I. Noise Supporting Documentation

This appendix provides detailed information, tables, and figures in support of Chapter 7, *Noise*. The contents of this appendix are summarized below.

I.1 Fundamentals of Acoustics and Environmental Noise

This section introduces the fundamentals of acoustics and noise terminology as well as the effects of noise on human activity and community annoyance.

I.1.1 Introduction to Acoustics and Noise Terminology

Chapter 7, *Noise* of this *2022 Environmental Status and Planning Report (ESPR)* relies largely on a measure of cumulative noise exposure over an entire calendar year, in terms of a metric called the Day-Night Average Sound Level (DNL). However, DNL does not always provide a sufficient description of noise for many purposes. Other measures are available to address essentially any issue of concern. This section introduces the following acoustic metrics, which are all related to DNL, but provide bases for evaluating a broad range of noise situations. These metrics include:

- Decibel (dB)
- A-Weighted Decibel (dBA)
- Sound Exposure Level (SEL)
- Equivalent Sound Level (Leq)
- Time Above (TA)
- Time Above, Night (TAN)
- DNL

I.1.2 The Decibel (dB)

All sounds come from a sound source – a musical instrument, a voice speaking, or an airplane that passes overhead. It takes energy to produce sound. The sound energy produced by any sound source is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear.

Human ears are sensitive to a wide range of sound pressures. The loudest sounds that we hear without pain have about one million times more energy than the quietest sounds we hear. However, our ears are incapable of detecting small differences in these pressures. Thus, to match how we hear this sound energy, humans compress the total range of sound pressures to a more meaningful range by introducing the concept of sound pressure level (SPL). SPL is a measure of the sound pressure of a given noise source relative to a standard reference value (typically the quietest sound that a young person with good hearing can detect). SPLs are measured in decibels (abbreviated dB). Decibels are logarithmic quantities – logarithms of the squared ratio of two pressures, the numerator being the pressure of the sound source of interest, and the denominator being the reference pressure (the quietest sound we can hear).

The logarithmic conversion of sound pressure to SPL means that the quietest sound we can hear (the reference pressure) has a SPL of about zero dB, while the loudest sounds we hear without pain have SPLs of about 120 dB. Most sounds in our day-to-day environment have SPLs from 30 to 100 dB.

Because decibels are logarithmic quantities, they do not behave like regular numbers with which we are more familiar. For example, if two sound sources each produce 100 dB and they are operated together, they produce only 103 dB – not 200 dB as we might expect. Four equal sources operating simultaneously result in a total SPL of 106 dB. In fact, for every doubling of the number of equal sources, the SPL goes up another three decibels. A tenfold increase in the number of sources makes the SPL go up 10 dB. A hundredfold increase makes the level go up 20 dB, and it takes a thousand equal sources to increase the level 30 dB.

If one source is much louder than another source, the two sources together will produce the same SPL (and sound to our ears) as if the louder source were operating alone. For example, a 100-dB source plus an 80-dB source produces 100 dB when operating together. The louder source “masks” the quieter one, but if the quieter source gets louder, it will have an increasing effect on the total SPL. When the two sources are equal, as described above, they produce a level 3 dB above the sound of either one by itself.

From these basic concepts, note that 100 80 dB sources will produce a combined level of 100 dB; if a single 100-dB source is added, the group will produce a total SPL of 103 dB. Clearly, the loudest source has the greatest effect on the total decibel level.

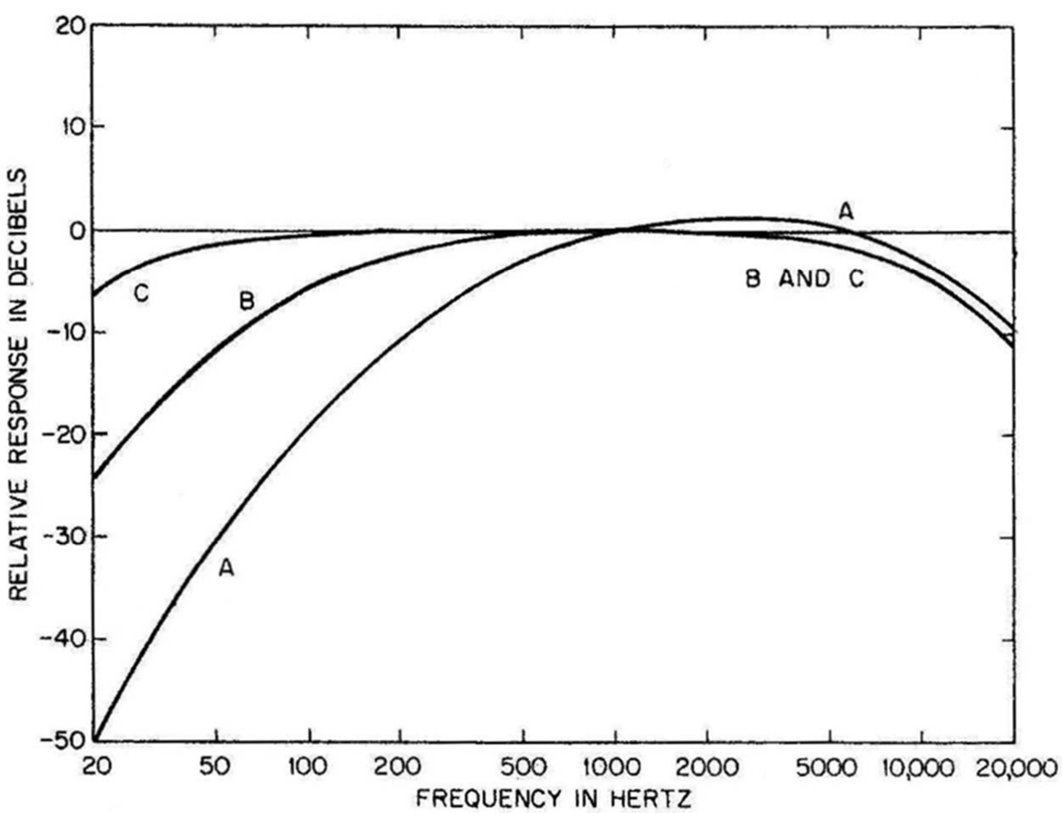
I.1.2.1 A-Weighted Decibel (dBA)

