summary-Based Metrics

Day-Night Average sound level (DNL) is prescribed by the Federal Aviation Administration for representing the total accumulation of all sound energy during an average 24-hour day with a 10 dB penalty added to each sound between 10:00 P.M. and 7:00 A.M. The current federally established threshold of significance is 65 dB DNL. DNL at or above 65 dB are considered incompatible for sensitive land uses such as residences and schools.

Figure 3.5 shows the Aircraft DNL (ADNL) and Community DNL (CDNL) accumulations during the study period for each site. The highest ADNL during the study period occurred at Site 5, on airport property, on July 30 and August 4 with 63.7 and 63.2 dB DNL, below the FAA threshold of significance. The CDNL at Site 5 on these days was about 10 dB DNL lower, calculated at 53.9 and 53.5 dB DNL on each of the noted dates. The combined DNL for Site 5 peaked at 64.1 dB DNL on July 30, the second highest combined DNL during the study period considering all aircraft and community sounds at all sites.

The highest combined DNL was 75.8 dB DNL, which occurred at Site 2, on airport property, on July 29. The CDNL of 75.6 dB DNL and the ADNL of 62.3 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 3.5: Aircraft and Community DNL Accumulations



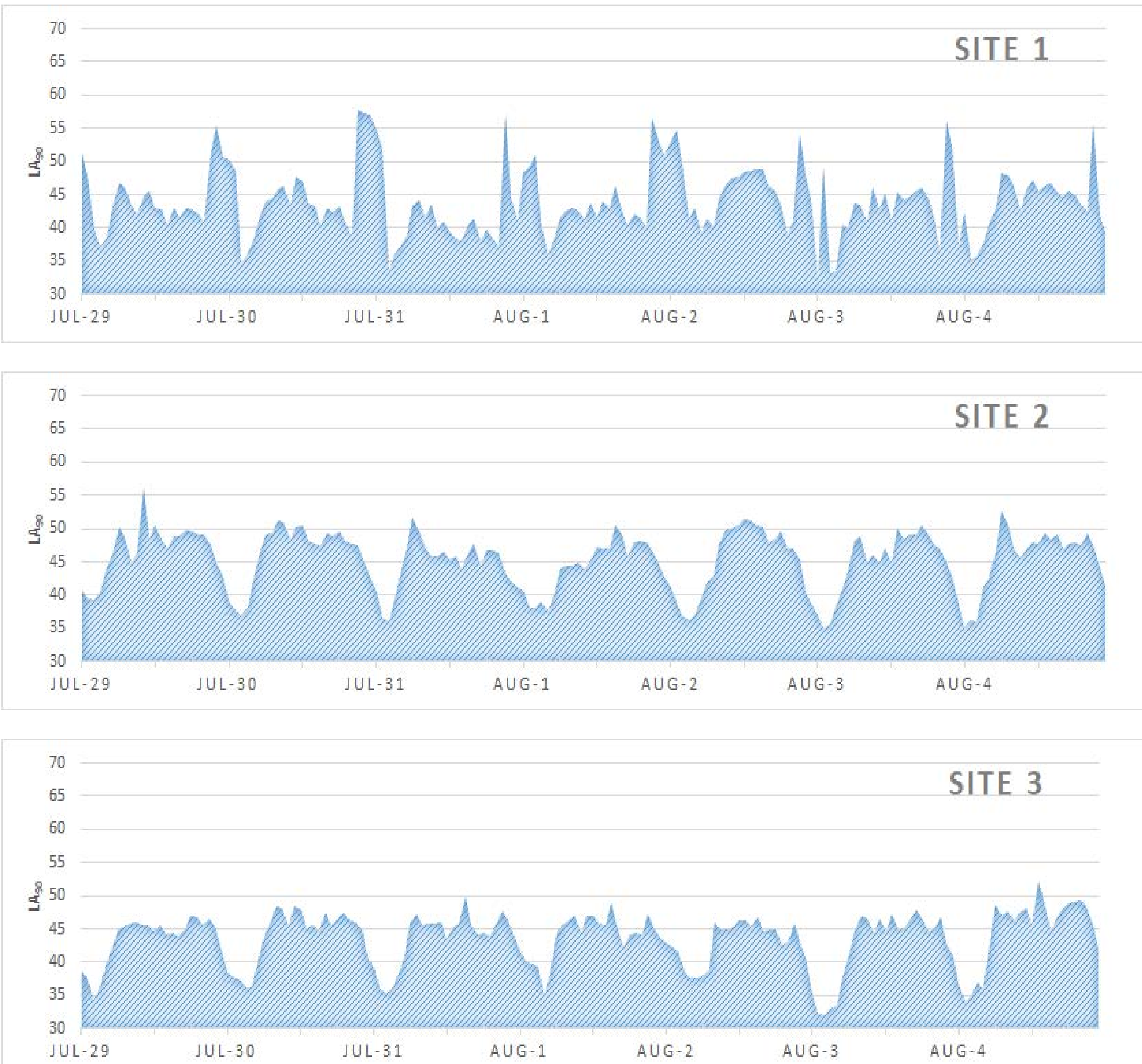
Background Sound Levels

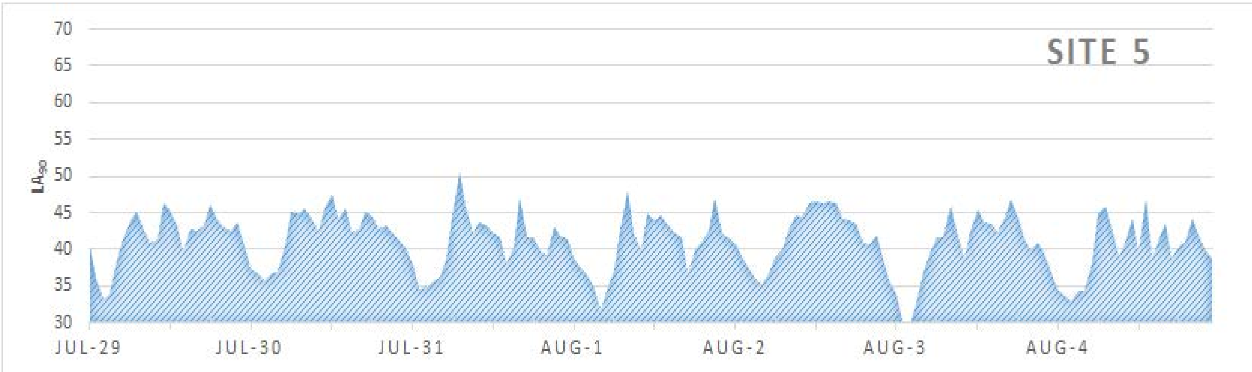
Sounds are emitted around us constantly by sources we cannot always see, such as wind, mechanical equipment, insects, freeways, etc. Because these sounds vary in intensity and frequency, the levels may fluctuate from second-to-second and from hour-to-hour. Background levels are important when observing and comparing sound sources to achieve objectivity.

A common method to estimate the background sound level is to use a statistical metric called the LA_{90} which provides us the A-Weighted sound level that is exceeded 90 percent of the time. In this study, we measured the hourly LA_{90} for each field measurement site throughout the study period. Figure 3.6 shows the LA_{90} levels measured at each site during the study period.

The LA_{90} levels were highest in the vicinity of Site 1, with averages of 57.7 dB, 57.2 dB, and 57.1 dB closing out the day on July 30 during the 9:00 P.M., 10:00 P.M., and 11:00 P.M. hours, respectively.

