E AIRPORT MASTER PLAN NOISE TECHNICAL REPORT

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Trenton-Mercer Airport Master Plan Noise Technical Report

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1 Background

This Technical Noise Report provides the results of the noise analyses completed by Harris Miller Miller & Hanson (HMMH) under contract to Urban Engineers for the Trenton-Mercer Airport (TTN) Master Plan.

1.1 Project Description

Trenton-Mercer Airport (TTN) is a publically owned and operated airport located in Ewing Township, New Jersey. The airport is owned and operated by the Mercer County, New Jersey and serves Trenton, New Jersey and surrounding areas. Airside facilities include: a 6,006 foot long by 150 foot wide asphalt runway, oriented along a northeast / southwest axis (Runway 6/24) and a 4,800 foot long by 150 foot wide asphalt crosswind runway, oriented along a northwest / southeast axis (Runway 16/34). The airport also has a terminal building and several hangars including facilities for the New Jersey State Police and New Jersey National Guard. The airport currently accommodates approximately 78,000 annual aircraft operations.

The purpose of the noise analysis for this Master Plan is to examine the existing noise exposure and the likely potential noise exposure in the future due to growth at the Airport.

1.1.1 Aircraft Noise Terminology

Noise is a complex physical quantity. The properties, measurement, and presentation of noise involve specialized terminology that can be difficult to understand. To provide a basic reference on these technical issues, this section introduces fundamentals of noise terminology (Section 1.1.2), the effects of noise on human activity (Section 1.1.3), noise propagation (Section 1.1.4), and noise-land use compatibility guidelines (Section 1.1.5).

1.1.2 Introduction to Noise Terminology

Analyses of potential impacts from changes in aircraft noise levels rely largely on a measure of cumulative noise exposure over an entire calendar year, expressed in terms of a metric called the Day-Night Average Sound Level (DNL). However, DNL does not provide an adequate description of noise for many purposes. A variety of measures, which are further described in subsequent sub-sections, are available to address essentially any issue of concern, including:

- Sound Pressure Level, SPL, and the Decibel, dB
- A-Weighted Decibel, dBA
- Maximum A-Weighted Sound Level, L_{max}
- Time Above, TA
- Sound Exposure Level, SEL
- Equivalent A-Weighted Sound Level, L_{eq}
- Day-Night Average Sound Level, DNL

1.1.2.1 Sound Pressure Level, SPL, and the Decibel, dB

All sounds come from a sound source – a musical instrument, a voice speaking, an airplane passing overhead. It takes energy to produce sound. The sound energy produced by any sound source travels through the air in sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. The ear senses these pressure variations and – with much processing in our brain – translates them into "sound."

Our ears are sensitive to a wide range of sound pressures. The loudest sounds that we can hear without pain contain about one million times more energy than the quietest sounds we can detect. To allow us to perceive sound over this very wide range, our ear/brain "auditory system" compresses our response in a complex manner, represented by a term called sound pressure level (SPL), which we express in units called decibels (dB).

Mathematically, SPL is a logarithmic quantity based on the ratio of two sound pressures, the numerator being the pressure of the sound source of interest (P_{source}), and the denominator being a reference pressure ($P_{reference}$) [1]

$$\text{Sound Pressure Level (SPL)} = 20 * \text{Log}\left(\frac{P_{source}}{P_{reference}}\right) dB$$

The logarithmic conversion of sound pressure to SPL means that the quietest sound that we can hear (the reference pressure) has a sound pressure level of about 0 dB, while the loudest sounds that we hear without pain have sound pressure levels of about 120 dB. Most sounds in our day-to-day environment have sound pressure levels from about 40 to 100 dB[2].

Because decibels are logarithmic quantities, we cannot use common arithmetic to combine them. For example, if two sound sources each produce 100 dB operating individually, when they operate simultaneously they produce 103 dB -- not the 200 dB we might expect. Increasing to four equal sources operating simultaneously will add another three decibels of noise, resulting in a total SPL of 106 dB. For every doubling of the number of equal sources, the SPL goes up another three decibels.

If one noise source is much louder than another is, the louder source "masks" the quieter one and the two sources together produce virtually the same SPL as the louder source alone. For example, a 100 dB and 80 dB sources produce approximately 100 dB of noise when operating together.

Two useful "rules of thumb" related to SPL are worth noting: (1) humans generally perceive a six to 10 dB increase in SPL to be about a doubling of loudness,[3] and (2) changes in SPL of less than about three decibels for an particular sound are not readily detectable outside of a laboratory environment.

1.1.2.2 A-Weighted Decibel

An important characteristic of sound is its frequency, or "pitch." This is the per-second oscillation rate of the sound pressure variation at our ear, expressed in units known as Hertz (Hz).

When analyzing the total noise of any source, acousticians often break the noise into frequency components (or bands) to consider the "low," "medium," and "high" frequency components. This breakdown is important for two reasons:

- Our ear is better equipped to hear mid and high frequencies and is least sensitive to lower frequencies. Thus, we find mid- and high-frequency noise more annoying.
- Engineering solutions to noise problems differ with frequency content. Low-frequency noise is generally harder to control.

The normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of about 10,000 to 15,000 Hz. Most people respond to sound most readily when the predominant frequency is in the range of normal conversation – typically around 1,000 to 2,000 Hz. The acoustical community

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[1] The reference pressure is approximately the quietest sound that a healthy young adult can hear.
[2] The logarithmic ratio used in its calculation means that SPL changes relatively quickly at low sound pressures and more slowly at high pressures. This relationship matches human detection of changes in pressure. We are much more sensitive to changes in level when the SPL is low (for example, hearing a baby crying in a distant bedroom), than we are to changes in level when the SPL is high (for example, when listening to highly amplified music).
[3] A "10 dB per doubling" rule of thumb is the most often used approximation.

has defined several “filters,” which approximate this sensitivity of our ear and thus, help us to judge the relative loudness of various sounds made up of many different frequencies.

The so-called "A" filter (“A weighting”) generally does the best job of matching human response to most environmental noise sources, including natural sounds and sound from common transportation sources. “A-weighted decibels” are abbreviated “dBA.” Because of the correlation with our hearing, the U. S. Environmental Protection Agency (EPA) and nearly every other federal and state agency have adopted A-weighted decibels as the metric for use in describing environmental and transportation noise. Figure 1 depicts A-weighting adjustments to sound from approximately 20 Hz to 10,000 Hz.

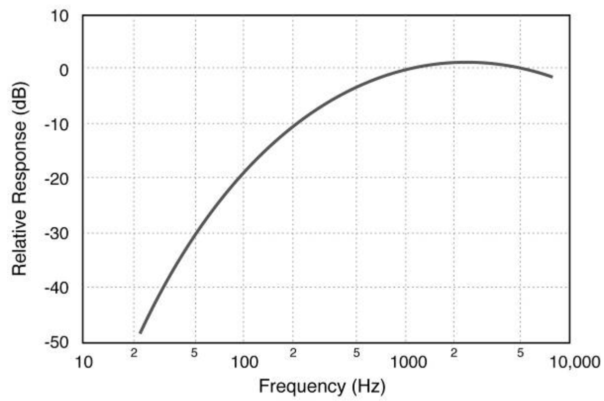


Figure 1 A-Weighting Frequency Response

Source: Extract from Harris, Cyril M., Editor, “Handbook of Acoustical Measurements and Control,” McGraw-Hill, Inc., 1991, pg. 5.13; HMMH

As the figure shows, A-weighting significantly de-emphasizes noise content at lower and higher frequencies where we do not hear as well, and has little effect, or is nearly "flat,” in for mid-range frequencies between 1,000 and 5,000 Hz. All sound pressure levels presented in this document are A-weighted unless otherwise specified.

Figure 2 depicts representative A-weighted sound levels for a variety of common sounds.

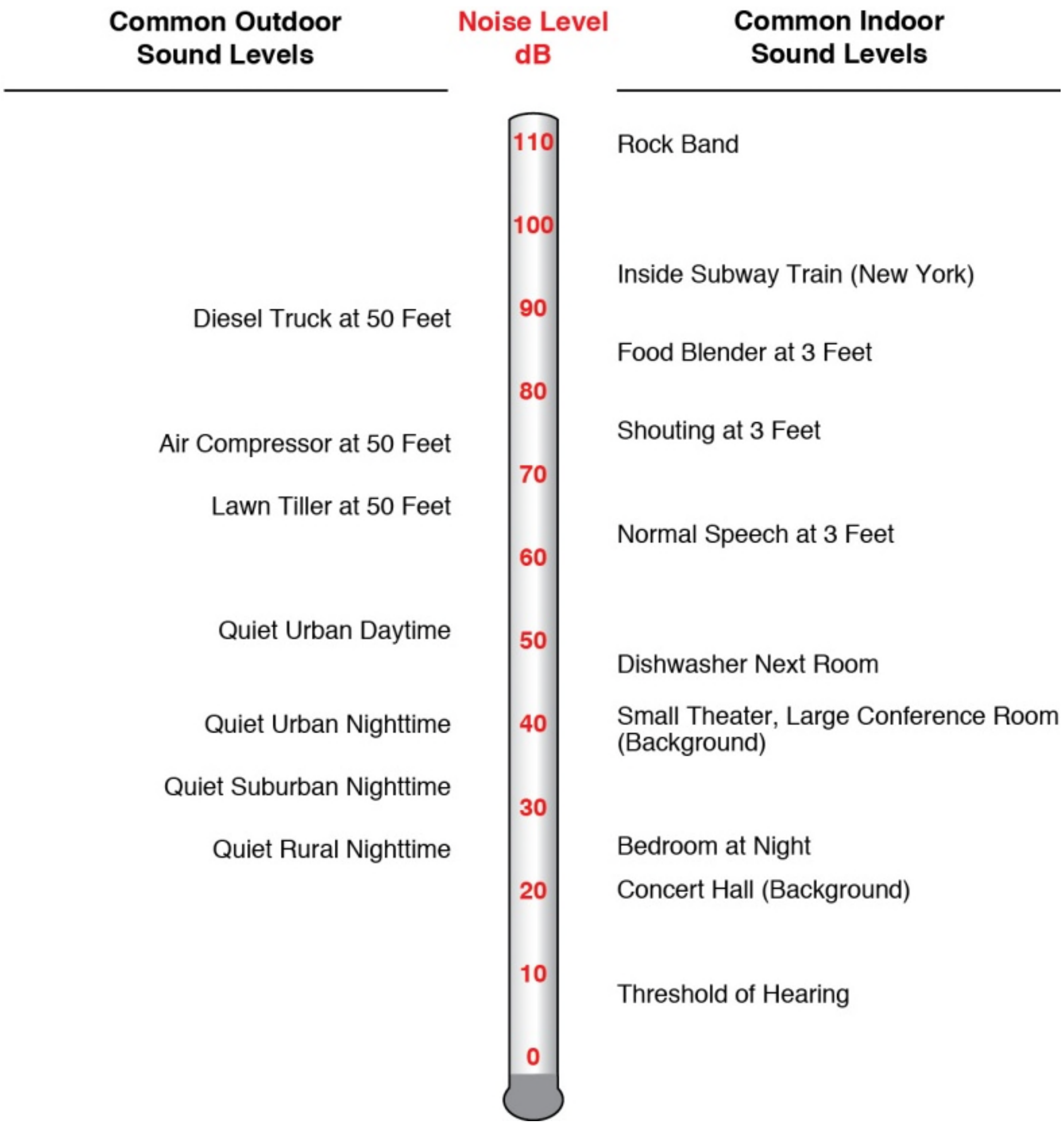


Figure 2 A-Weighted Sound Levels for Common Sounds

1.1.2.3 Maximum A-Weighted Sound Level, L_{max}

An additional dimension to environmental noise is that A-weighted levels vary with time. For example, the sound level increases as a car or aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance. The background or "ambient" level continues to vary in the absence of a distinctive source, for example due to birds chirping, insects buzzing, leaves rustling, etc. It is often convenient to describe a particular noise "event" (such as a vehicle passing by, a dog barking, etc.) by its maximum sound level, abbreviated as L_{max}.