Another important characteristic of sound is its frequency, or “pitch.” This is the rate of repetition of the sound pressure oscillations as they reach our ear. Formerly expressed in cycles per second, frequency is now expressed in units known as Hertz (Hz).

Most people hear from about 20 Hz to about 10,000 to 15,000 Hz. People respond to sound most readily when the predominant frequency is in the range of normal conversation, around 1,000 to 2,000 Hz. Acousticians have developed "filters" to match our ears' sensitivity and help us to judge the relative loudness of sounds made up of different frequencies. The so-called "A" filter does the best job of matching the sensitivity of our ears to most environmental noises. SPLs measured through this filter are referred to as A-weighted levels (dBA). A-weighting significantly de-emphasizes noise at low and very high frequencies (below about 500 Hz and above about 10,000 Hz) where we do not hear as well. Because this filter generally matches our ears' sensitivity, sounds having higher A-weighted sound levels are usually judged louder than those with lower A-weighted sound levels, a relationship which does not always hold true for unweighted levels. It is for these reasons that A-weighted sound levels are normally used to evaluate environmental noise.

Other weighting networks include the B and C filters. They correspond to different level ranges of the ear. The rarely used B-weighting attenuates low frequencies (those less than 500 Hz), but to a lesser degree than A-weighting. C weighting is nearly flat throughout the audible frequency range, hardly de-emphasizing low frequency noise. C-weighted levels can be preferable in evaluating sounds for which low-frequency components are responsible for secondary effects such as the shaking of a building, window rattle, or perceptible vibrations. Uses include the evaluation of blasting noise, artillery fire, and in some cases, aircraft noise inside buildings. **Figure I-1** compares these various weighting networks.

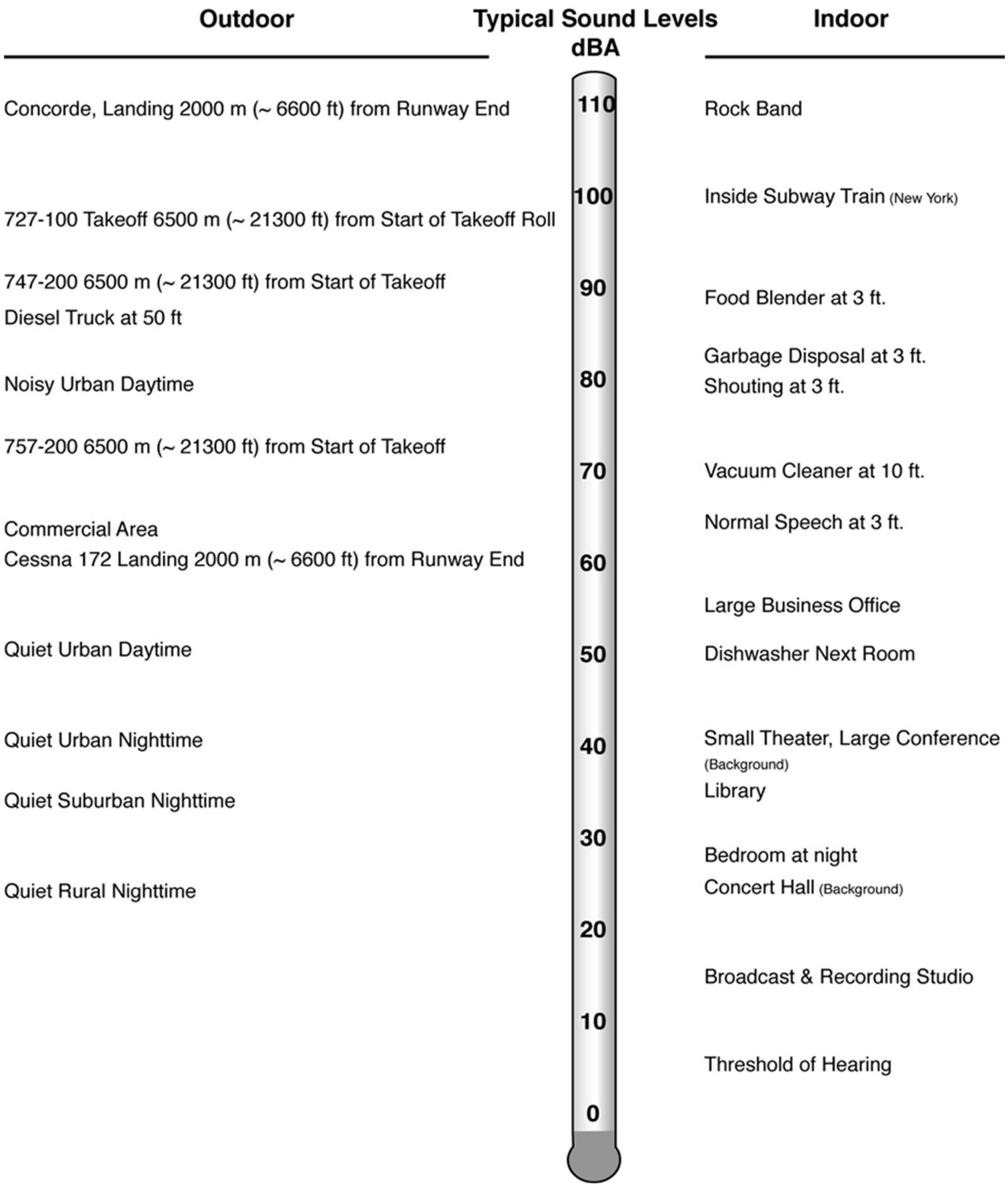
Figure I-1 Frequency-Response Characteristics of Various Weighting Networks