Figure 3.6: Hourly Average Background Sound Levels




SITE 5
70
65
60
55
50
45
40
35
30
LA_{90}
JUL-29
JUL-30
JUL-31
AUG-1
AUG-2
AUG-3
AUG-4

4.0 Sound Modeling

In addition to field monitoring, FCM aircraft activity from July 29, 2020 through August 4, 2020 was modeled using the FAA's modeling tool, AEDT, Version 3b. 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. Additionally, modeling provides sound data over a wider area compared to monitoring, which only allows data to be collected near the field measurement site.

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 operating characteristics. Additionally, modeling requires aircraft substitutions. While many aircraft have sound data available in the model, all aircraft types operating at FCM are not represented and need to use a substitute aircraft in the model. While the goal of conducting monitoring studies and producing modeling results are similar and will often times produce the same sound metric results, the differences between actual monitoring and sound modeling will result in variances between the data due to community sound, measurement parameters, and necessary model assumptions.

The AEDT model can produce various sound metrics. Two metric options available are the Number Above Sound Level and Time Above Sound 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 FCM from July 29, 2020 through August 4, 2020 using model inputs such as runway use, aircraft fleet mix, aircraft performance and thrust settings, topography, and atmospheric conditions. Actual flight tracks for arrivals and departures were used. Touch and go operations were quantified and applied to modeled tracks.

Quantifying aircraft-specific sound characteristics in AEDT is accomplished using a comprehensive sound database that has been developed under 14 CFR Part 36. As part of the airworthiness certification process, aircraft manufacturers are required to subject aircraft to a battery of sound measurement 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.3 includes the fleet mix and Appendix A.4 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.4, 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.

