Aviation Planning at the Leading Edge

To: CHRIS POMEROY, FRIEDMAN MEMORIAL AIRPORT

From: Chris Sandfoss

Cc: Rob Adams

Date: 11/28/2017

Re: SUN Peak Day Noise Modeling Methodology

INTRODUCTION

This memo summarizes the methodology and results of the 2017 average-annual day and peak day noise analysis for Friedman Memorial Airport (SUN). This analysis focused on three operating conditions at SUN as described below:

1. 2017 Average-Annual Day: This scenario assessed typical conditions at SUN based upon the average daily number of operations. For this scenario, the total number of operations during the most recent 12-month period was calculated and divided by 365 to determine the average-annual operating levels.

2. 2017 Peak Month - Average Day: This scenario is based on the average day of the peak operating month at SUN. For this scenario, the total number of operations during the during the busiest month over the last 12-month period (July 2017) was calculated and divided by 31 to determine the peak month average day operating levels.

3. 2017 Peak Day: This scenario is based on the day with the highest total operations over the last 12 months (August 22nd).

PROPERTIES AND MEASUREMENT OF NOISE

Sound is created by a source that induces vibrations in the air. Sound is measured using the logarithmic decibel (dB) scale. The range of audible sound ranges from approximately 1 to 140 dB, although everyday sounds rarely rise above about 120 dB and typically, ambient (background) noise levels usually are in the 40-50 dB range depending upon whether the setting is urban or rural.

There are many ways to describe and measure sound. Sounds can be defined in terms of four components, level, pitch, duration, and propagation. Sound level is

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simply a measure of amplitude or "loudness" of a sound. Pitch or frequency is based on the spacing of sound vibrations or wavelength that determines whether or not the noise is low (such as a rumble) or high (such as a whistle). Duration refers to the length of time during which a sound is audible. Propagation refers to the dispersion of noise between the source of the sound and the receptor. As sound waves travel away from the source, the sound energy is distributed over a greater area, dispersing the sound energy. Propagation is affected by several factors, including distance, weather (wind, temperature, and humidity), and other features such as soft ground or trees that may absorb some of the sound energy.

Given the multiple dimensions of sound, a variety of descriptors, or metrics, have been developed for describing sound and noise. The 2017 average-annual day and peak day noise analysis for SUN used the following common noise metrics:

1. Maximum Level (Lmax)
2. Number of Events Above Level (NA)
3. Equivalent Sound Level (Leq)
4. Day-Night Average Sound Level (DNL)

<u>Maximum Level (Lmax)</u>

Lmax is simply the highest sound level recorded during an event or over a given period of time. Lmax, however, fails to provide any information about the <u>duration</u> of the sound event. This can be a critical shortcoming when comparing different sounds. Even if they have identical Lmax values, sounds of greater duration contain more sound energy than sounds of shorter duration.

<u>Number of Events Above Level (NA)</u>

The Number of Events Above (NA) metric indicates the total number of aircraft events at particular location that exceed a given sound level threshold in dB. The NA metric explicitly provides information about the number of sound events, although it conveys no information about the duration of the event(s). The particular noise threshold can be set to whatever level is appropriate for the situation being studied. Typically 65 dB is used, in which case the metric is abbreviated NA65.

<u>Equivalent Sound Level (LEQ)</u>

The equivalent sound level (Leq) metric may be used to define cumulative noise dosage, or noise exposure, over a period of time. In computing Leq, the total noise energy over a given period of time, during which numerous events may have occurred, is logarithmically averaged over the time period. The Leq represents the steady sound level that is equivalent to the varying sound levels actually occurring during the period of observation. For example, an 8-hour Leq of 67 dB indicates that

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the amount of sound energy in all the peaks and valleys that occurred in the 8-hour period is equivalent to the energy in a continuous sound level of 67 dB. Leq is typically computed for measurement periods of 1 hour, 8 hours, or 24 hours, although any time period can be specified.

Day-Night Average Sound Level (DNL)

The Day-Night Average Sound Level (DNL) metric is a variation of the 24-hour Leq metric. Like Leq, the DNL metric describes the total noise exposure during a given period. Unlike Leq, however, DNL, by definition, can only be applied to a 24-hour period. In computing DNL, an extra weight of 10 dB is assigned to any sound levels occurring between the hours of 10:00 p.m. and 7:00 a.m. This is intended to account for the greater annoyance that nighttime noise is presumed to cause for most people. Due to the logarithmic nature of the dB scale, this extra weight treats one nighttime noise event as equivalent to 10 daytime events of the same magnitude.

DNL is the standard metric used for environmental noise analysis per Federal requirements, including airport noise studies. Residential land uses are normally incompatible with noise levels at or above 65 DNL.

Due to the different ways in which noise can be perceived by different people, this analysis used the Lmax, NA, and DNL metrics to describe noise conditions. However, per Federal requirements, only DNL may be used to determine the significance of impacts for Federal noise mitigation funding. Other metrics are reported for informational purposes. The relationship between these metrics is shown in **Figure 1**. This graph shows a hypothetical example of continuous noise levels over a twenty minute period during which time several noise "events" occurred as shown by the blue line. In this example, five noise events occurred that caused noise levels to rise above background levels. Each of these five events has an Lmax value and the overall Lmax during the 20-minute period is 87.8 dB. The Leq, averaged over the 20-minute period, is 70.3. The NA65 value is four, since only four of the five events have an Lmax exceeding 65 dB. Note that DNL is not reported because this example does not cover a full 24-hour period.