Figure 3 depicts this general concept, for a hypothetical noise event with an L_{max} of approximately 102 dB.

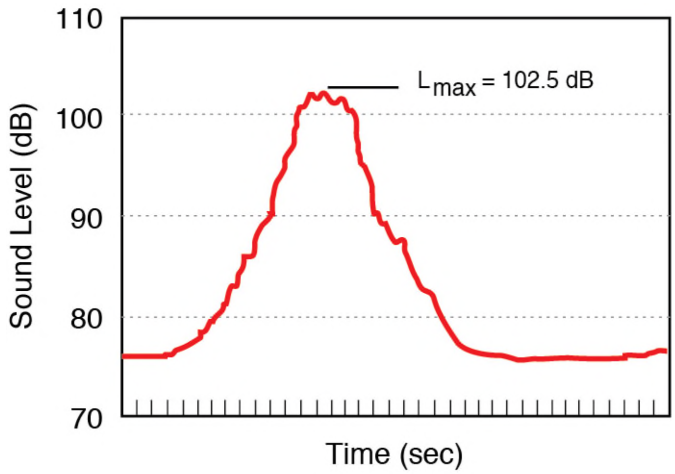


Figure 3 Variation in A-Weighted Sound Level over Time and Maximum Noise Level

Source: HMMH

While the maximum level is easy to understand, it suffers from a serious drawback when used to describe the relative “noisiness” of an event such as an aircraft flyover; i.e., it describes only one dimension of the event and provides no information on the event’s overall, or cumulative, noise exposure. In fact, two events with identical maximum levels may produce very different total exposures. One may be of very short duration, while the other may continue for an extended period and be judged much more annoying. The next section introduces a measure that accounts for this concept of a noise "dose," or the cumulative exposure associated with an individual “noise event” such as an aircraft flyover.

1.1.2.4 Sound Exposure Level, SEL

The most commonly used measure of cumulative noise exposure for an individual noise event, such as an aircraft flyover, is the Sound Exposure Level, or SEL. SEL is a summation of the A-weighted sound energy over the entire duration of a noise event. SEL expresses the accumulated energy in terms of the one-second-long steady-state sound level that would contain the same amount of energy as the actual time-varying level.

SEL provides a basis for comparing noise events that generally match our impression of their overall “noisiness,” including the effects of both duration and level. The higher the SEL, the more annoying a noise event is likely to be. In simple terms, SEL “compresses” the energy for the noise event into a single second. Figure 4 depicts this compression, for the same hypothetical event shown in Figure 3. Note that the SEL is higher than the Lmax.

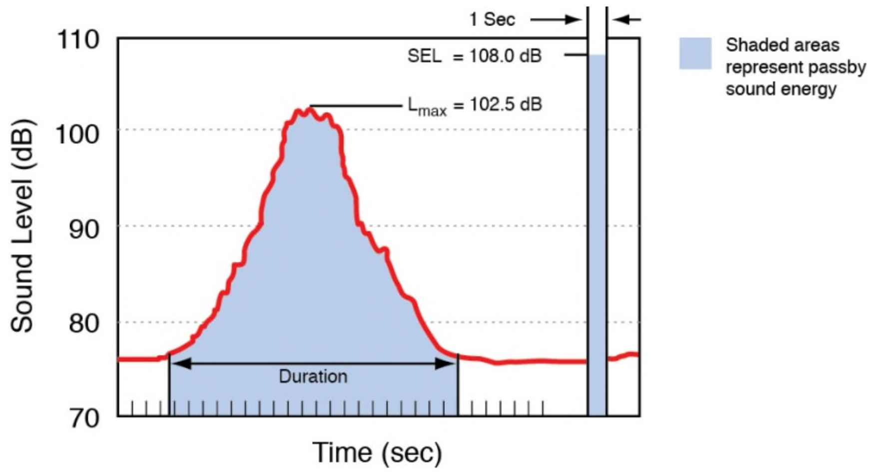


Figure 4 Graphical Depiction of Sound Exposure Level

Source: HMMH

The "compression " of energy into one second means that a given noise event's SEL will almost always will be a higher value than its Lmax. For most aircraft flyovers, SEL is roughly five to 12 dB higher than Lmax. Adjustment for duration means that relatively slow and quiet propeller aircraft can have the same or higher SEL than faster, louder jets, which produce shorter duration events.

1.1.2.5 Equivalent A-Weighted Sound Level, L_{eq}

The Equivalent Sound Level, abbreviated L_{eq}, is a measure of the exposure resulting from the accumulation of sound levels over a particular period of interest; e.g., one hour, an eight-hour school day, nighttime, or a full 24-hour day. Leq plots for consecutive hours can help illustrate how the noise dose rises and falls over a day or how a few loud aircraft significantly affect some hours.

Leq may be thought of as the constant sound level over the period of interest that would contain as much sound energy as the actual varying level. It is a way of assigning a single number to a time-varying sound level. Figure 5 illustrates this concept for the same hypothetical event shown in Figure 3 and Figure 4. Note that the Leq is lower than either the Lmax or SEL.

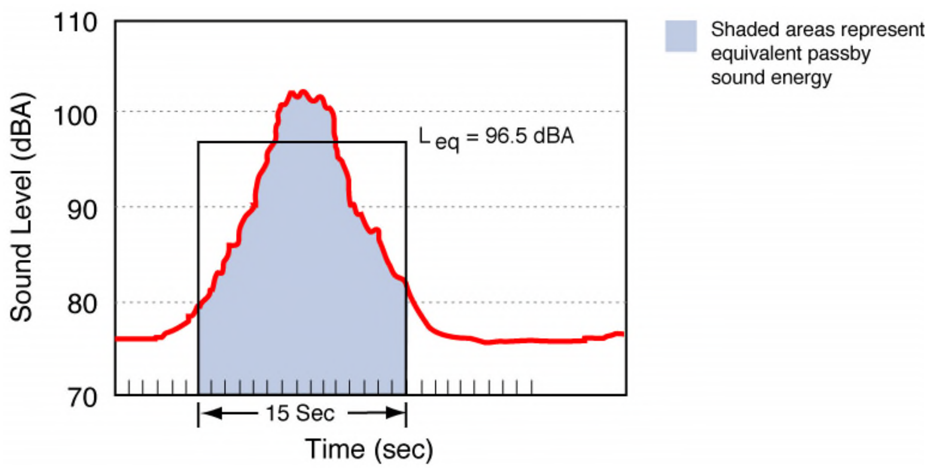


Figure 5 Example of a 15-Second Equivalent Sound Level

Source: HMMH

1.1.2.6 Day-Night Average Sound Level, DNL or Ldn

The FAA requires that airports use a measure of noise exposure that is slightly more complicated than Leq to describe cumulative noise exposure – the Day-Night Average Sound Level, DNL.

The U.S. Environmental Protection Agency identified DNL as the most appropriate means of evaluating airport noise based on the following considerations[4].

- The measure should be applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods.
- The measure should correlate well with known effects of the noise environment and on individuals and the public.
- The measure should be simple, practical, and accurate. In principal, it should be useful for planning as well as for enforcement or monitoring purposes.
- The required measurement equipment, with standard characteristics, should be commercially available.
- The measure should be closely related to existing methods currently in use.
- The single measure of noise at a given location should be predictable, within an acceptable tolerance, from knowledge of the physical events producing the noise.
- The measure should lend itself to small, simple monitors, which can be left unattended in public areas for long periods.

Most federal agencies dealing with noise have formally adopted DNL. The Federal Interagency Committee on Noise (FICON) reaffirmed the appropriateness of DNL in 1992. The FICON summary report stated: “There are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric.”

In simple terms, DNL is the 24-hour Leq with one adjustment; all noises occurring at night (defined as 10 p.m. through 7 a.m.) are increased by 10 dB, to reflect the added intrusiveness of nighttime noise events when background noise levels decrease. In calculating aircraft exposure, this 10 dB increase is mathematically identical to counting each nighttime aircraft noise event ten times.

[4] "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U. S. EPA Report No. 550/9-74-004, March 1974.

DNL can be measured or estimated. Measurements are practical only for obtaining DNL values for limited numbers of points, and, in the absence of a permanently installed monitoring system, only for relatively short periods. Most airport noise studies use computer-generated DNL estimates depicted as equal-exposure noise contours (much as topographic maps have contours of equal elevation).

The annual DNL is mathematically identical to the DNL for the average annual day; i.e., a day on which the number of operations is equal to the annual total divided by 365 (366 in a leap year). Figure 6 graphically depicts the manner in which the nighttime adjustment applies in calculating DNL. Figure 7 presents representative outdoor DNL values measured at various U.S. locations.

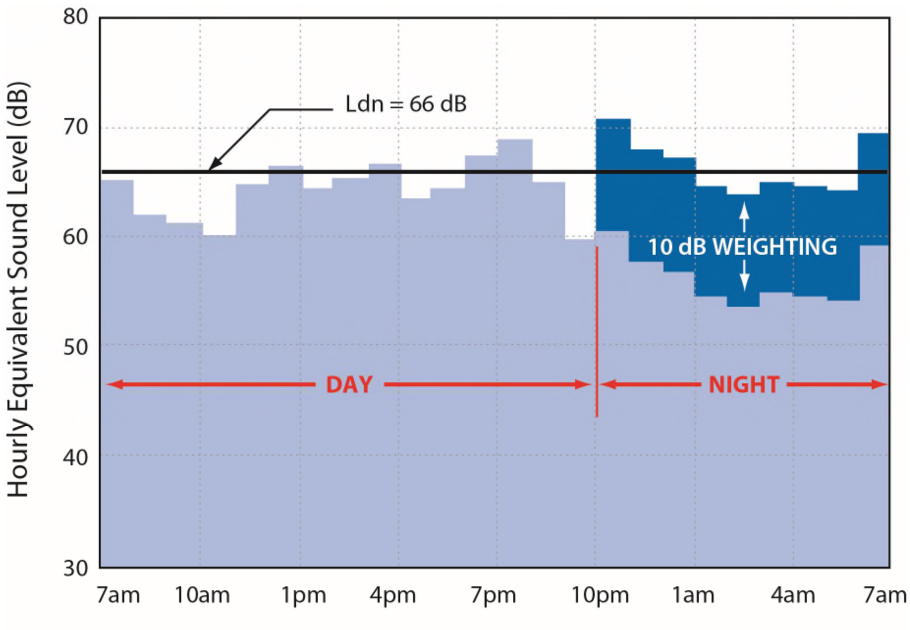


Figure 6 Example of a Day-Night Average Sound Level Calculation

Source: HMMH

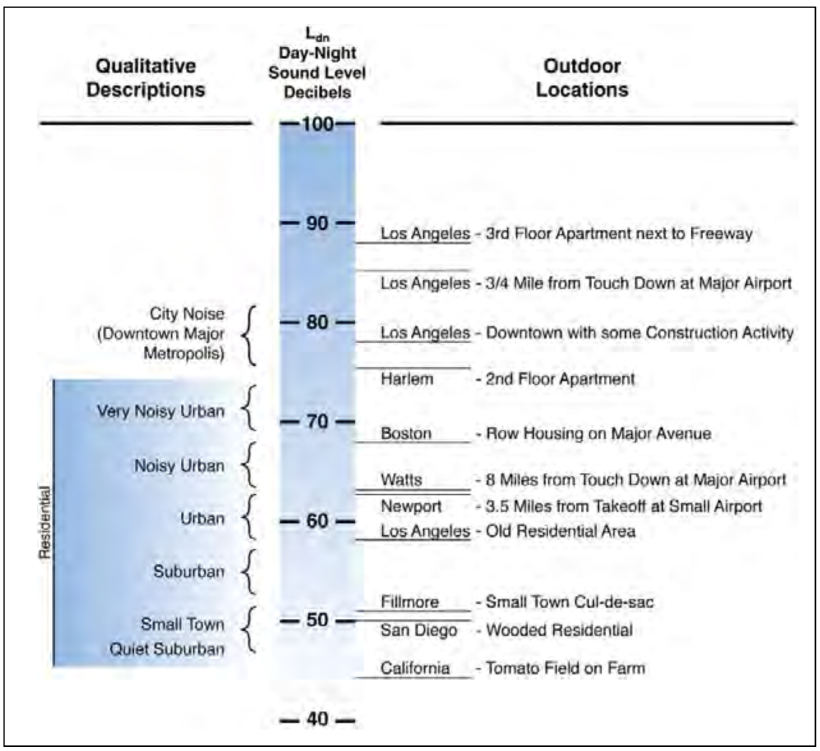


Figure 7 Examples of Measured Day-Night Average Sound Levels, DNL

Source: U.S. Environmental Protection Agency, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," March 1974, p.14.