Figure 4.1: Number of Events Above 65 dB per Day

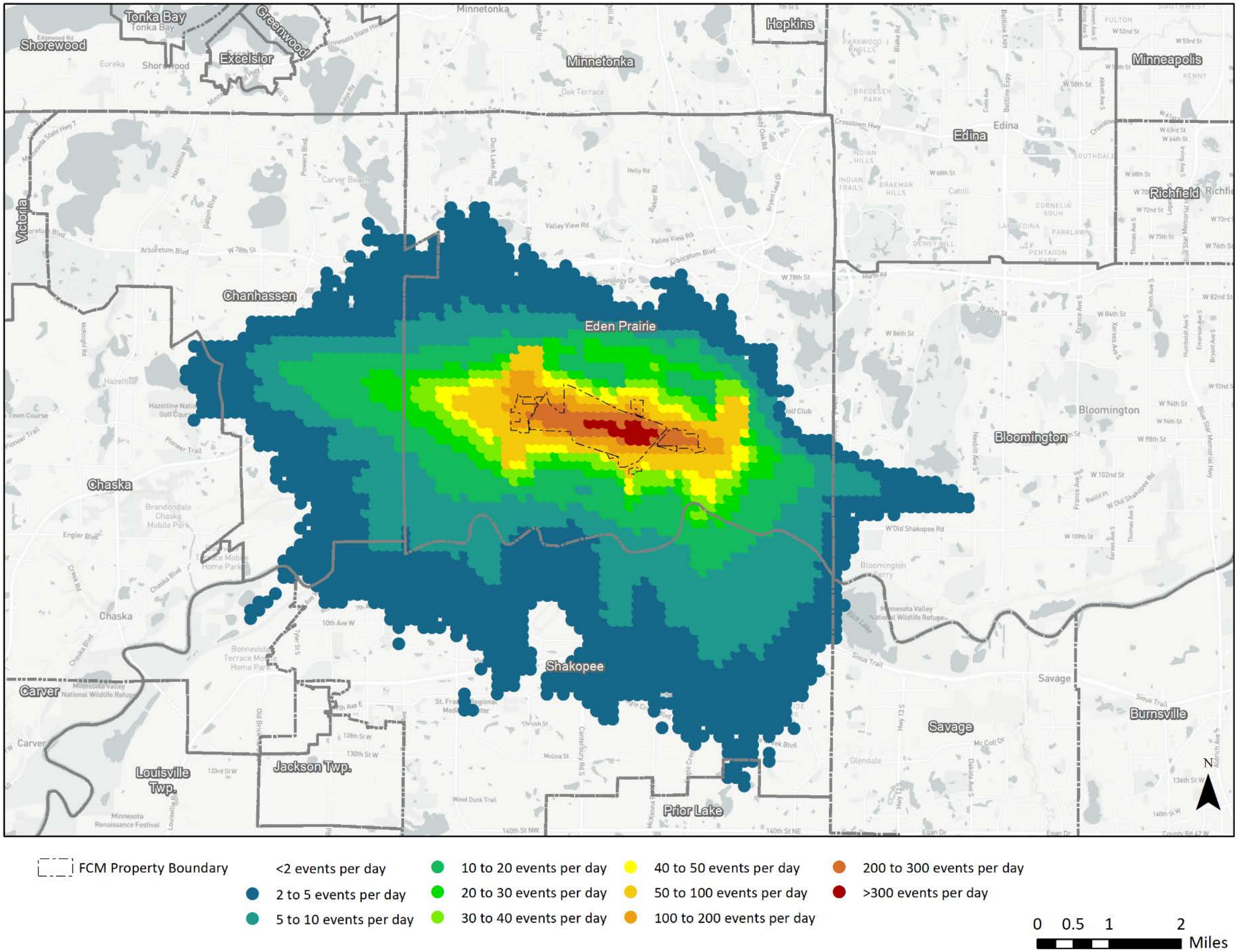


Table 4.1 below provides the total number of sound events above 65 dBA modeled to occur at a monitoring location during the study period at FCM. The table also provides the number of monitored sound events above 65 dBA correlated to FCM aircraft during the study period for comparison.