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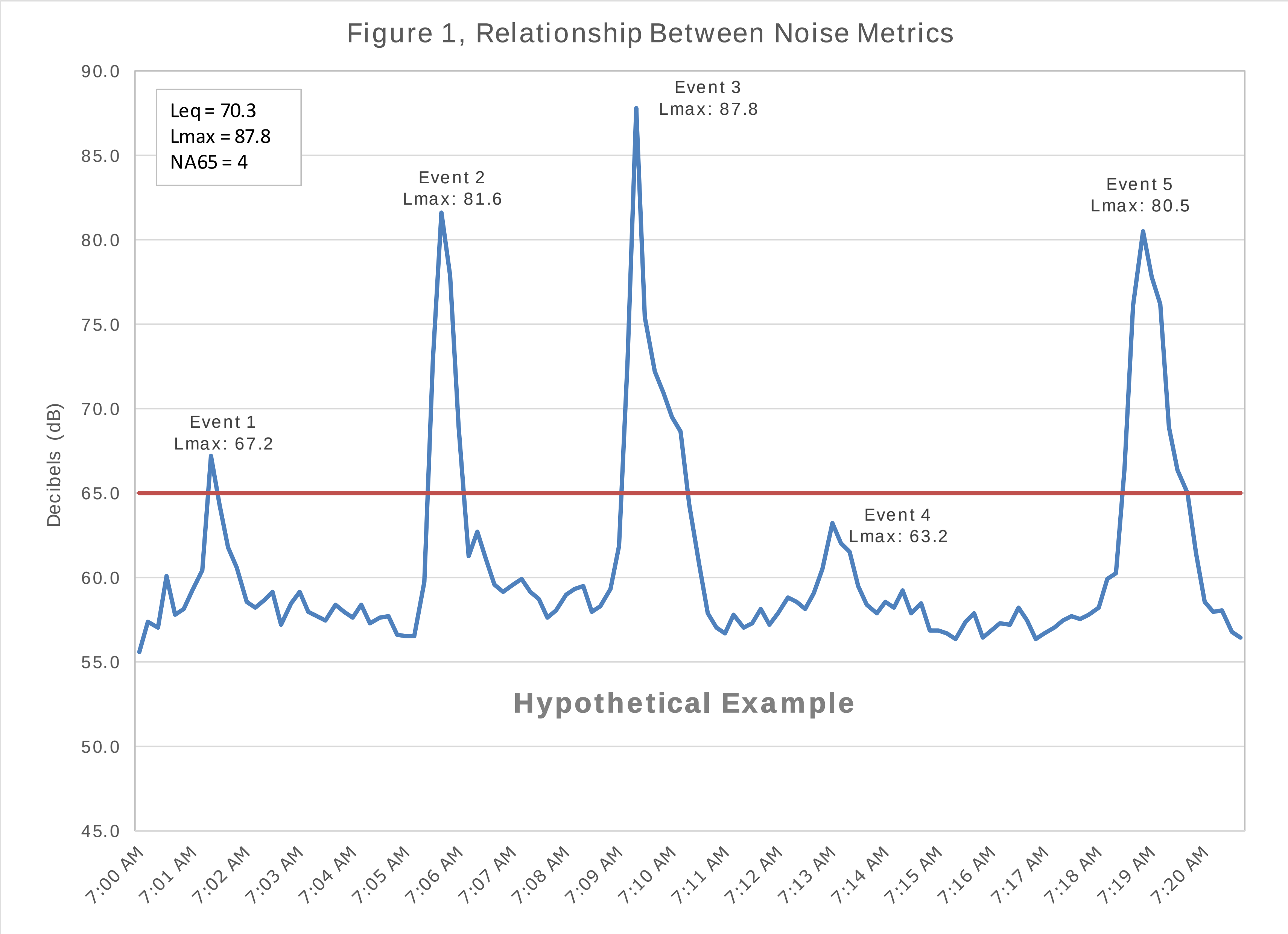

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NOISE MODELING METHODOLOGY

This noise analysis was conducted using the Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT) Version 2d. Inputs into the AEDT include the total number of aircraft operations, aircraft type, daytime (7:00 am to 9:59 pm) or nighttime (10:00 pm to 6:59 am) operations, the percent of time each runway end is used for arrival and departure, flight paths to and from the runway ends, and the percent distribution on each flight path.

Number of Operations and Fleet Mix: The total number of operations that was modeled for each of the scenarios at SUN is based on the FAA Operational Network (OPSNET) database. The total number of operations for each scenario is listed below.

	Arrivals	Departures	Total
Average-Annual Day	34.7	34.7	69.4
Peak Month Average Day	65.2	65.3	130.5
Peak Day	120.0	120.0	240.0

The aircraft fleet mix that would be modeled for each scenario is based on the FAA Traffic Flow Management System Counts (TFMSC) database and data provided by the Friedman Memorial Airport Authority (FMAA). **Table 1** provides a detailed list of average-annual day operations at SUN, organized by aircraft type and aircraft category. **Table 2** provides a detailed list of the peak month average day operations at SUN, organized by aircraft type and aircraft category. **Table 3** provides a detailed list of the peak day operations at SUN, organized by aircraft type and aircraft category.

Daytime/Nighttime Operations: Data on the ratio of daytime to nighttime operations is based on data from the Draft Environmental Impact Statement (DEIS) and data from FMAA staff. Approximately 98 percent of all operations occur during the daytime (7:00 am to 9:59 pm) and two percent of all operations occur during the nighttime (10:00 pm to 6:59 am). Therefore, this overall ratio was modeled for the three scenarios at SUN.

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Table 1
DISTRIBUTION OF OPERATIONS BY AIRCRAFT CATEGORY – AVERAGE ANNUAL DAY
Friedman Memorial Airport

Aircraft Type	Noise Model ID	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Regional Jets						
Bombardier Canadair CRJ701	CRJ701	3.9	0.0	3.9	0.0	7.9
Embraer ERJ-145	EMB145	1.5	0.0	1.5	0.0	3.1
Subtotal		*5.4*	*0.1*	*5.4*	*0.1*	*11.0*
General Aviation Jets						
Beechcraft Baron 58	BEC58P	0.3	0.0	0.3	0.0	0.6
Cessna Citation 3	CIT3	1.0	0.0	1.0	0.0	2.1
Bombardier Challenger CL30	CL600	1.4	0.0	1.4	0.0	2.8
Bombardier Challenger CL60	CL601	2.6	0.1	2.6	0.1	5.3
Cessna 500 Citation	CNA500	1.2	0.0	1.2	0.0	2.4
Cessna 510 Mustang	CNA510	0.2	0.0	0.2	0.0	0.4
Cessna 525 Citation	CNA525C	0.4	0.0	0.4	0.0	0.7
Cessna 550 Citation Bravo	CNA55B	0.8	0.0	0.8	0.0	1.6
Cessna 560 Citation Encore	CNA560E	0.9	0.0	0.9	0.0	1.9
Cessna 560 Citation Ultra	CNA560U	0.6	0.0	0.6	0.0	1.3
Cessna 560 Citation Excel	CNA560XL	2.2	0.0	2.2	0.0	4.6
Cessna 680 Citation Sovereign	CNA680	0.9	0.0	0.9	0.0	1.8
Cessna Citation X	CNA750	1.1	0.0	1.1	0.0	2.3
Fokker F100	F10062	0.4	0.0	0.4	0.0	0.8
Gulfstream GIV	GIV	0.5	0.0	0.5	0.0	1.0
Gulfstream GV	GV	1.7	0.0	1.7	0.0	3.5
IAI 1125 Astra	IA1125	0.4	0.0	0.4	0.0	0.8
Lear 35	LEAR35	3.0	0.1	3.0	0.1	6.1
Mitsubishi MU3001	MU3001	0.9	0.0	0.9	0.0	1.9
Subtotal		*20.6*	*0.4*	*20.6*	*0.4*	*41.9*

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Table 1, *(continued)*
DISTRIBUTION OF OPERATIONS BY AIRCRAFT CATEGORY – AVERAGE ANNUAL DAY
Friedman Memorial Airport