1.1.3 Aircraft Noise Effects on Human Activity

Aircraft noise can be an annoyance and a nuisance. It can interfere with conversation and listening to television, disrupt classroom activities in schools, and disrupt sleep. Relating these effects to specific noise metrics helps in the understanding of how and why people react to their environment.

1.1.3.1 Speech Interference

One potential effect of aircraft noise is its tendency to "mask" speech, making it difficult to carry on a normal conversation. The sound level of speech decreases as the distance between a talker and listener increases. As the background sound level increases, it becomes harder to hear speech.

Figure 8 presents typical distances between talker and listener for satisfactory outdoor conversations, in the presence of different steady A-weighted background noise levels for raised, normal, and relaxed voice effort. As the background level increases, the talker must raise his/her voice, or the individuals must get closer together to continue talking.

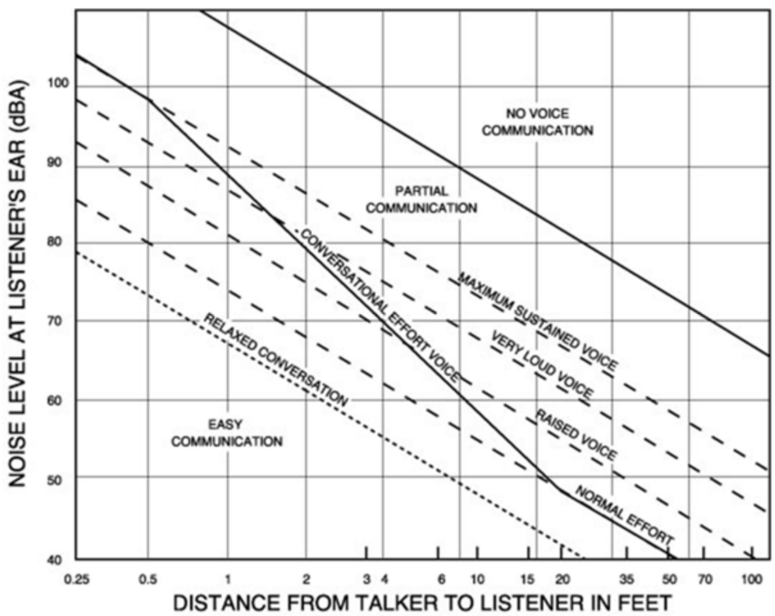


Figure 8 Outdoor Speech Intelligibility

Source: U.S. Environmental Protection Agency, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," March 1974, p.D-5.

Satisfactory conversation does not always require hearing every word; 95% intelligibility is acceptable for many conversations. In relaxed conversation, however, we have higher expectations of hearing speech and generally require closer to 100% intelligibility. Any combination of talker-listener distances and background noise that falls below the bottom line in the figure (which roughly represents the upper boundary of 100% intelligibility) represents an ideal environment for outdoor speech communication. Indoor communication is generally acceptable in this region as well.

One implication of the relationships in Figure 8 is that for typical communication distances of three or four feet, acceptable outdoor conversations can be carried on in a normal voice as long as the background noise outdoors is less than about 65 dB. If the noise exceeds this level, as might occur when an aircraft passes overhead, intelligibility would be lost unless vocal effort were increased or communication distance were decreased.

Indoors, typical distances, voice levels, and intelligibility expectations generally require a background level less than 45 dB. With windows partly open, housing generally provides about 10 to 15 dB of interior-to-exterior noise level reduction. Thus, if the outdoor sound level is 60 dB or less, there is a reasonable chance that the resulting indoor sound level will afford acceptable interior conversation. With windows closed, 24 dB of attenuation is typical.

1.1.3.2 Sleep Interference

Research on sleep disruption from noise has led to widely varying observations. In part, this is because (1) sleep can be disturbed without awakening, (2) the deeper the sleep the more noise it takes to cause arousal, (3) the tendency to awaken increases with age, and other factors. Figure 9 shows a recent summary of findings on the topic.

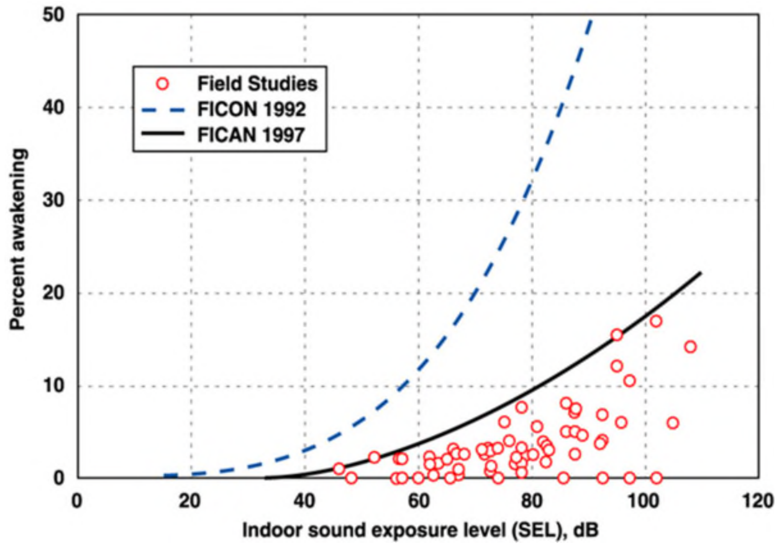


Figure 9 Sleep Interference

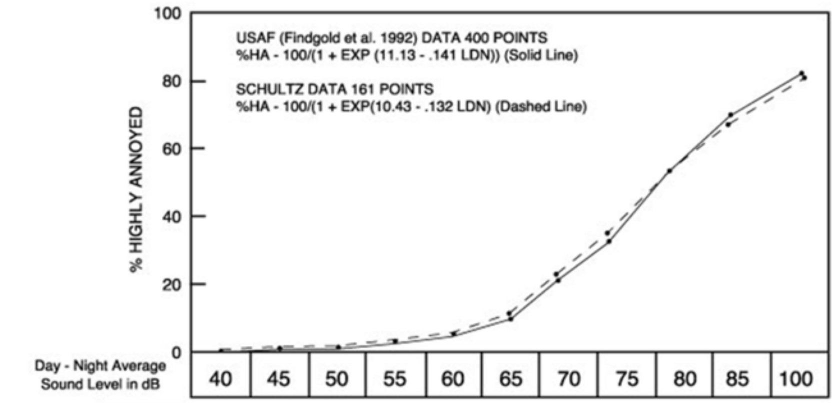
Source: Federal Interagency Committee on Aircraft Noise (FICAN), "Effects of Aviation Noise on Awakenings from Sleep," June 1997, pg. 6

Figure 9 uses indoor SEL as the measure of noise exposure; current research supports the use of this metric in assessing sleep disruption. An indoor SEL of 80 dBA results in a maximum of 10% awakening.[5]

1.1.3.3 Community Annoyance

Numerous psychoacoustic surveys provide substantial evidence that individual reactions to noise vary widely with noise exposure level. Since the early 1970s, researchers have determined (and subsequently confirmed) that aggregate community response is generally predictable and relates reasonably well to cumulative noise exposure such as DNL. Figure 10 depicts the widely recognized relationship between environmental noise and the percentage of people "highly annoyed," with annoyance being the key indicator of community response usually cited in this body of research.

[5] The awakening data presented in Figure 9 apply only to individual noise events. The American National Standards Institute (ANSI) has published a standard that provides a method for estimating the number of people awakened at least once from a full night of noise events: ANSI/ASA S12.9-2008 / Part 6, "Quantities and Procedures for Description and Measurement of Environmental Sound – Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes." This method can use the information on single events computed by a program such as the FAA's Aviation Environmental Design Tool, to compute awakenings.



Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	100
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Figure 10 Percentage of People Highly Annoyed

Source: FICON, "Federal Agency Review of Selected Airport Noise Analysis Issues," September 1992

Separate work by the EPA has shown that overall community reaction to a noise environment is also dependent on DNL. Figure 11 depicts this relationship.

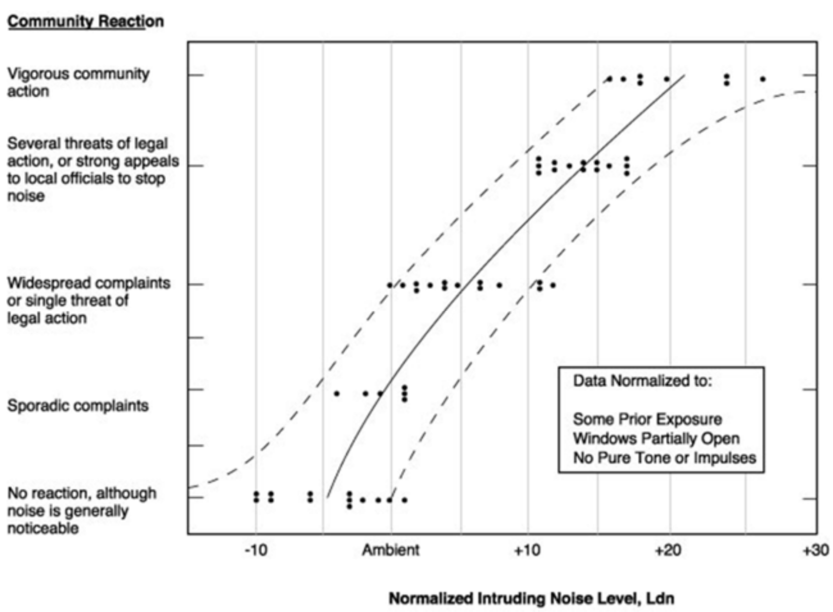


Figure 11 Community Reaction as a Function of Outdoor DNL

Source: Wyle Laboratories, Community Noise, prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., December 1971, pg. 63

Data summarized in the figure suggest that little reaction would be expected for intrusive noise levels five decibels below the ambient, while widespread complaints can be expected as intruding noise exceeds background levels by about five decibels. Vigorous action is likely when levels exceed the background by 20 dB.