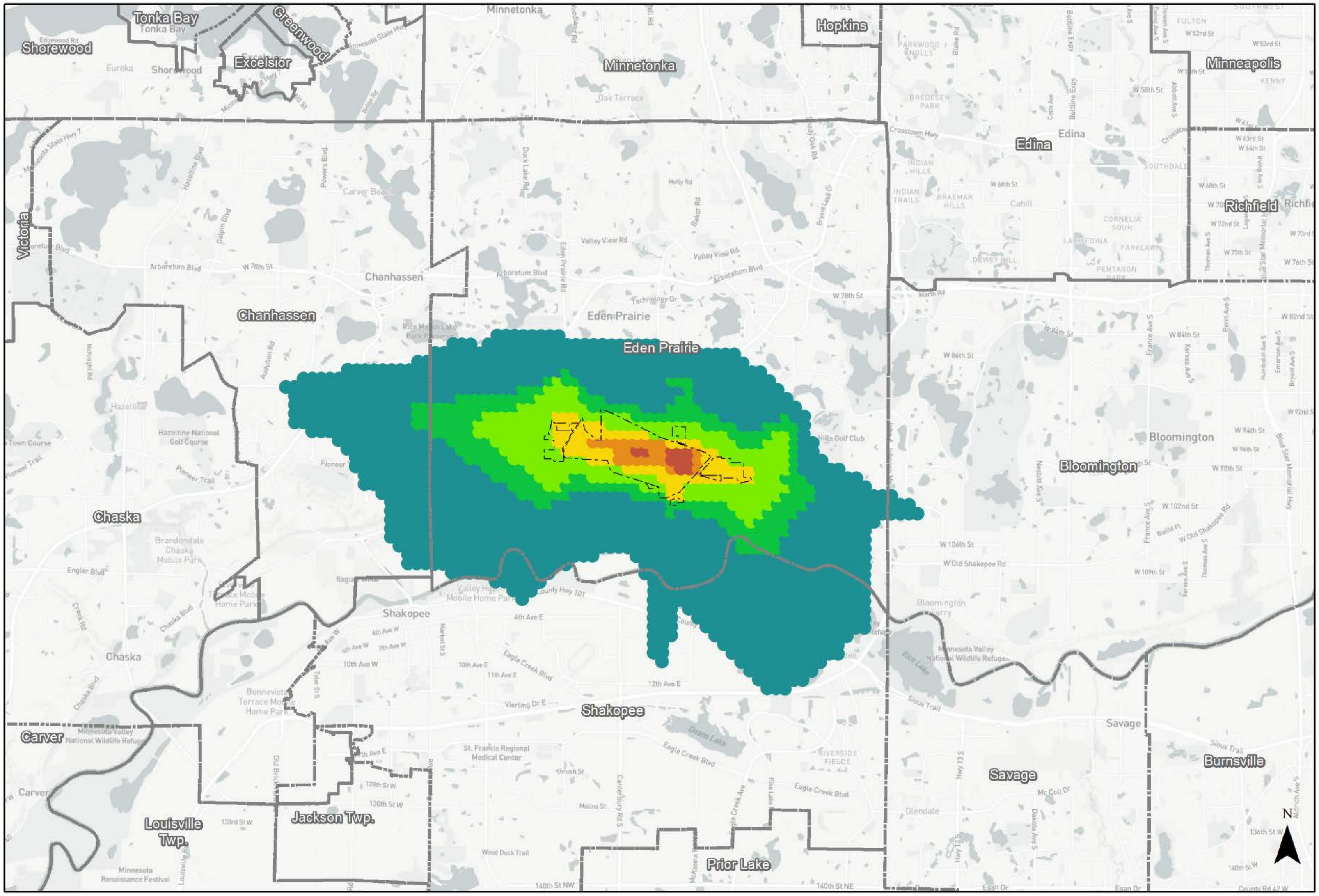
Table 4.1 Measured Vs Modeled Number Above 65dB			
Site	N^{65} Measured	N^{65} Modeled	Difference
1	157	364	207
2	847	1,745	898
3	137	773	636
4	-	1,904	1,904
5	778	1,541	763

Figure 4.2 shows the modeled grid points by average time spent above 65 dBA per day during the study period. Grid points that exceeded 65 dBA for more than 90 minutes per day are all located within airport property.

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

Table 4.2 Measured Vs Modeled Time Above 65dB			
Site	TA^{65} Measured (min)	TA^{65} Modeled (min)	Difference (min)
1	30.23	95.66	64.43
2	164.72	310.2	145.48
3	26.7	199.44	172.74
4	-	477.36	477.36
5	141.83	360.95	219.12

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



FCM Property Boundary
<1 min per day
1 to 5 min per day
5 to 10 min per day
10 to 30 min per day
30 to 60 min per day
60 to 90 min per day
>90 min per day

0 0.5 1 2 Miles

5.0 Noise Complaints

During the study period, 1,339 complaints were received from 25 households. Table 5.1 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	Complaints per Operation
Commercial	2	1	0.5
Helicopter	18	2	0.1
Jet	174	136	0.8
Piston	1,669	1,055	0.6
Prop Single Engine	9	7	0.8
Turbo-Prop	113	86	0.8
Unknown	23	14	0.6
Blank	0	38	-
Total	**2,008**	**1,339**	**0.7**

Of the complaints received, 160 were received during nighttime hours, between 10:00 P.M. and 7:00 A.M. As noted previously, there were 67 operations that occurred between these hours during the study period.

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: FCM Study Period Complaint Heat Map