Aircraft Type	Noise Model ID	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Propeller Aircraft						
Cessna 172 Skyhawk	CNA172	0.6	0.0	0.6	0.0	1.2
Cessna 208 Caravan	CNA208	2.6	0.1	2.6	0.1	5.2
Cessna 441 Conquest	CNA441	1.8	0.0	1.8	0.0	3.6
De Havilland DHC-6 Twin Otter	DHC6	0.1	0.0	0.1	0.0	0.2
De Havilland Dash-8	DHC830	1.0	0.0	1.0	0.0	2.1
Dornier 228	DO228	0.8	0.0	0.8	0.0	1.6
General Aviation Single Engine Prop	GASEPV	0.6	0.0	0.6	0.0	1.2
Piper Navajo	PA31	0.1	0.0	0.1	0.0	0.2
Shorts SD330	SD330	0.3	0.0	0.3	0.0	0.6
Subtotal		*7.8*	*0.1*	*7.8*	*0.1*	*15.9*
Helicopters						
Agusta A-109	A109	0.0	0.0	0.0	0.0	0.0
Bell 212 Huey	B212	0.0	0.0	0.0	0.0	0.1
Bell 222	B222	0.0	0.0	0.0	0.0	0.2
Bell 407	B407	0.0	0.0	0.0	0.0	0.0
Eurocopter EC-130	EC130	0.2	0.2	0.2	0.2	0.6
Robinson R22B	R22	0.0	0.0	0.0	0.0	0.0
Sikorsky S-76 Spirit	S76	0.0	0.0	0.0	0.0	0.0
Subtotal		0.2	0.2	0.2	0.2	*1.0*
Grand Total		**34.1**	**0.9**	**34.1**	**0.9**	**69.9**

Source: FAA TFMSC Database, FMAA, Landrum & Brown, 2017.

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Table 2
DISTRIBUTION OF OPERATIONS BY AIRCRAFT CATEGORY – PEAK MONTH AVERAGE DAY
Friedman Memorial Airport

Aircraft Type	Noise Model ID	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Regional Jets						
Bombardier Canadair CRJ900	CRJ9-ER	2.4	0.8	3.1	0.0	6.3
Embraer ERJ-145	EMB145	0.0	0.0	0.0	0.0	0.1
Embraer ERJ170-100	EMB170	2.2	0.0	2.2	0.0	4.3
Subtotal		*4.6*	*0.8*	*5.3*	*0.0*	*10.7*
General Aviation Jets						
Bombardier BD-700 Global Express	BD700	0.9	0.0	0.9	0.0	1.8
Beechcraft Baron 58	BEC58P	1.0	0.1	1.0	0.1	2.1
Cessna Citation 3	CIT3	0.3	0.0	0.3	0.0	0.7
Bombardier Challenger CL30	CL600	4.2	0.1	4.2	0.1	8.5
Bombardier Challenger CL60	CL601	4.3	0.1	4.3	0.1	8.7
Cessna 500 Citation	CNA500	2.4	0.0	2.4	0.0	4.9
Cessna 510 Mustang	CNA510	0.2	0.0	0.2	0.0	0.5
Cessna 525 Citation	CNA525C	1.5	0.0	1.5	0.0	3.1
Cessna 550 Citation Bravo	CNA55B	3.0	0.1	3.0	0.1	6.1
Cessna 560 Citation Ultra	CNA560U	2.2	0.0	2.2	0.0	4.4
Cessna 560 Citation Excel	CNA560XL	4.4	0.1	4.4	0.1	8.9
Cessna 680 Citation Sovereign	CNA680	1.8	0.0	1.8	0.0	3.6
Cessna Citation X	CNA750	0.9	0.0	0.9	0.0	1.9
Eclipse 500	ECLIPSE500	0.3	0.0	0.3	0.0	0.6
Fokker F100	F10062	1.4	0.0	1.4	0.0	2.9
Falcon 20	FAL20	0.1	0.0	0.1	0.0	0.2
Gulfstream GIV	GIV	2.5	0.1	2.5	0.1	5.0
Gulfstream GV	GV	5.5	0.1	5.5	0.1	11.3
IAI 1125 Astra	IA1125	0.6	0.0	0.6	0.0	1.2
Lear 35	LEAR35	3.6	0.1	3.6	0.1	7.3
Mitsubishi MU3001	MU3001	0.3	0.0	0.3	0.0	0.6
Subtotal		*41.3*	*0.9*	*41.3*	*0.8*	*84.3*

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Table 2, *(continued)*
DISTRIBUTION OF OPERATIONS BY AIRCRAFT CATEGORY – PEAK MONTH AVERAGE DAY
Friedman Memorial Airport

Aircraft Type	Noise Model ID	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Propeller Aircraft						
Cessna 172 Skyhawk	CNA172	0.0	0.0	0.0	0.0	0.1
Cessna 182 Skylane	CNA182	0.1	0.0	0.1	0.0	0.3
Cessna 206 Stationair	CNA206	0.6	0.0	0.6	0.0	1.2
Cessna 208 Caravan	CNA208	5.1	0.3	5.1	0.3	10.7
Cessna 441 Conquest	CNA441	4.3	0.1	4.3	0.1	8.8
De Havilland DHC-6 Twin Otter	DHC6	0.2	0.0	0.2	0.0	0.5
De Havilland Dash-8	DHC830	2.5	0.1	2.5	0.1	5.1
Dornier 228	DO228	0.7	0.0	0.7	0.0	1.4
General Aviation Single Engine Prop	GASEPV	2.3	0.1	2.3	0.1	4.7
Piper Navajo	PA31	0.2	0.0	0.2	0.0	0.4
Shorts SD330	SD330	0.9	0.0	0.9	0.0	1.8
Subtotal		*16.9*	*0.6*	*16.9*	*0.6*	*35.0*
Helicopters						
Agusta A-109	A109	0.0	0.0	0.0	0.0	0.0
Bell 212 Huey	B212	0.0	0.0	0.0	0.0	0.0
Bell 222	B222	0.0	0.0	0.0	0.0	0.1
Bell 407	B407	0.0	0.0	0.0	0.0	0.0
Eurocopter EC-130	EC130	0.2	0.0	0.2	0.0	0.3
Robinson R22B	R22	0.0	0.0	0.0	0.0	0.0
Sikorsky S-76 Spirit	S76	0.0	0.0	0.0	0.0	0.0
Subtotal		0.3	0.0	0.3	0.0	*0.5*
Grand Total		**63.0**	**2.2**	**63.8**	**1.4**	**130.5**

Source: FAA TFMSC Database, FMAA, Landrum & Brown, 2017.