1.1.4 Noise Propagation

This section presents information sound-propagation effect due to weather, source-to-listener distance, and vegetation.

1.1.4.1 Weather-Related Effects

Weather (or atmospheric) conditions that can influence the propagation of sound include humidity, precipitation, temperature, wind, and turbulence (or gustiness). The effect of wind – turbulence in particular – is generally more important than the effects of other factors. Under calm-wind conditions, the importance of temperature (in particular vertical "gradients") can increase, sometimes to very significant levels. Humidity generally has little significance relative to the other effects.

Influence of Humidity and Precipitation

Humidity and precipitation rarely effect sound propagation in a significant manner. Humidity can reduce propagation of high-frequency noise under calm-wind conditions. This is called "Atmospheric absorption." In very cold conditions, listeners often observe that aircraft sound "tinny," because the dry air increases the propagation of high-frequency sound. Rain, snow, and fog also have little, if any noticeable effect on sound propagation. A substantial body of empirical data supports these conclusions.[6]

Influence of Temperature

The velocity of sound in the atmosphere is dependent on the air temperature.[7] As a result, if the temperature varies at different heights above the ground, sound will travel in curved paths rather than straight lines. During the day, temperature normally decreases with increasing height. Under such "temperature lapse" conditions, the atmosphere refracts ("bends") sound waves upwards and an acoustical shadow zone may exist at some distance from the noise source.

Under some weather conditions, an upper level of warmer air may trap a lower layer of cool air. Such a "temperature inversion" is most common in the evening, at night, and early in the morning when heat absorbed by the ground during the day radiates into the atmosphere.[8] The effect of an inversion is just the opposite of lapse conditions. It causes sound propagating through the atmosphere to refract downward.

The downward refraction caused by temperature inversions often allows sound rays with originally upward-sloping paths to bypass obstructions and ground effects, increasing noise levels at greater distances. This type of effect is most prevalent at night, when temperature inversions are most common and when wind levels often are very low, limiting any confounding factors.[9] Under extreme conditions, one study found that noise from ground-borne aircraft might be amplified 15 to 20 dB by a temperature inversion. In a similar study, noise caused by an aircraft on the ground registered a higher level at an observer location 1.8 miles away than at a second observer location only 0.2 miles from the aircraft.[10]

Influence of Wind

Wind has a strong directional component that can lead to significant variation in propagation. In general, receivers that are downwind of a source will experience higher sound levels, and those that are upwind will experience lower sound levels. Wind perpendicular to the source-to-receiver path has no significant effect.

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[6]Ingard, Uno. "A Review of the Influence of Meteorological Conditions on Sound Propagation," *Journal of the Acoustical Society of America*, Vol. 25, No. 3, May 1953, p. 407.
[7]In dry air, the approximate velocity of sound can be obtained from the relationship:
$c = 331 + 0.6T_c$ (c in meters per second, T_c in degrees Celsius). Pierce, Allan D., *Acoustics: An Introduction to its Physical Principles and Applications.* McGraw-Hill. 1981. p. 29.
[8]Embleton, T.F.W., G.J. Thiessen, and J.E. Piercy, "Propagation in an inversion and reflections at the ground," *Journal of the Acoustical Society of America*, Vol. 59, No. 2, February 1976, p. 278.
[9]Ingard, p. 407.
[10]Dickinson, P.J., "Temperature Inversion Effects on Aircraft Noise Propagation," (Letters to the Editor) *Journal of Sound and Vibration.* Vol. 47, No. 3, 1976, p. 442.

The refraction caused by wind direction and temperature gradients is additive. [11] One study suggests that for frequencies greater than 500 Hz, the combined effects of these two factors tends towards two extreme values: approximately 0 dB in conditions of downward refraction (temperature inversion or downwind propagation) and -20 dB in upward refraction conditions (temperature lapse or upwind propagation). At lower frequencies, the effects of refraction due to wind and temperature gradients are less pronounced. [12]

Wind turbulence (or "gustiness") can also affect sound propagation. Sound levels heard at remote receiver locations will fluctuate with gustiness. In addition, gustiness can cause considerable attenuation of sound due to effects of eddies traveling with the wind. Attenuation due to eddies is essentially the same in all directions, with or against the flow of the wind, and can mask the refractive effects discussed above. [13]

1.1.4.2 Distance-Related Effects

People often ask how distance from an aircraft to a listener affects sound levels. Changes in distance may be associated with varying terrain, offsets to the side of a flight path, or aircraft altitude. The answer is a bit complex, because distance affects the propagation of sound in several ways.

The principal effect results from the fact that any emitted sound expands in a spherical fashion – like a balloon – as the distance from the source increases, resulting in the sound energy being spread out over a larger volume. With each doubling of distance, spherical spreading reduces instantaneous or maximum level by approximately six decibels and SEL by approximately three decibels.

1.1.4.3 Vegetation-Related Effects

Sound can be scattered and absorbed as it travels through vegetation. This results in a decrease in sound levels. The literature on the effect of vegetation on sound propagation contains several approaches to calculating its effect. Though these approaches differ in some aspects, they agree on the following:

- The vegetation must be dense and deep enough to block the line of sight
- The noise reduction is greatest at high frequencies and least at low frequencies

The International Standard ISO 9613-2[14] provides a useful example of the types of calculations employed in these methods. Originally developed for industrial noise sources, ISO 9613-2 is well-suited for the evaluation of ground-based aircraft noise sources under favorable meteorological conditions for sound propagation. ISO 9613-2's methodology for calculating sound propagation includes geometric dispersion from acoustical point sources, atmospheric absorption, the effects of areas of hard and soft ground, screening due to barriers, and reflections. The attenuation provided by dense foliage varies by octave band and by distance as shown in Table 1.

For propagation through less than 10 m of dense foliage, no attenuation is assumed. For propagation through 10 m to 20 m of dense foliage, the total attenuation is shown in the first row of Table 1.

For distances between 20 m and 200 m, the total attenuation is computed by multiplying the distance of propagation through dense foliage by the dB/m values shown in the second row of Table 1.

[11]Piercy and Embleton, p. 1412. Note, in addition, that as a result of the scalar nature of temperature and the vector nature of wind, the following is true: under lapse conditions, the refractive effects of wind and temperature add in the upwind direction and cancel each other in the downwind direction. Under inversion conditions, the opposite is true.
[12]Piercy and Embleton, p. 1413.
[13]Ingard, pp. 409-410.
[14] International Organization for Standardization, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General Method of calculation, International Standard ISO9613-2, Geneva, Switzerland (15 December 1996).

Table 1 Dense Foliage Noise Attenuation

Source: ISO 9613-2, Table A.1

Propagation Distance	Nominal Midband Frequency (Hz)							
	63	125	250	500	1,000	2,000	4,000	8,000
10 m to 20 m (dB Attenuation)	0	0	1	1	1	1	2	3
20 m to 200 m (dB/m Attenuation)	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.12

ISO 9613-2 assumes a moderate downwind condition. The equations in the ISO Standard also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights. In either case, the sound is refracted downward. The radius of this curved path is assumed to be 5 km. With this curved sound path, only portions of the sound path may travel through the dense foliage, as illustrated by Figure 12. Thus the relative locations of the source and receiver, the dimensions of the volume of dense foliage, and the contours of the intervening terrain are essential to the estimation of the noise attenuation.

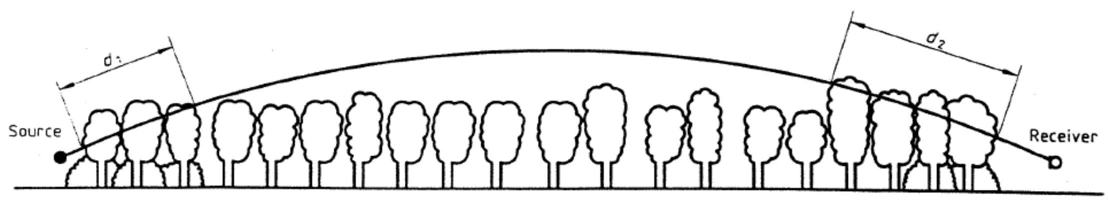

Figure 12 Downward Refracting Sound Path (source: ISO 9613-2)

As illustrated in, Figure 12, the foliage only provides attenuation if the sound path passes through the foliage. For aircraft in the air, the sound will pass through little, if any foliage. Additionally, either the noise source or receiver must be near the foliage for it to have an effect.

1.1.5 Noise / Land Use Compatibility Guidelines

DNL estimates provide a quantitative basis for identifying potential land use incompatibility. 14 CFR Part 150 Appendix A provides land use compatibility guidelines as a function of DNL values. Table 2 reproduces those guidelines.

Table 2 14 CFR Part 150 Noise / Land Use Compatibility Guidelines

Source: 14 CFR Part 150, Appendix A, Table 1

Land Use	Yearly Day-Night Average Sound Level, DNL, in Decibels (Key and notes on following page)					
	<65	65-70	70-75	75-80	80-85	>85
Residential Use						
Residential other than mobile homes and transient lodgings	Y	N(1)	N(1)	N	N	N
Mobile home park	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail--building materials, hardware and farm equipment	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade--general	Y	Y	Y(2)	Y(3)	Y(4)	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Key to Table 2

SLCUM: Standard Land Use Coding Manual.

Y(Yes): Land use and related structures compatible without restrictions.

N(No): Land use and related structures are not compatible and should be prohibited.

NLR: Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

25, 30, or 35: Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dBA must be incorporated into design and construction of structure.

Notes for Table 2

The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dBA and 30 dBA should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dBA, thus, the reduction requirements are often started as 5, 10, or 15 dBA over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

(2) Measures to achieve NLR of 25 dBA must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(3) Measures to achieve NLR of 30 dBA must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(4) Measures to achieve NLR of 35 dBA must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(5) Land use compatible provided special sound reinforcement systems are installed.

(6) Residential buildings require an NLR of 25.

(7) Residential buildings require an NLR of 30

(8) Residential buildings not permitted.

1.2 Regulatory Guidance

Navigable airspace and civil aircraft operations therein are regulated by the FAA. The airports, air traffic communications/navigation/surveillance infrastructure, operating rules, policies, and personnel engaged in air commerce are collectively referred to as the National Airspace System (NAS), and under US law the FAA, an agency of the US Department of Transportation, is the primary steward of the NAS. Accordingly, civil airports in the US are designed and operate according to FAA regulations.

The noise analysis for this Master Plan was conducted in accordance with the guidance and regulations specified in FAA Order 1050.1F, effective July 16, 2015, and its associated desk reference. These include:

- Acceptable noise models to be used and
- The metrics to be used for characterizing the noise environment.

1.2.1 Noise Models and Metrics

For a noise analysis of a single airport, the desk reference directs the use of the Aviation Environmental Design Tool for detailed noise modeling (§11.1.4 of FAA Order 1050.1F desk reference). This software package models aircraft operations to determine predicted noise exposure in the form of DNL 75 dB, DNL 70 dB, and DNL 65 dB contours.

2 Development of Noise Modeling Input

The basic tool used to model aircraft flight operations is the AEDT, developed by the FAA. For all analyses in the Master Plan, HMMH used the latest available version of AEDT at the initiation of the noise analysis, Version 2c SP2. The AEDT uses airport geometry, descriptions of aircraft operations, and an internal database of noise and performance characteristics to compute the noise of individual flights. The AEDT then adds noise of individual flights together and presents the accumulation as a set of contours noise calculations at specific points. These results can be reported at each point or presented as a set of contours of equal noise exposure.