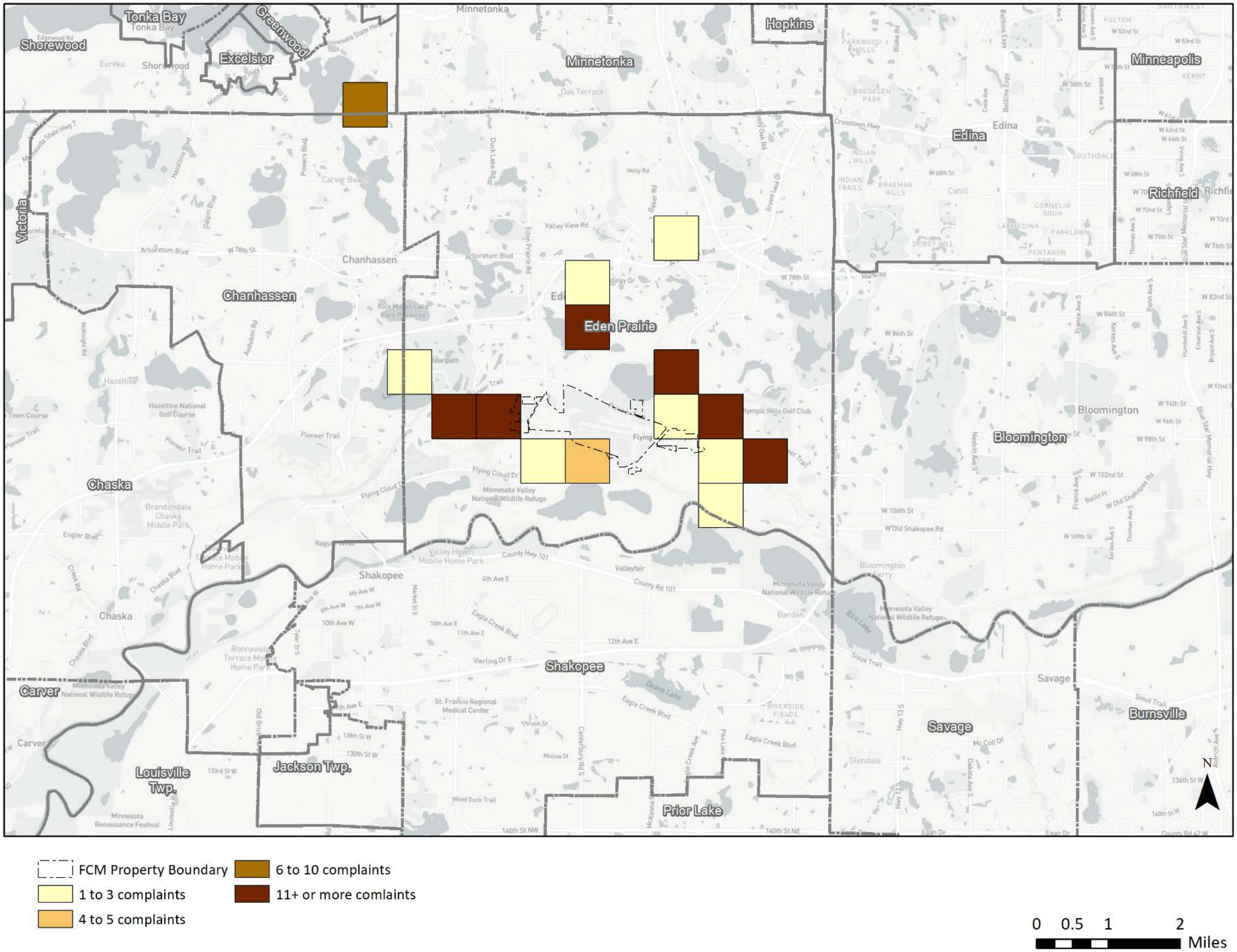
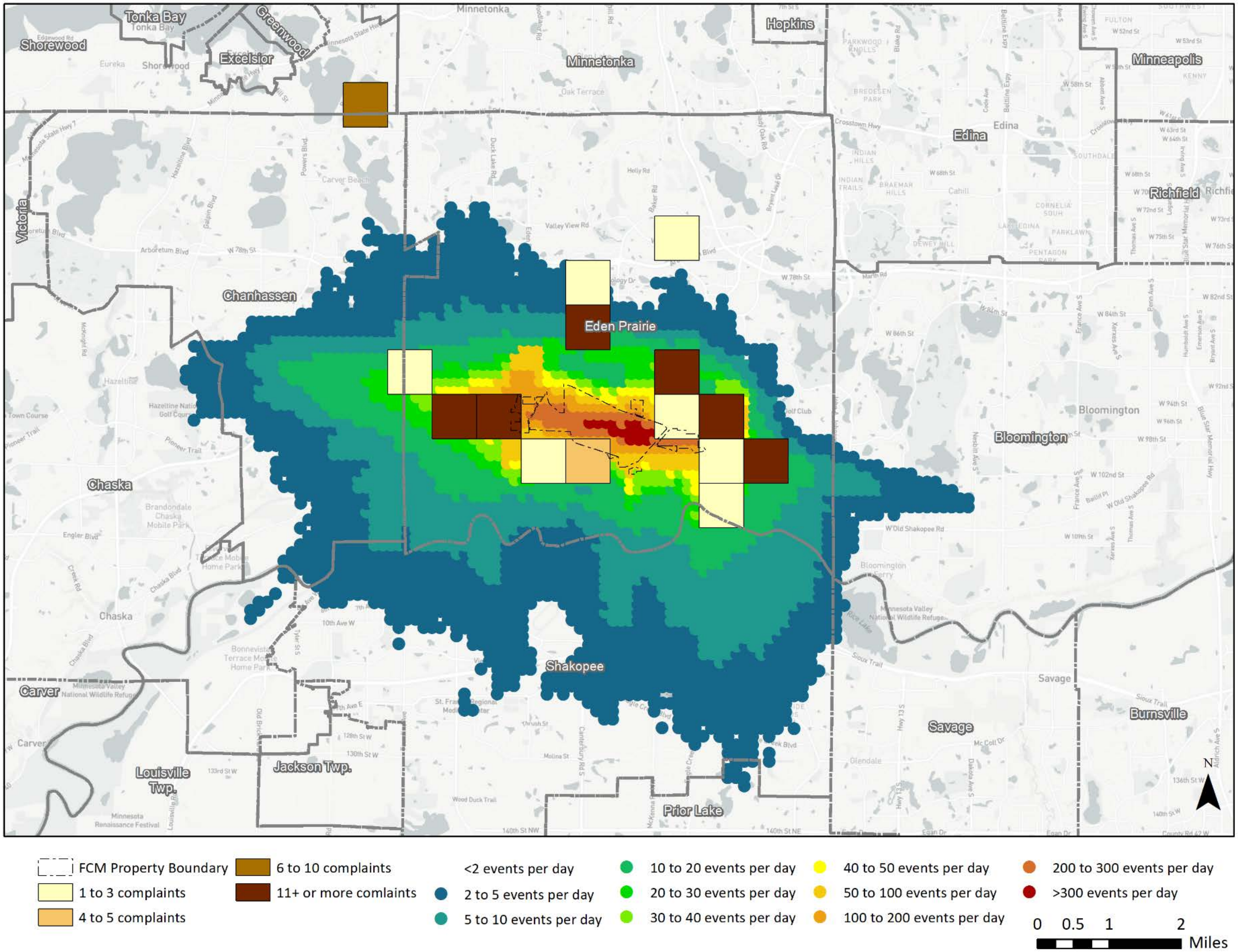