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Table 3
DISTRIBUTION OF OPERATIONS BY AIRCRAFT CATEGORY – PEAK DAY
Friedman Memorial Airport

Aircraft Type	Noise Model ID	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Regional Jets						
Bombardier Canadair CRJ900	CRJ9-ER	4.0	0.0	4.0	0.0	8.0
Embraer ERJ170-100	EMB170	2.0	0.0	2.0	0.0	4.0
Subtotal		*6.0*	*0.0*	*6.0*	*0.0*	*12.0*
General Aviation Jets						
Bombardier BD-700 Global Express	BD700	5.0	0.0	5.0	0.0	10.0
Beechcraft Baron 58	BEC58P	1.0	0.0	1.0	0.0	2.0
Bombardier Challenger CL30	CL600	11.0	0.0	11.0	0.0	22.0
Bombardier Challenger CL60	CL601	7.5	0.5	7.5	0.5	16.0
Cessna 500 Citation	CNA500	4.0	0.0	4.0	0.0	8.0
Cessna 550 Citation Bravo	CNA55B	3.0	0.0	3.0	0.0	6.0
Cessna 560 Citation Ultra	CNA560U	8.0	0.0	8.0	0.0	16.0
Cessna 560 Citation Excel	CNA560XL	13.5	0.5	13.5	0.5	28.0
Cessna 680 Citation Sovereign	CNA680	4.0	0.0	4.0	0.0	8.0
Cessna Citation X	CNA750	2.0	0.0	2.0	0.0	4.0
Gulfstream GIV	GIV	5.0	0.0	5.0	0.0	10.0
Gulfstream GV	GV	2.0	0.0	2.0	0.0	4.0
IAI 1125 Astra	IA1125	2.0	0.0	2.0	0.0	4.0
Lear 35	LEAR35	10.5	0.5	10.5	0.5	22.0
Mitsubishi MU3001	MU3001	5.0	0.0	5.0	0.0	10.0
Subtotal		*83.5*	*1.5*	*83.5*	*1.5*	*170.0*
Propeller Aircraft						
Cessna 182 Skylane	CNA182	2.0	0.0	2.0	0.0	4.0
Cessna 208 Caravan	CNA208	10.0	0.0	10.0	0.0	20.0
Cessna 441 Conquest	CNA441	2.5	0.5	2.5	0.5	6.0
De Havilland DHC-6 Twin Otter	DHC6	8.0	0.0	8.0	0.0	16.0
De Havilland Dash-8	DHC830	2.0	0.0	2.0	0.0	4.0
General Aviation Single Engine Prop	GASEPV	1.0	0.0	1.0	0.0	2.0
Shorts SD330	SD330	2.0	0.0	2.0	0.0	4.0
Subtotal		*27.5*	*0.5*	*27.5*	*0.5*	*56.0*

Table 3, *(continued)*
DISTRIBUTION OF OPERATIONS BY AIRCRAFT CATEGORY – PEAK DAY
Friedman Memorial Airport

Aircraft Type	Noise Model ID	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Helicopters						
Eurocopter EC-130	EC130	1.0	0.0	1.0	0.0	2.0
Subtotal		1.0	0.0	1.0	0.0	*2.0*
Grand Total		**118.0**	**2.0**	**118.0**	**2.0**	**240.0**

Source: FAA TFMSC Database, FMAA, Landrum & Brown, 2017.

Runway End Utilization: Due to the surrounding terrain and land uses, aircraft typically arrive to SUN from the south, landing on Runway 31 and take off to the south from Runway 13. Average-annual day runway end utilization is based on data provided by FMAA staff. Data shows that approximately 95 percent of all aircraft arrive from the south, landing on Runway 31; and depart to the south, taking off from Runway 13. Approximately 5 percent of aircraft arrive from the north, landing on Runway 13 and depart to the north on Runway 31. Of this 5 percent, approximately 3 percent are single-engine prop aircraft and the other 2 percent are turboprops or general aviation jets. Arrivals to Runway 13 land with a 1,701 foot displaced threshold.

Flight Tracks: Flight tracks used for this analysis are based on historic radar data and information provided by FMAA staff. Flight track locations are shown in **Exhibit 1**, **Exhibit 2**, and **Exhibit 3**. Flight track locations and percent of use is based on a data from the DEIS, FAA published flight routes, and visual observation of flight track locations. Aircraft on approach to Runway 31 fly either a visual approach or an instrument approach. Exhibit 1 shows arrival flight tracks for both the visual and the instrument approaches. For noise modeling, it is assumed that 99 percent of commercial regional jet arrivals, 50 percent of general aviation jet arrivals, and 25 percent of prop aircraft arrivals follow one of the instrument approach routes.

NOISE MODELING RESULTS

The results of the noise analysis are presented using noise contours and grid points. Noise contours are lines representing areas of equal noise exposure. Noise contours are generally depicted using the Day-Night Average Sound Level (DNL) metric and 65 DNL is the generally the threshold of significance for noise-sensitive land uses, including residences, that have not been mitigated.

Noise Contours

For this analysis, equal noise contour lines for the levels of 65 and 70 DNL were calculated and represent average-annual day conditions. Because DNL is typically used to represent average-annual day conditions, DNL contours were not developed for the peak day or average day peak month scenarios.

Existing (2017) Baseline Noise Contour: The Existing (2017) Baseline noise contour represents current conditions at SUN. The 65 DNL of the Existing (2017) Baseline noise contour is shown on **Exhibit 4**. The shape of the noise contour reflects the predominant runway use patterns at SUN in which aircraft primarily arrive from the south and depart to the south. Therefore, the noise contour shape comes to a point on the south end due to the influence of noise levels from aircraft arrivals on a straight-in approach. The noise contour on the north end expands outward due to the engine noise from aircraft starting their departure roll.

The 65 DNL noise contour primarily remains over Airport property. On the north side, the noise contour extends outward beyond airport property; however, it remains over commercial and undeveloped property.

Grid Points

Grid points represent calculated noise levels at a specific point or points surrounding an airport. Grid points can present information using different metrics that describe noise levels or aircraft event information. For this analysis, grids points were generated to show the total number of events in which the maximum noise level exceeded 65 decibels (NA65). **Exhibit 5** shows the grid point locations and the NA65 range of each grid point for the 2017 average-annual day conditions. **Exhibit 6** shows the grid point locations and the NA65 range of each grid point for the 2017 peak month average day conditions. **Exhibit 7** shows the grid point locations and the NA65 range of each grid point for the 2017 peak day conditions.

In addition to the NA65 ranges shown on Exhibits 5 to 7, two individual locations were selected at which additional detailed noise modeling information was provided. These grid point locations are shown in **Exhibit 8**. At each of these locations, the average annual day DNL value and overall Lmax is reported along with the number of events above 65 dB (NA65). Table 4 shows the results of this analysis. On an

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average-annual day, the two grid point locations (G1 and G2) experience approximately 38 to 50 aircraft overflights above 65 dB. Overall this equates to a DNL level of 49.1 to 52.2, which is well below the Federal threshold of significance of 65 DNL.