Detailed inputs to the AEDT fall into two general categories of information:

- Physical characteristics
  - Airfield layout
  - Flight track geometry
  - Terrain
  - Climatological data
  - Aircraft noise and performance data
- Operational characteristics
  - Aircraft operations (daily by time of day)
  - Runway use
  - Flight track use

Historical data traceable to sources, such as airport operations records and radar data, are used to develop descriptions of past noise environments. Predicted aspects of an airport's operations are used to evaluate the noise effects of future growth.

2.1 Physical Characteristics

The physical characteristics of the noise model input are distinguished from operational inputs by the fact that they can be measured in physical units. The characteristics of the airfield layout and flight track geometry inputs are specified by their spatial geometry with geographic coordinates and elevations. Climatological data, aircraft noise, and aircraft performance are measured using other physical units such as percent relative humidity, decibels, or pounds of thrust.

2.1.1 Airfield Layout

The airfield layout at TTN is not slated to change in the Master Plan. The current runway layout is shown in Table 3.

Table 3 Runway Layout

Source: FAA Form 5010

Runway	Latitude	Longitude	Elevation (ft.)	Threshold Crossing Height (ft.)	Glide Slope (deg.)	Displaced Threshold (ft)	Width (ft)
6	40.269753	-74.821577	160	50	3	0	150
24	40.281106	-74.80597	192	42	3	0	150
16	40.283715	-74.817971	212	40	3	0	150
34	40.272837	-74.808267	174	50	3	0	150

2.1.2 Flight Track Geometry

The AEDT models aircraft flight corridors with a system of primary flight tracks (or “backbone” tracks) and additional “dispersed” tracks. The backbone track lies at the center of the corridor, flanked by one or more dispersed tracks on each side. The AEDT distributes the operations assigned to a track among the backbone and dispersed tracks using a normal distribution or a user-defined distribution based on the observed flight track density. This dispersion more accurately models each flight corridor by accounting for variability attributed to weather, aircraft type, traffic, pilot technique and other factors.

HMMH developed the representative AEDT flight tracks and flight track utilization rates from a one-year sample of radar data from the FAA covering the period of June, 2016 to May, 2017. The data included itinerant arrivals and departures for propeller and jet aircraft, as well as local traffic by propeller aircraft.

Flight tracks were developed separately for air carrier jets, other jets, propeller aircraft and helicopters.

Figure 13 and Figure 14 display the model flight tracks for jet aircraft arrivals and departures, respectively. Figure 15, Figure 16, and Figure 17 show the model flight tracks for propeller aircraft arrival, departure, and touch and go operations. The propeller aircraft arrival and departure figures include model tracks for helicopters.