Figure 5.2: FCM Study Period Complaint Heat Map with Number of Events Above 65 dB



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 publicly-owned property (preferred).

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

Site	Year	Date	ADNL	CDNL	Combined DNL
1	2020	29-Jul	49.7	56.6	57.4
1	2020	30-Jul	49.5	59	59.5
1	2020	31-Jul	44.1	55	55.3
1	2020	1-Aug	33.1	56.4	56.4
1	2020	2-Aug	40.9	56.8	56.9
1	2020	3-Aug	51.1	54.4	56.1
1	2020	4-Aug	39.8	60.7	60.7
2	2020	29-Jul	62.3	75.6	75.8
2	2020	30-Jul	61.8	55.8	62.8
2	2020	31-Jul	53.3	54.2	56.8
2	2020	1-Aug	52.5	53.4	56
2	2020	2-Aug	53.6	53.7	56.7
2	2020	3-Aug	60.2	53.7	61.1
2	2020	4-Aug	52.6	56.5	58
3	2020	29-Jul	43.4	52.8	53.3
3	2020	30-Jul	47.2	53.5	54.4
3	2020	31-Jul	39.8	53.3	53.5
3	2020	1-Aug	28.9	53.3	53.3
3	2020	2-Aug	56.8	53	58.3
3	2020	3-Aug	45	51.9	52.7
3	2020	4-Aug	37.8	56.6	56.7
5	2020	29-Jul	58.9	53.6	60
5	2020	30-Jul	63.7	53.9	64.1
5	2020	31-Jul	58.6	52.8	59.6
5	2020	1-Aug	58.5	52.7	59.5
5	2020	2-Aug	58	50.4	58.7
5	2020	3-Aug	55.7	50.3	56.8
5	2020	4-Aug	63.2	53.5	63.6