Table 4
DETAILED GRID POINT RESULTS
Friedman Memorial Airport

GRID ID	AVERAGE ANNUAL DAY			PEAK MONTH - AVERAGE DAY	PEAK DAY
	DNL	LMAX	NA65	NA65	NA65
G1	52.2	88.1	50	95	182
G2	49.1	84.7	38	74	144

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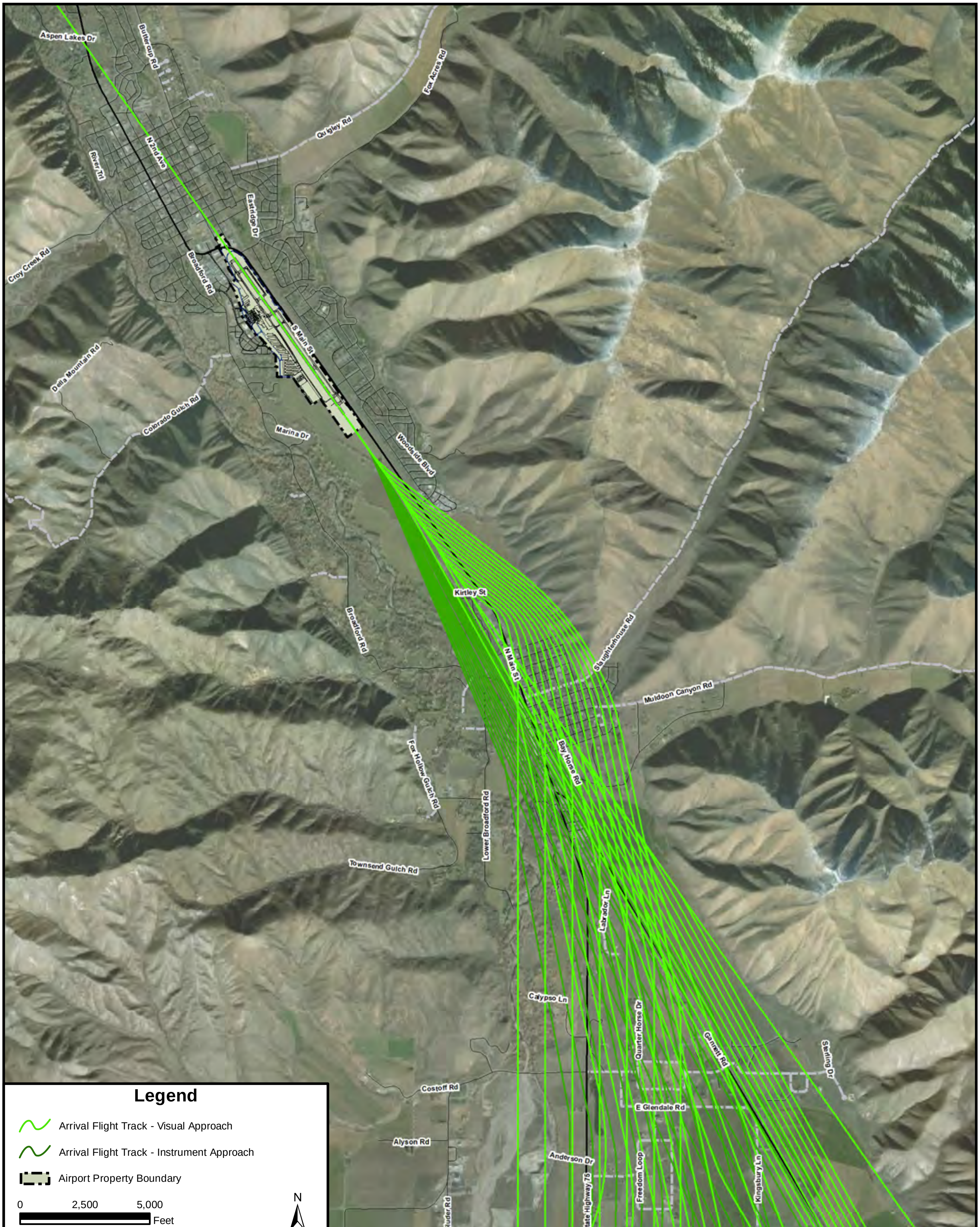

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Noise Analysis
Friedman Memorial Airport

L&B
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Modeled Arrival Flight Tracks

EXHIBIT:
1

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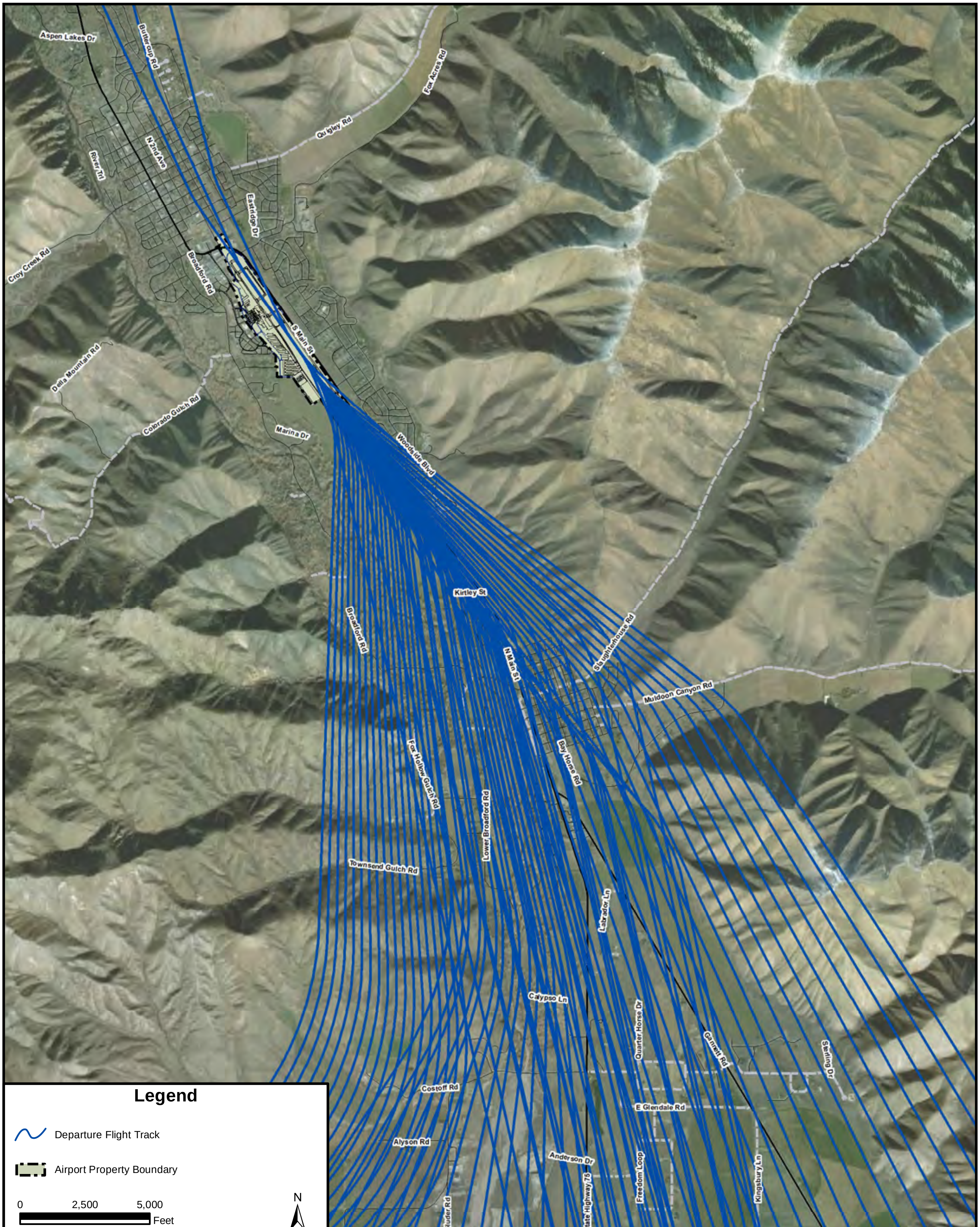