Figure 13 Jet Arrival Model Tracks

Source: HMMH

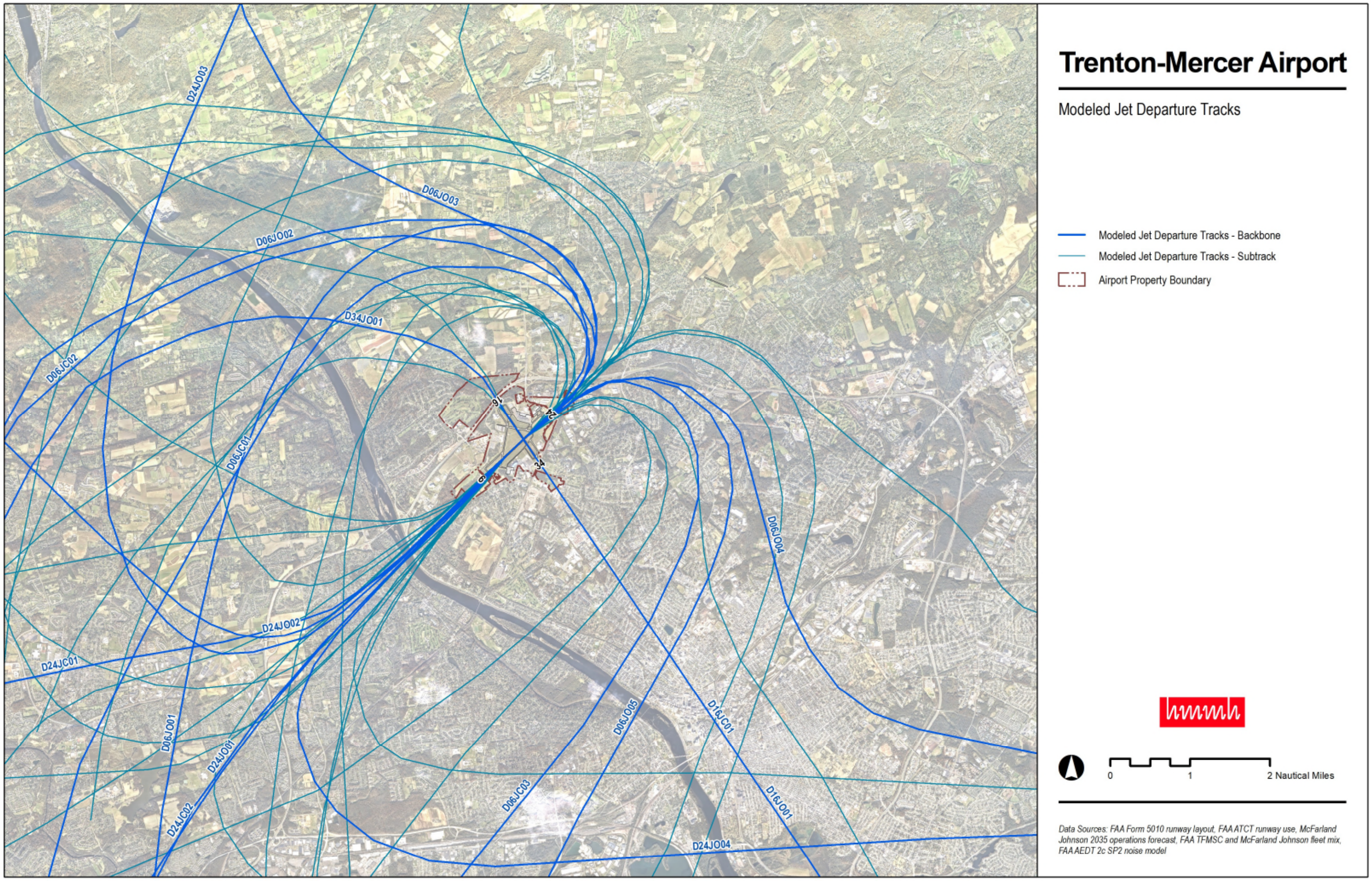

Figure 14 Jet Departure Model Tracks

Source: HMMH

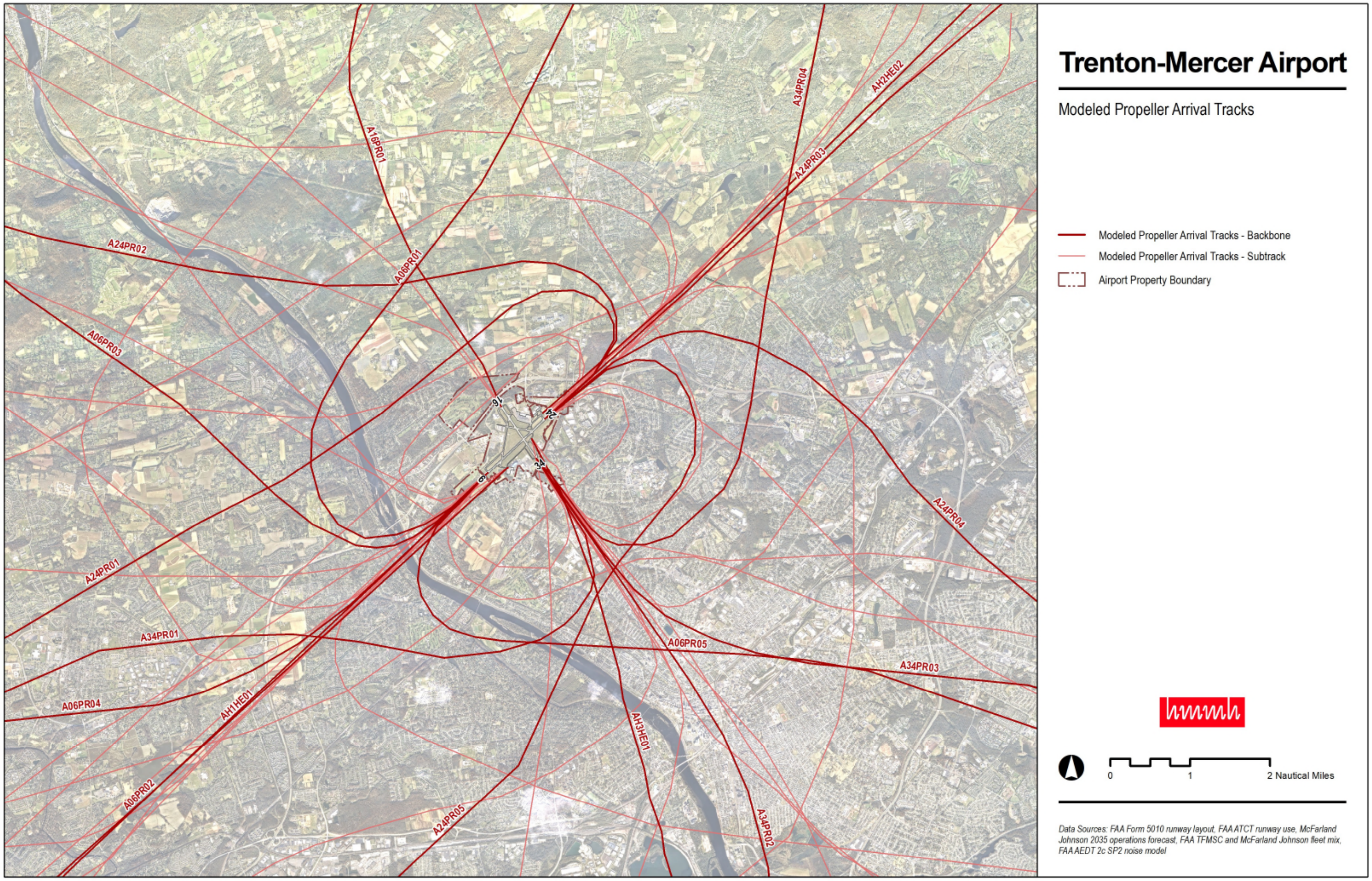

Figure 15 Propeller Aircraft Arrival Model Tracks

Source: HMMH

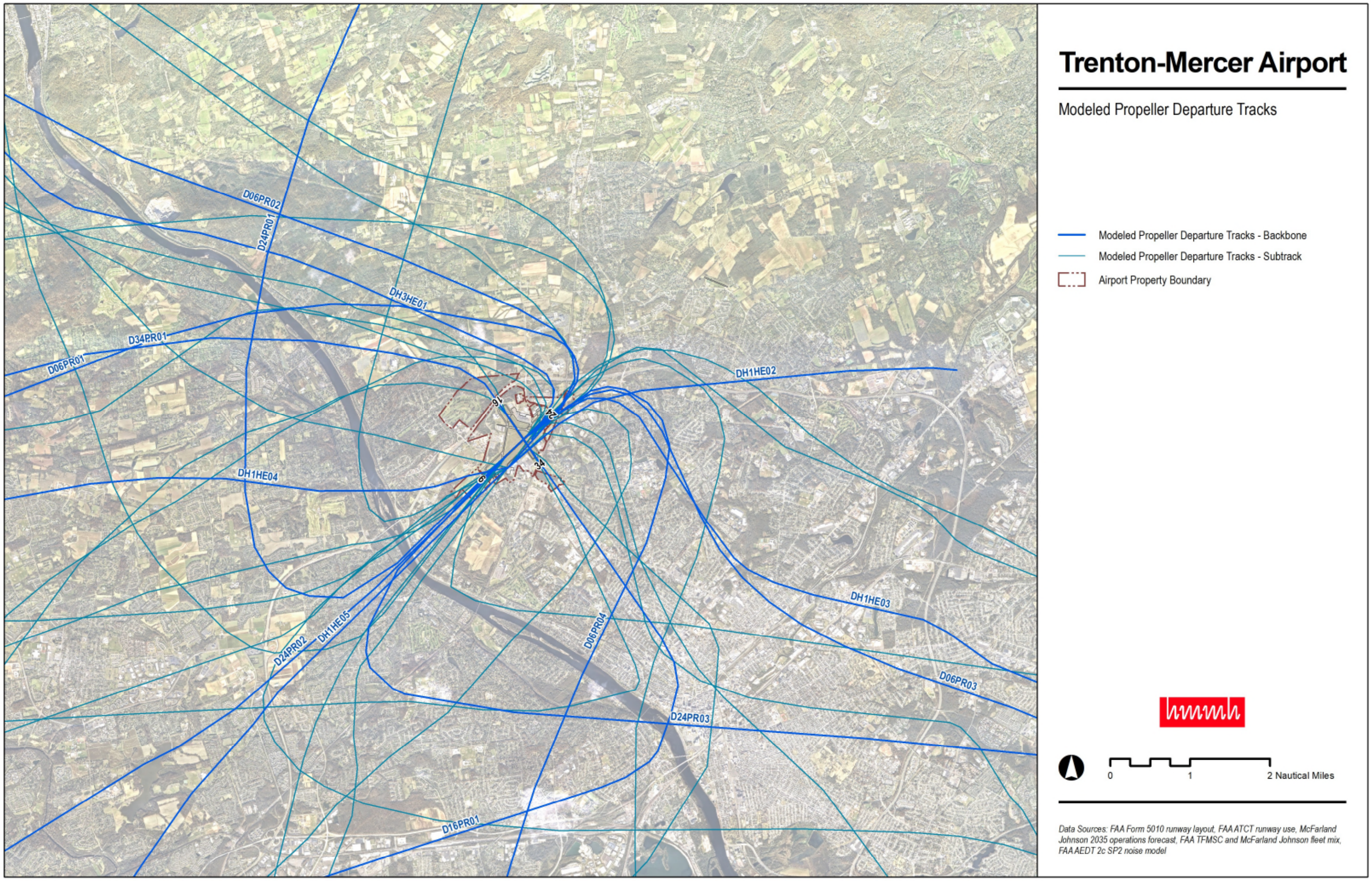

Figure 16 Propeller Aircraft Departure Model Tracks

Source: HMMH

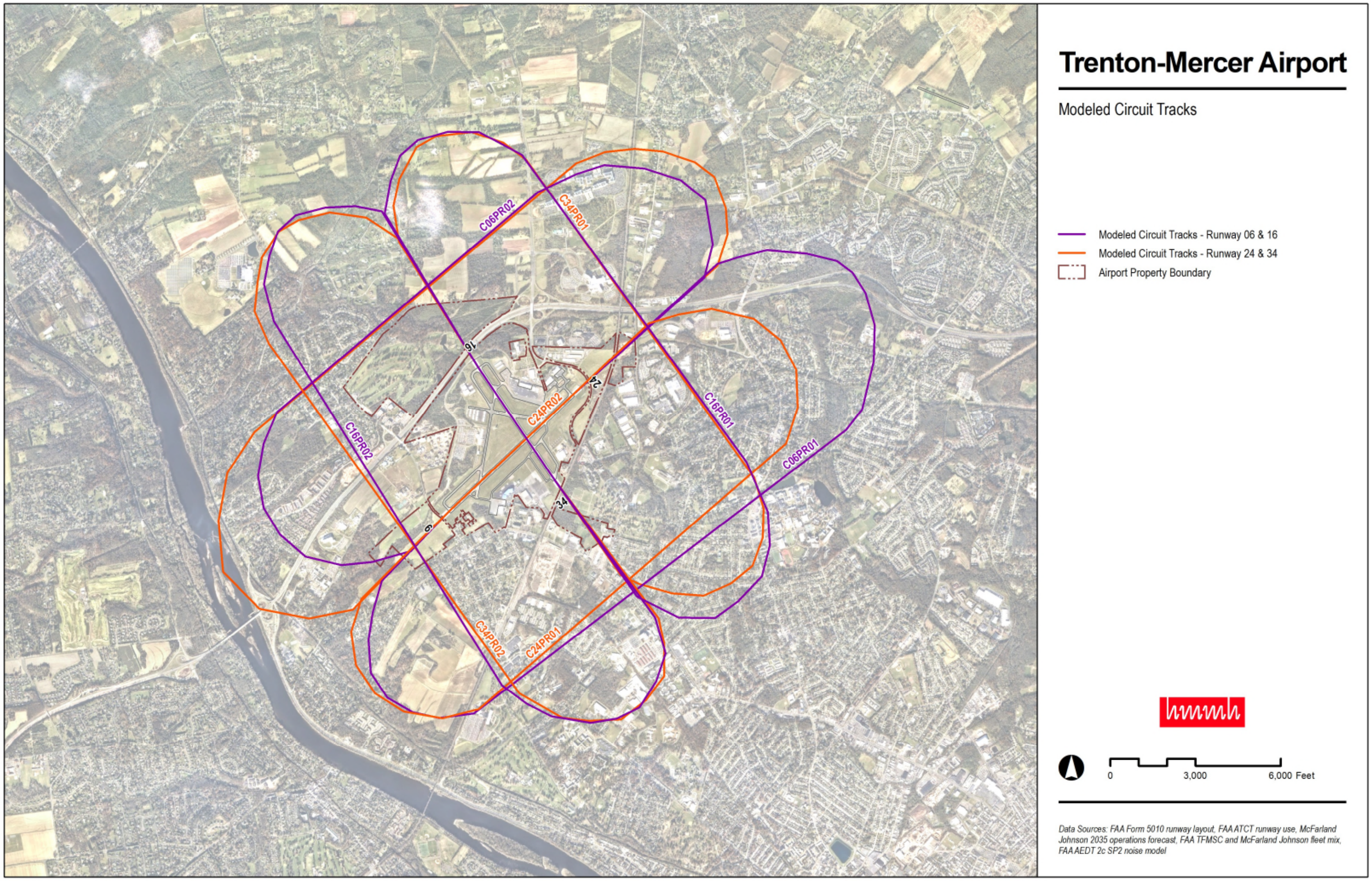

Figure 17 Propeller Aircraft Touch and Go Model Tracks

Source: HMMH

2.1.3 Aircraft Noise and Performance Characteristics

The AEDT includes a database of noise and performance data for a broad range of representative aircraft types. Noise data cover a range of distances (from 200 feet to 25,000 feet) for specific thrust levels. Performance data include thrust, speed, and altitude profiles for takeoff and landing operations. The AEDT database contains more than three hundred different aircraft types, including fixed-wing aircraft and helicopters, both civilian and military. The program automatically accesses the applicable noise and performance data for departure and approach operations by those aircraft. For aircraft not included in the database, the FAA maintains a list of acceptable substitutes.

AEDT users do not normally alter the model's internal noise and performance databases as a part of the modeling process. However, when there is an identifiable need such as a frequently-used non-standard thrust setting or climb profile, the FAA requires that any changes to these databases be approved by them prior to use on any FAA-sponsored project. FAA also requires approval for certain substitutions of aircraft types that occasionally appear in historical radar data but are not represented within the AEDT database.

HMMH did not use any aircraft substitutions or alter any noise or performance characteristics for AEDT standard aircraft.

2.1.4 Climatological Data

The AEDT accounts for the effects that airfield elevation and the average annual meteorological conditions have on aircraft performance. Aircraft departing an airport with a high temperature and/or a high elevation must use more thrust than at lower temperatures and elevations. The performance data used by the model define the length of the takeoff roll (based on aircraft takeoff weight), the climb rate, and speeds for each flight segment. Additionally, the AEDT accounts for the effect of temperature and humidity on acoustic propagation as explained in Section 1.1.4.1. The AEDT contains standard reference climatological data for airports throughout the US. The Master Plan noise modeling utilized the following average data for TTN from the AEDT database:

- Temperature of 52.7 degrees F
- Sea-level pressure of 1017.35 millibars
- Relative humidity of 68.64 percent
- Wind speed of 5.17 knots

2.2 Operational Characteristics

Once the physical characteristics are defined in AEDT, the numbers and types of aircraft using the runways, flight tracks, and noise and performance data must be specified. These operational characteristics can be broken into three categories: airport operations data, runway use, and flight track use.

2.2.1 Airport Operations Data

Noise modeling in the AEDT requires a detailed specification of the number of operations, types of aircraft, and the time of day at which the aircraft depart and land. Each aspect influences the total computed noise exposure. Obviously, the number of flights is important to the noise generated, but the time of day for aircraft operations is equally vital. Each nighttime flight has a ten-decibel increase applied. This makes each nighttime flight equivalent to ten daytime flights. Likewise, the careful selection of AEDT aircraft types ensures that the most representative noise and performance data is used from AEDT's database.

Urban Engineers developed general aircraft group estimates for current (2015) and future (2035) conditions at the airport. HMMH took the operations by aircraft group and further developed detailed fleet mix, day/night splits, and stagelength splits of operations using flight plan data from the FAA's Traffic Flow Management System. Table 4 and Table 5 present the noise modeling operations for the current and future scenarios, respectively. Note that these numbers represent daily operations. In annual terms, the noise modeling used 78,263 aircraft operations in 2015 and 95,275 in 2035.