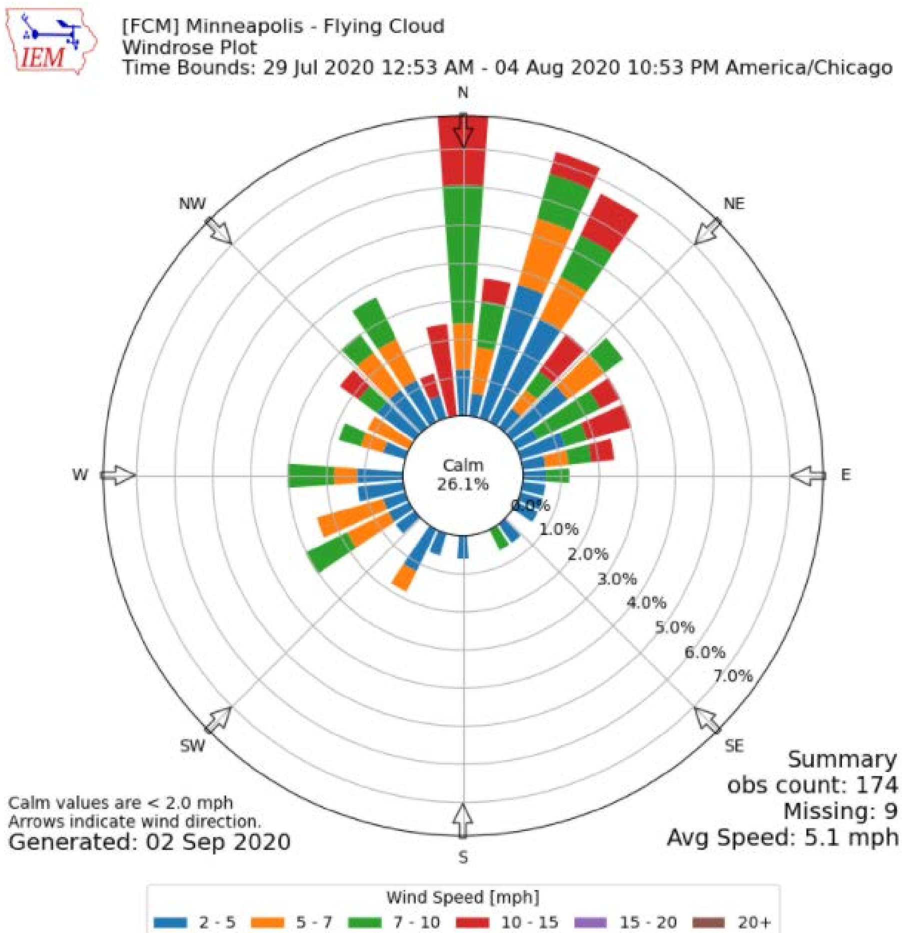
A.3 Modeled Aircraft Distribution

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Jet	**105.7**	**105.7**	**0.0**	**211.3**
Bombardier Challenger 300	3.4	3.4	0.0	6.8
Bombardier Challenger 350	3.4	3.4	0.0	6.8
Bombardier Challenger 601	3.4	4.5	0.0	8.0
Bombardier Learjet 40	0.0	1.1	0.0	1.1
Bombardier Learjet 45	3.4	3.4	0.0	6.8
Cessna 500 Citation I	1.1	0.0	0.0	1.1
Cessna 525 CitationJet	5.7	5.7	0.0	11.4
Cessna 525A CitationJet	0.0	1.1	0.0	1.1
Cessna 525B CitationJet	5.7	5.7	0.0	11.4
Cessna 525C CitationJet	5.7	5.7	0.0	11.4
Cessna 550 Citation II	2.3	1.1	0.0	3.4
Cessna 560 Citation Excel	23.9	25.0	0.0	48.9
Cessna 650 Citation III	1.1	1.1	0.0	2.3
Cessna 680 Citation Sovereign	9.1	9.1	0.0	18.2
Cessna 750 Citation X	2.3	2.3	0.0	4.5
CESSNA CITATION 510	1.1	1.1	0.0	2.3
Dassault Falcon 10	1.1	1.1	0.0	2.3
Dassault Falcon 2000	2.3	2.3	0.0	4.5
Dassault Falcon 50	2.3	3.4	0.0	5.7
Dassault Falcon 900	2.3	2.3	0.0	4.5
Embraer 500	10.2	8.0	0.0	18.2
Embraer ERJ135-LR	1.1	1.1	0.0	2.3
Raytheon Beechjet 400	13.6	12.5	0.0	26.1
Raytheon Hawker 800	1.1	1.1	0.0	2.3
Piston	**749.9**	**651.0**	**2338.2**	**3739.1**
Single Engine	**712.4**	**620.3**	**2315.5**	**3648.2**
Aero Commander	0.0	1.1	0.0	1.1
American Champion Cibrata	2.3	1.1	20.5	23.9
American Champion Scout	1.1	0.0	4.5	5.7
Beech 24 Musketeer Super Sierra	1.1	1.1	0.0	2.3
Beechcraft Bonanza 33	5.7	5.7	4.5	15.9
Beechcraft Bonanza 35	9.1	10.2	2.3	21.6
Bellanca 8 Scout Super Decathlon	9.1	6.8	29.5	45.4
Bellanca Viking	1.1	1.1	0.0	2.3
Boeing Stearman PT-17 / A75N1	1.1	1.1	11.4	13.6
Cessna 140	2.3	3.4	6.8	12.5
Cessna 150 Series	29.5	23.9	52.3	105.7
Cessna 152	77.3	50.0	427.2	554.4
Cessna 172 Skyhawk	165.9	143.2	974.8	1283.9
Cessna 175	2.3	2.3	0.0	4.5
Cessna 177	2.3	1.1	13.6	17.0
Cessna 182	21.6	25.0	0.0	46.6
Cessna 182R	1.1	0.0	0.0	1.1
Cessna 190	1.1	1.1	0.0	2.3
Cessna 206	11.4	4.5	0.0	15.9
Cessna 210 Centurion	8.0	8.0	0.0	15.9
Cessna 210 Turbo	1.1	2.3	0.0	3.4
Cirrus SR20	14.8	11.4	115.9	142.0
Cirrus SR22	51.1	47.7	38.6	137.5