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Friedman Memorial Airport

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Modeled Departure Flight Tracks

EXHIBIT:
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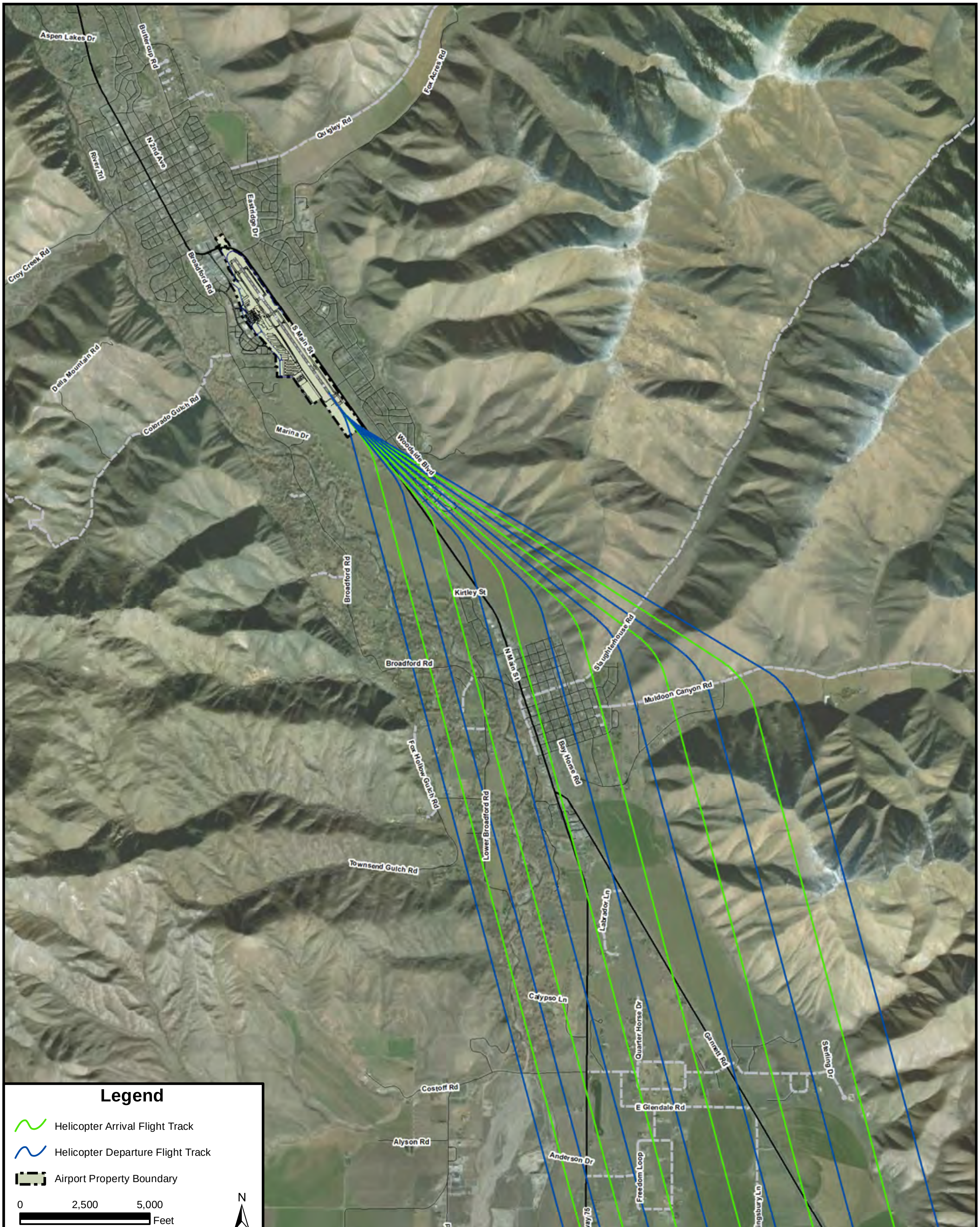

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Friedman Memorial Airport

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Modeled Helicopter Flight Tracks

EXHIBIT:
3

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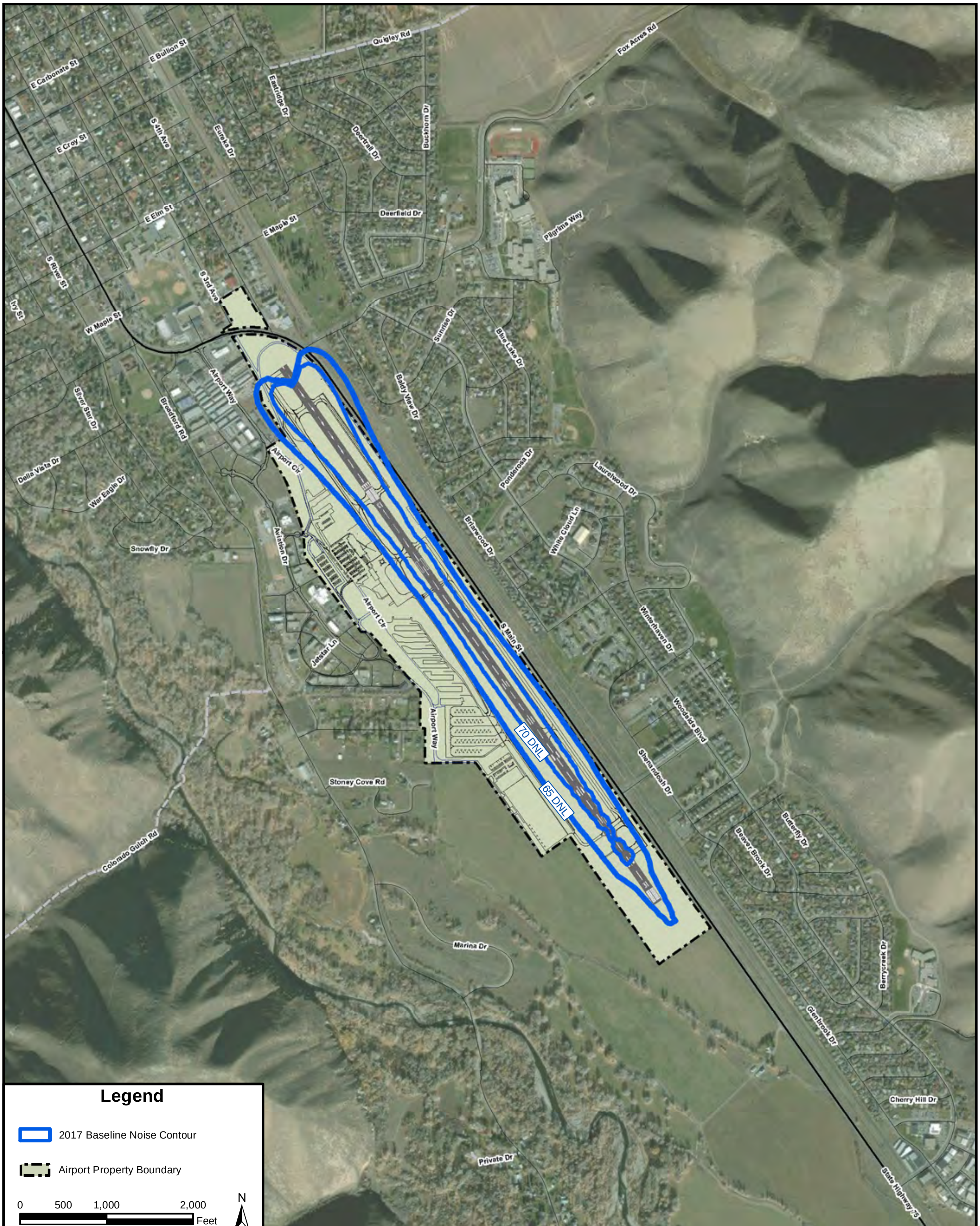