Table 4 Existing (2015) Conditions Operations

Source: Urban Engineers, HMMH

AEDT Type	Ops Group	Arrivals			Departures			Total
		Day	Night	Total	Day	Night	Total	
A319-131	Air Carrier Jet	9.67	3.48	**13.15**	10.43	2.72	**13.15**	**26.30**
CIT3	Other Jet	0.11	0.00	**0.11**	0.11	0.00	**0.11**	**0.22**
CL600	Other Jet	2.91	0.19	**3.10**	3.04	0.06	**3.10**	**6.20**
CNA500	Other Jet	3.32	0.12	**3.44**	3.35	0.08	**3.44**	**6.88**
CNA510	Other Jet	0.19	0.01	**0.20**	0.20	0.00	**0.20**	**0.41**
CNA525C	Other Jet	0.06	0.00	**0.06**	0.06	0.00	**0.06**	**0.12**
CNA55B	Other Jet	2.42	0.07	**2.49**	2.45	0.04	**2.49**	**4.98**
CNA560U	Other Jet	0.55	0.02	**0.56**	0.50	0.06	**0.56**	**1.12**
CNA560XL	Other Jet	1.23	0.06	**1.28**	1.21	0.07	**1.28**	**2.56**
CNA680	Other Jet	0.56	0.03	**0.59**	0.57	0.02	**0.59**	**1.17**
CNA750	Other Jet	4.63	0.35	**4.98**	4.76	0.22	**4.98**	**9.96**
ECLIPSE500	Other Jet	0.23	0.00	**0.23**	0.23	0.00	**0.23**	**0.46**
EMB145	Other Jet	0.12	0.01	**0.13**	0.12	0.01	**0.13**	**0.27**
GIV	Other Jet	4.12	0.33	**4.45**	4.22	0.23	**4.45**	**8.91**
GV	Other Jet	7.52	1.14	**8.66**	7.94	0.72	**8.66**	**17.33**
IA1125	Other Jet	0.31	0.01	**0.32**	0.31	0.01	**0.32**	**0.64**
LEAR35	Other Jet	5.83	0.39	**6.22**	5.89	0.33	**6.22**	**12.44**
BEC58P	Propeller	12.15	0.42	**12.57**	12.42	0.15	**12.57**	**25.13**
CNA172	Propeller	25.88	0.89	**26.76**	26.04	0.72	**26.76**	**53.53**
CNA182	Propeller	2.48	0.01	**2.49**	2.37	0.12	**2.49**	**4.98**
CNA206	Propeller	0.28	0.01	**0.29**	0.29	0.00	**0.29**	**0.58**
CNA208	Propeller	2.90	0.16	**3.06**	2.92	0.14	**3.06**	**6.11**
CNA441	Propeller	0.05	0.02	**0.07**	0.07	0.00	**0.07**	**0.14**
COMSEP	Propeller	0.55	0.01	**0.57**	0.57	0.00	**0.57**	**1.13**
DHC6	Propeller	3.67	0.26	**3.93**	3.76	0.17	**3.93**	**7.86**
GASEPV	Propeller	1.89	0.10	**1.99**	1.93	0.06	**1.99**	**3.97**
PA28	Propeller	2.13	0.04	**2.17**	2.16	0.01	**2.17**	**4.34**
PA30	Propeller	0.09	0.12	**0.21**	0.17	0.04	**0.21**	**0.43**
PA42	Propeller	0.16	0.00	**0.16**	0.16	0.00	**0.16**	**0.32**
B222	Helicopter	1.03	0.03	**1.05**	1.05	0.01	**1.05**	**2.10**
S70	Helicopter	0.48	0.00	**0.48**	0.48	0.00	**0.48**	**0.95**
S76	Helicopter	0.74	0.07	**0.81**	0.75	0.06	**0.81**	**1.62**
SA330J	Helicopter	0.55	0.07	**0.62**	0.57	0.05	**0.62**	**1.24**
TOTAL		**98.80**	**8.41**	**107.21**	**101.08**	**6.13**	**107.21**	**214.42**

Table 5 Future (2035 Forecast) Operations

Source: Urban Engineers, HMMH

AEDT Type	Ops Group	Arrivals			Departures			Total
		Day	Night	Total	Day	Night	Total	
A320-211	Air Carrier Jet	5.60	2.02	**7.62**	6.05	1.57	**7.62**	**15.24**
A320-232	Air Carrier Jet	5.60	2.02	**7.62**	6.05	1.57	**7.62**	**15.24**
EMB175	Air Carrier Jet	1.25	0.45	**1.69**	1.34	0.35	**1.69**	**3.39**
CIT3	Other Jet	0.14	0.00	**0.14**	0.14	0.00	**0.14**	**0.28**
CL600	Other Jet	3.56	0.24	**3.80**	3.73	0.07	**3.80**	**7.59**
CNA500	Other Jet	4.07	0.14	**4.21**	4.11	0.10	**4.21**	**8.42**
CNA510	Other Jet	0.24	0.01	**0.25**	0.25	0.00	**0.25**	**0.50**
CNA525C	Other Jet	0.08	0.00	**0.08**	0.08	0.00	**0.08**	**0.15**
CNA55B	Other Jet	2.91	0.09	**3.00**	2.95	0.05	**3.00**	**6.00**
CNA560U	Other Jet	0.66	0.02	**0.68**	0.62	0.07	**0.68**	**1.37**
CNA560XL	Other Jet	1.51	0.07	**1.58**	1.49	0.09	**1.58**	**3.16**
CNA680	Other Jet	0.69	0.04	**0.72**	0.70	0.02	**0.72**	**1.45**
CNA750	Other Jet	5.68	0.43	**6.12**	5.84	0.28	**6.12**	**12.24**
ECLIPSE500	Other Jet	0.28	0.00	**0.29**	0.29	0.00	**0.29**	**0.57**
EMB145	Other Jet	0.15	0.02	**0.16**	0.15	0.02	**0.16**	**0.33**
GIV	Other Jet	5.04	0.41	**5.44**	5.15	0.29	**5.44**	**10.89**
GV	Other Jet	9.34	1.42	**10.76**	9.86	0.90	**10.76**	**21.52**
IA1125	Other Jet	0.38	0.01	**0.40**	0.38	0.01	**0.40**	**0.79**
LEAR35	Other Jet	7.13	0.49	**7.62**	7.21	0.41	**7.62**	**15.25**
BEC58P	Propeller	14.49	0.52	**15.01**	14.83	0.18	**15.01**	**30.02**
CNA172	Propeller	30.69	1.06	**31.75**	30.90	0.85	**31.75**	**63.50**
CNA182	Propeller	2.93	0.01	**2.94**	2.79	0.15	**2.94**	**5.88**
CNA206	Propeller	0.33	0.01	**0.34**	0.34	0.00	**0.34**	**0.68**
CNA208	Propeller	3.56	0.19	**3.75**	3.58	0.17	**3.75**	**7.50**
CNA441	Propeller	0.06	0.02	**0.09**	0.09	0.00	**0.09**	**0.18**
COMSEP	Propeller	0.69	0.01	**0.70**	0.70	0.00	**0.70**	**1.41**
DHC6	Propeller	4.53	0.32	**4.85**	4.64	0.21	**4.85**	**9.70**
GASEPV	Propeller	2.35	0.12	**2.47**	2.40	0.07	**2.47**	**4.94**
PA28	Propeller	2.60	0.05	**2.65**	2.63	0.01	**2.65**	**5.29**
PA30	Propeller	0.11	0.15	**0.26**	0.21	0.05	**0.26**	**0.53**
PA42	Propeller	0.20	0.00	**0.20**	0.20	0.00	**0.20**	**0.40**
B222	Helicopter	1.03	0.03	**1.06**	1.05	0.01	**1.06**	**2.12**
S70	Helicopter	0.48	0.00	**0.48**	0.48	0.00	**0.48**	**0.95**
S76	Helicopter	0.92	0.09	**1.01**	0.93	0.08	**1.01**	**2.01**
SA330J	Helicopter	0.68	0.09	**0.77**	0.71	0.06	**0.77**	**1.54**
TOTAL		**119.96**	**10.56**	**130.51**	**122.84**	**7.67**	**130.51**	**261.03**

2.2.2 Runway Use

Runway use refers to the frequency with which aircraft utilize each runway during the course of a year, as dictated or permitted by wind, weather, aircraft weight, air traffic control conditions, and noise considerations. Aircraft generally take off and land facing into the wind, making it the primary factor in selecting a runway for takeoff or landing. Using the one year radar data sample, HMMH developed runway use rates for air carrier jet, other jet, and propeller aircraft operations. Table 6 shows the results of the runway use analysis for arrivals and departures by fixed wing aircraft. Table 7 shows the touch and go runway utilization. Table 8 shows the helipad utilization.

Table 6 Runway Utilization

Source: HMMH

Aircraft Group	Arrival					Departure				
	Runway 6	Runway 16	Runway 24	Runway 34	Total	Runway 6	Runway 16	Runway 24	Runway 34	Total
Air Carrier Jet	50%	<1%	48%	2%	**100%**	39%	<1%	60%	0%	**100%**
Other Jet	43%	<1%	50%	6%	**100%**	34%	2%	61%	3%	**100%**
Propeller	44%	1%	46%	9%	**100%**	38%	8%	46%	8%	**100%**

Table 7 Touch and Go Runway Utilization

Source: HMMH

Aircraft Group	Runway 6	Runway 16	Runway 24	Runway 34	Total
Propeller	27%	2%	60%	11%	**100%**

Table 8 Helipad Utilization

Source: HMMH

Aircraft Group	H1	H2	H3	Total
Helicopter	75%	10%	15%	**100%**

2.2.3 Flight Track Use

Track use refers to the frequency with which aircraft utilize each flight path during the course of a year. Using the one year radar data sample, HMMH developed flight track use rates for air carrier jet, other jet, propeller aircraft, and helicopter operations. Table 9 through Table 12 show the results of the track use analysis. The percentages for each aircraft group, operation, and runway combination add to 100%.

Table 9 Air Carrier Jet Flight Track Utilization

Source: HMMH

Aircraft Group	Operation	Runway	Flight Track	Utilization
Air Carrier Jet	Arr	6	A06JC01	100%
Air Carrier Jet	Arr	16	A16JC01	100%
Air Carrier Jet	Arr	24	A24JC01	10%
Air Carrier Jet	Arr	24	A24JC02	90%
Air Carrier Jet	Arr	34	A34JC01	100%
Air Carrier Jet	Dep	6	D06JC01	34%
Air Carrier Jet	Dep	6	D06JC02	35%
Air Carrier Jet	Dep	6	D06JC03	31%
Air Carrier Jet	Dep	16	D16JC01	100%
Air Carrier Jet	Dep	24	D24JC01	9%
Air Carrier Jet	Dep	24	D24JC02	91%

Table 10 Other Jet Flight Track Utilization

Source: HMMH

Aircraft Group	Operation	Runway	Flight Track	Utilization
Other Jet	Arr	6	A06JO01	5%
Other Jet	Arr	6	A06JO02	81%
Other Jet	Arr	6	A06JO03	14%
Other Jet	Arr	16	A16JO01	100%
Other Jet	Arr	24	A24JO01	25%
Other Jet	Arr	24	A24JO02	9%
Other Jet	Arr	24	A24JO03	12%
Other Jet	Arr	24	A24JO04	16%
Other Jet	Arr	24	A24JO05	35%
Other Jet	Arr	24	A24JO06	3%
Other Jet	Arr	34	A34JO01	18%
Other Jet	Arr	34	A34JO02	19%
Other Jet	Arr	34	A34JO03	41%
Other Jet	Arr	34	A34JO04	21%
Other Jet	Dep	6	D06JO01	22%
Other Jet	Dep	6	D06JO02	41%
Other Jet	Dep	6	D06JO03	12%
Other Jet	Dep	6	D06JO04	4%
Other Jet	Dep	6	D06JO05	21%
Other Jet	Dep	16	D16JO01	100%
Other Jet	Dep	24	D24JO01	90%
Other Jet	Dep	24	D24JO02	2%
Other Jet	Dep	24	D24JO03	5%
Other Jet	Dep	24	D24JO04	3%
Other Jet	Dep	34	D34JO01	100%