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Cirrus SR22 Turbo	10.2	9.1	29.5	48.9
Columbia Aircraft Lancair (COL3/4 All Types)	4.5	5.7	0.0	10.2
Diamond DA40	2.3	0.0	11.4	13.6
Diamond DV-20 Katana	6.8	6.8	0.0	13.6
Glasair	1.1	1.1	0.0	2.3
Grumman AA-5A/B	1.1	1.1	4.5	6.8
Mooney M20-K	15.9	17.0	2.3	35.2
North American T-6 Texan	9.1	9.1	0.0	18.2
Piper J-3 Cub	1.1	1.1	0.0	2.3
Piper PA-18-150	6.8	6.8	0.0	13.6
Piper PA-24 Comanche	3.4	3.4	4.5	11.4
Piper PA-28 Cherokee Series	210.2	187.5	561.3	958.9
Piper PA-32 Cherokee Six	4.5	4.5	0.0	9.1
Piper PA46 Malibu	3.4	3.4	0.0	6.8
Raytheon Beech Bonanza 36	9.1	8.0	0.0	17.0
Vans RV6	1.1	1.1	0.0	2.3
Vans RV7	0.0	2.3	0.0	2.3
Vans RV9	1.1	0.0	0.0	1.1
Multi Engine	**37.5**	**30.7**	**22.7**	**90.9**
Cessna 340	1.1	0.0	0.0	1.1
Cessna 421 Piston	0.0	1.1	0.0	1.1
Piper PA-23 Apache/Aztec	2.3	1.1	20.5	23.9
Piper PA-27 Aztec	2.3	2.3	2.3	6.8
Piper PA-30 Twin Comanche	8.0	5.7	0.0	13.6
Piper PA-31 Navajo	1.1	1.1	0.0	2.3
Piper PA-34 Seneca	3.4	3.4	0.0	6.8
Piper PA-44	9.1	4.5	0.0	13.6
Raytheon Beech 55 Baron	4.5	3.4	0.0	8.0
Raytheon Beech 60 Duke	1.1	1.1	0.0	2.3
Raytheon Beech Baron 58	4.5	6.8	0.0	11.4
Turboprop	**72.7**	**78.4**	**50.0**	**201.1**
Single Engine	**30.7**	**35.2**	**11.4**	**77.3**
Cessna 180	8.0	9.1	11.4	28.4
Cessna 208 Caravan	2.3	3.4	0.0	5.7
EADS Socata TBM-700	5.7	4.5	0.0	10.2
Maule MT-7-235	1.1	1.1	0.0	2.3
Pilatus PC-12	6.8	6.8	0.0	13.6
Piper PA46-TP Meridian	4.5	5.7	0.0	10.2
Quest Kodiak 100	1.1	2.3	0.0	3.4
Socata TBM-9	1.1	2.3	0.0	3.4
Multi Engine	**42.0**	**43.2**	**38.6**	**123.8**
Aero Commander 680 Turbo Commander	5.7	6.8	0.0	12.5
Cessna 441 Conquest II	2.3	2.3	0.0	4.5
Raytheon King Air 90	2.3	2.3	31.8	36.4
Raytheon Super King Air 200	26.1	25.0	6.8	57.9
Raytheon Super King Air 300	5.7	6.8	0.0	12.5
Helicopter	**5.7**	**6.8**	**0.0**	**12.5**
Single Engine	**3.4**	**5.7**	**0.0**	**9.1**
Bell 206B-3	3.4	5.7	0.0	9.1
Multi Engine	**2.3**	**1.1**	**0.0**	**3.4**
Robinson R44 Raven / Lycoming O-540-F1B5	2.3	1.1	0.0	3.4

Aircraft Type	Arrival	Departure	Touch and Go	Total Operations
Grand Total	**933.9**	**841.9**	**2388.2**	**4164.0**

A.4 FCM Weather Details



Source:http://mesonet.agron.iastate.edu/sites/dyn_windrose.phtml?station=FCM&network=MN_ASOS&bin0=2&bin1=5&bin2=7&bin3=10&bin4=15&bin5=20&units=mph&nsector=36&fmt=png&dpi=100&year1=2020&month1=7&day1=29&hour1=0&minute1=0&year2=2020&month2=8&day2=4&hour2=23&minute2=0

Table A.1: Model Weather Inputs	
Average Temp	70
Average Wind Speed	6.2
Average Dew Point	56
Average Sea Level Pressure (SLP)	29.19
Average Relative Humidity	60.7
Average SLP (millibar)	988.52

A.5 Glossary

Aircraft Operation

Aircraft arriving or departing from FCM, 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 the background sound levels or 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

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