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2017 Average-Annual Day Noise Contour

EXHIBIT:
4

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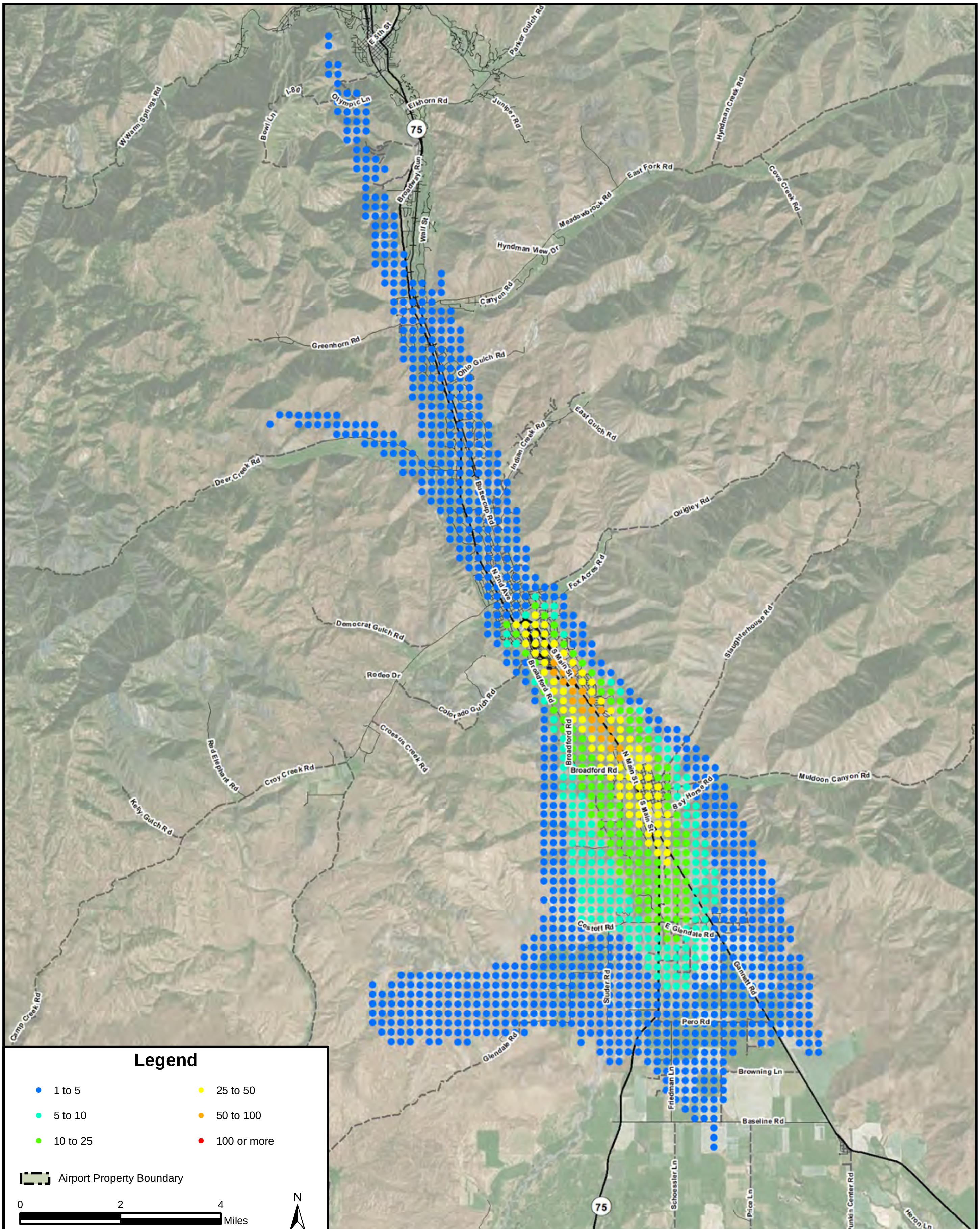