Table 11 Propeller Aircraft Flight Track Utilization

Source: HMMH

Aircraft Group	Operation	Runway	Flight Track	Utilization
Propeller	Arr	6	A06PR01	5%
Propeller	Arr	6	A06PR02	64%
Propeller	Arr	6	A06PR03	7%
Propeller	Arr	6	A06PR04	17%
Propeller	Arr	6	A06PR05	7%
Propeller	Arr	16	A16PR01	100%
Propeller	Arr	24	A24PR01	23%
Propeller	Arr	24	A24PR02	10%
Propeller	Arr	24	A24PR03	26%
Propeller	Arr	24	A24PR04	22%
Propeller	Arr	24	A24PR05	20%
Propeller	Arr	34	A34PR01	34%
Propeller	Arr	34	A34PR02	28%
Propeller	Arr	34	A34PR03	27%
Propeller	Arr	34	A34PR04	11%
Propeller	Arr	6	A06PR01	5%
Propeller	Arr	6	A06PR02	64%
Propeller	Arr	6	A06PR03	7%
Propeller	Arr	6	A06PR04	17%
Propeller	Arr	6	A06PR05	7%
Propeller	Arr	16	A16PR01	100%
Propeller	Arr	24	A24PR01	23%
Propeller	Arr	24	A24PR02	10%
Propeller	Arr	24	A24PR03	26%
Propeller	Arr	24	A24PR04	22%
Propeller	Arr	24	A24PR05	20%
Propeller	Arr	34	A34PR01	34%
Propeller	Arr	34	A34PR02	28%
Propeller	Arr	34	A34PR03	27%
Propeller	Arr	34	A34PR04	11%
Propeller	Dep	6	D06PR01	49%
Propeller	Dep	6	D06PR02	8%
Propeller	Dep	6	D06PR03	29%
Propeller	Dep	6	D06PR04	14%
Propeller	Dep	16	D16PR01	100%
Propeller	Dep	24	D24PR01	10%
Propeller	Dep	24	D24PR02	63%
Propeller	Dep	24	D24PR03	27%
Propeller	Dep	34	D34PR01	100%
Propeller	Dep	6	D06PR01	49%
Propeller	Dep	6	D06PR02	8%
Propeller	Dep	6	D06PR03	29%
Propeller	Dep	6	D06PR04	14%
Propeller	Dep	16	D16PR01	100%
Propeller	Dep	24	D24PR01	10%
Propeller	Dep	24	D24PR02	63%
Propeller	Dep	24	D24PR03	27%
Propeller	Dep	34	D34PR01	100%
Propeller	Touch and Go	6	C06PR01	48%
Propeller	Touch and Go	6	C06PR02	52%
Propeller	Touch and Go	16	C16PR01	71%
Propeller	Touch and Go	16	C16PR02	29%
Propeller	Touch and Go	24	C24PR01	93%
Propeller	Touch and Go	24	C24PR02	7%
Propeller	Touch and Go	34	C34PR01	42%
Propeller	Touch and Go	34	C34PR02	58%

Table 12 Helicopter Flight Track Utilization

Source: HMMH

Aircraft Group	Operation	Helipad	Flight Track	Utilization
Helicopter	Arr	H1	AH1HE01	100%
Helicopter	Arr	H2	AH2HE02	100%
Helicopter	Arr	H3	AH3HE01	100%
Helicopter	Dep	H1	DH1HE02	26%
Helicopter	Dep	H1	DH1HE03	20%
Helicopter	Dep	H1	DH1HE04	29%
Helicopter	Dep	H1	DH1HE05	26%
Helicopter	Dep	H3	DH3HE01	100%

3 AEDT Noise Modeling Results

Figure 18 displays the 65 dB, 70 dB, and 75 dB DNL contours for the Existing Conditions (2015) AEDT noise modeling scenario. Table 13 shows the area at various noise contour intervals for 2015.

Table 13 Existing Conditions (2015) Noise Contour Area

Source: HMMH

Day Night Average Sound Level (dB)	Contour Area (Acres)
65 - 70	197.93
70 - 75	92.48
75 +	81.99
Total (65 +)	**372.40**

Figure 19 displays the 65 dB, 70 dB, and 75 dB DNL contours for the Forecast Conditions (2035) AEDT noise modeling scenario. Table 14shows the area at various noise contour intervals for 2035.

Table 14 Forecast Conditions (2035) Noise Contour Area

Source: HMMH

Day Night Average Sound Level (dB)	Contour Area (Acres)
65 - 70	257.35
70 - 75	106.44
75 +	104.74
Total (65 +)	**468.53**

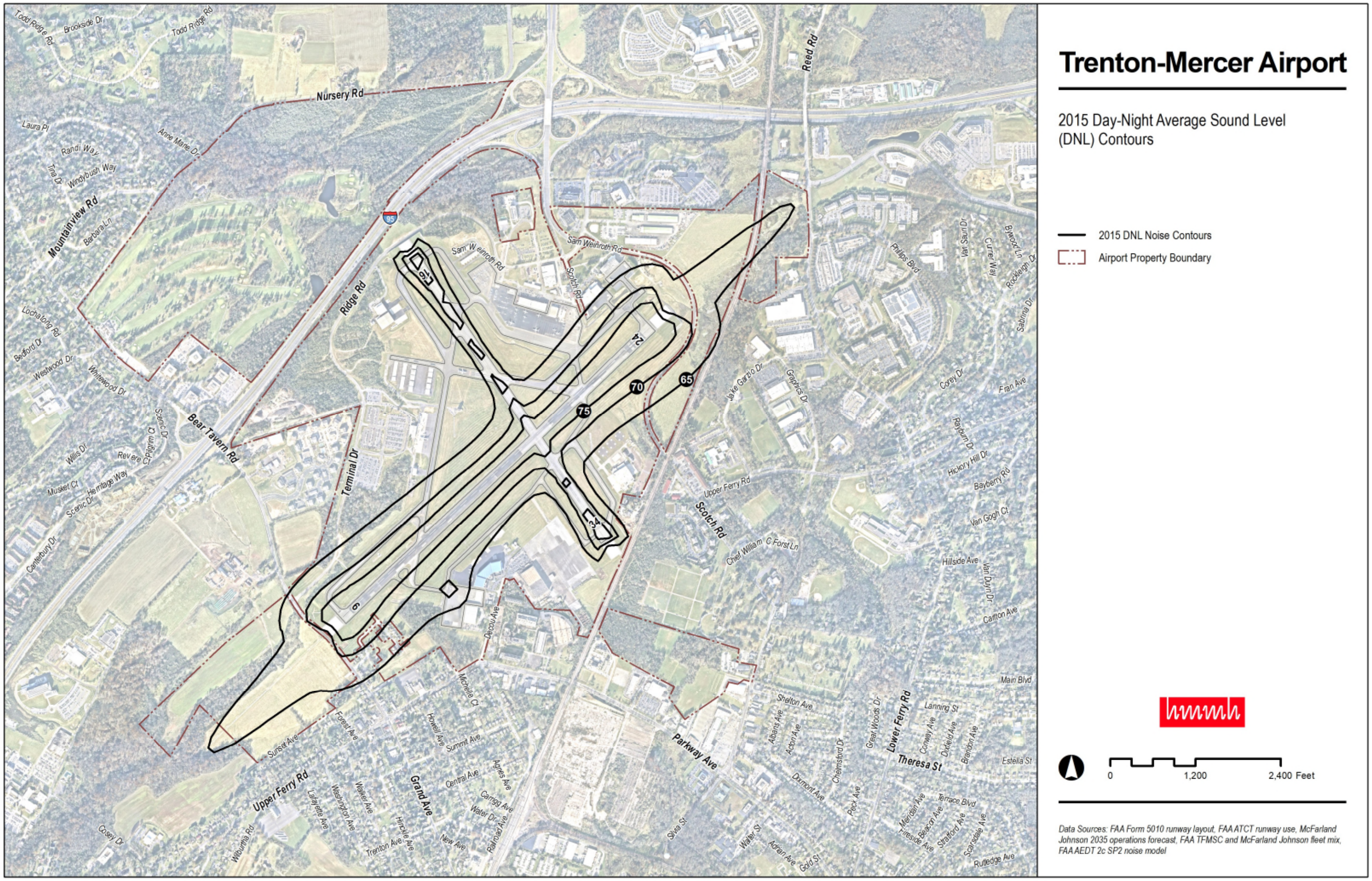

Figure 18 Existing Conditions (2015) 65, 70, 75 dB DNL Contours

Source: HMMH

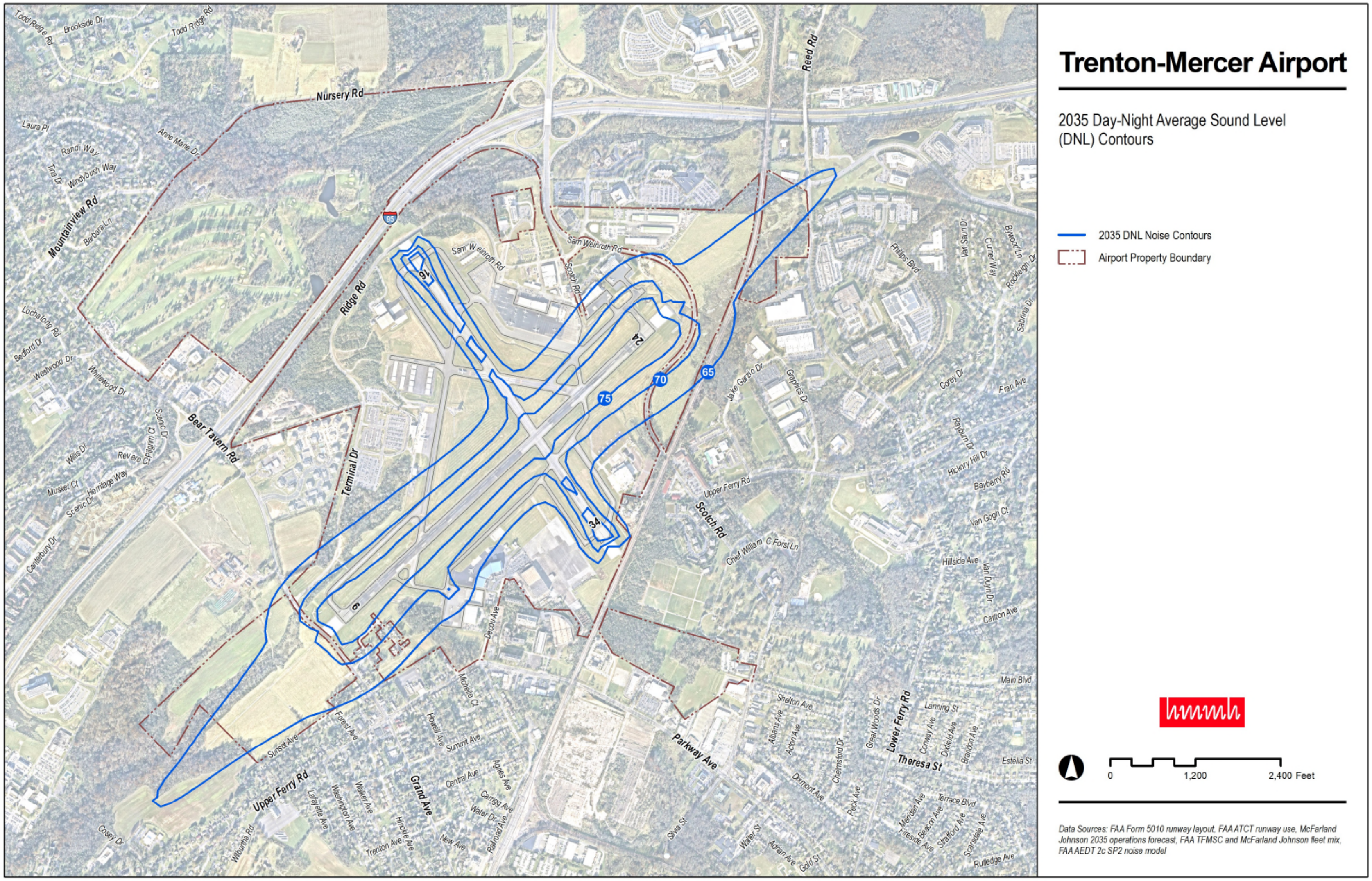

Figure 19 Future Conditions (2035) 65, 70, 75 dB DNL Contours

Source: HMMH