Noise Analysis
Friedman Memorial Airport

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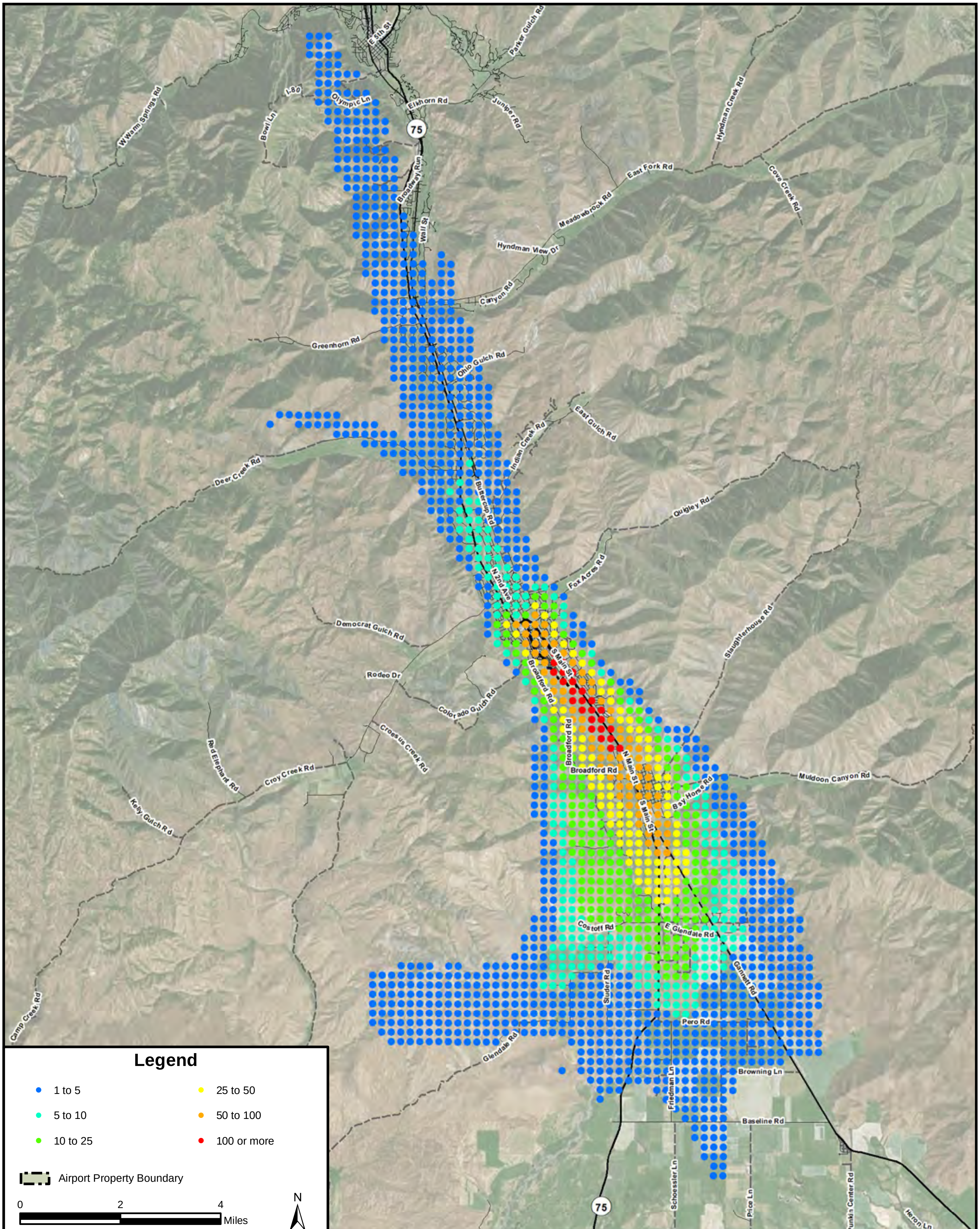
Number of Events Above 65 Lmax -
Average-Annual Day

EXHIBIT:
5



Noise Analysis
Friedman Memorial Airport

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Number of Events Above 65 Lmax -
Peak Month - Average Day

EXHIBIT:
6

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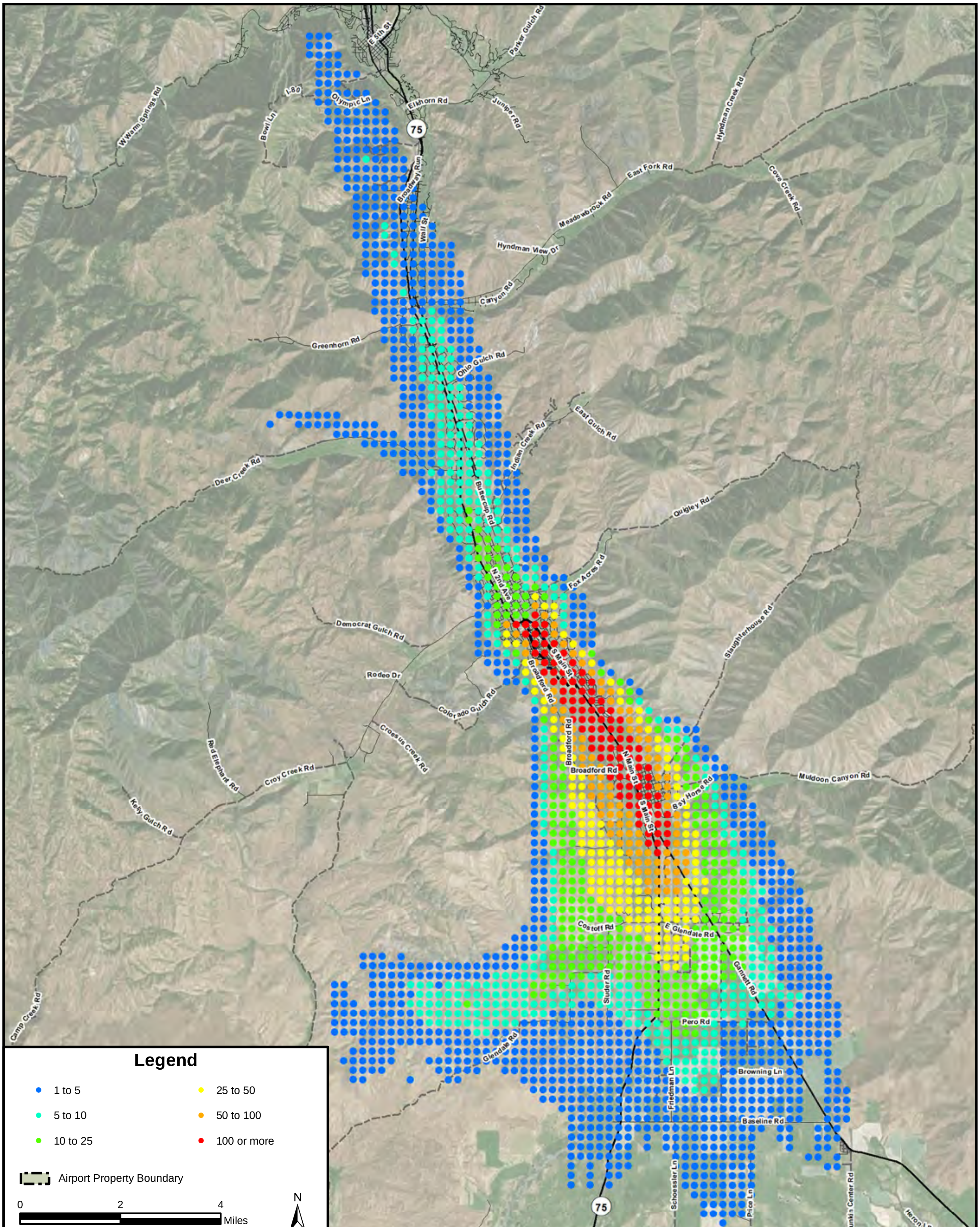

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Friedman Memorial Airport

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Number of Events Above 65 Lmax - Peak Day

EXHIBIT: 7

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Noise Analysis
Friedman Memorial Airport

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Detailed Grid Point Locations

EXHIBIT:
8

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