Source: Harris, Cyril M., editor; Handbook of Acoustical Measurements and Noise Control, (Chapter 5, "Acoustical Measurement Instruments"; Johnson, Daniel L.; Marsh, Alan H.; and Harris, Cyril M.); New York; McGraw-Hill, Inc.; 1991; p. 5.13.

Because of the correlation with human hearing, the A-weighted level has been adopted as the basic measure of environmental noise by the U.S. Environmental Protection Agency (EPA) and by nearly every other federal and state agency concerned with community noise. **Figure I-2** presents typical A-weighted sound levels of several common environmental sources.

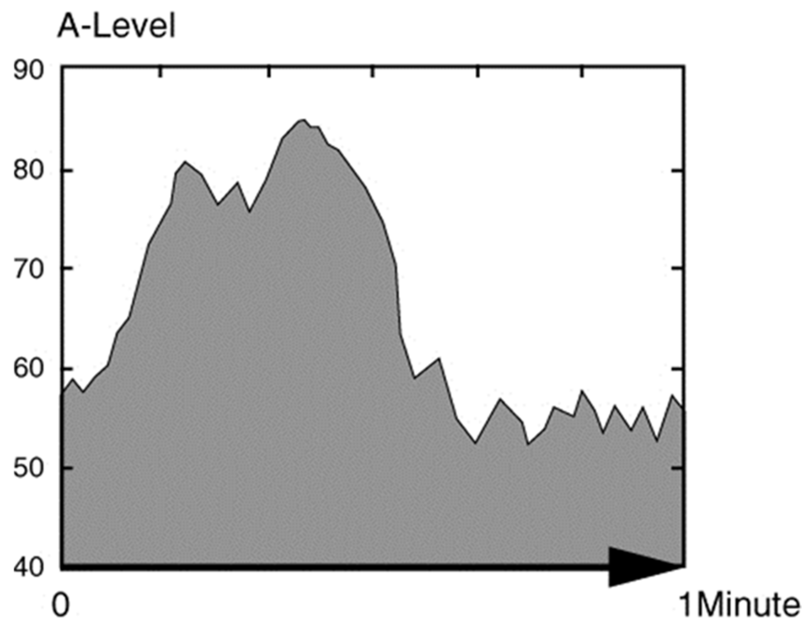
Figure I-2 Common Environmental Sound Levels, in dBA



Source: HMMH (Aircraft noise levels from FAA Advisory Circular 36-3H)
Note: dBA – A-weighted decibel.

An additional dimension to environmental noise is that A-weighted levels vary with time. For example, the sound level increases as an aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance (though even the background varies as birds chirp or the wind blows, or a vehicle passes by). **Figure I-3** illustrates this concept.

Figure I-3 Variations in the A-Weighted Sound Level Over Time



Source: HMMH.

I.1.2.2 Maximum A-Weighted Noise Level (L_{max})

The variation in noise level over time often makes it convenient to describe a particular noise "event" by its maximum sound level, abbreviated as L_{max}. In the figure above, it is approximately 85 dBA.

The maximum level describes only one dimension of an event; it provides no information on the cumulative noise exposure. In fact, two events with identical maxima 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 measure corrects for this deficiency.

I.1.2.3 Sound Exposure Level (SEL)

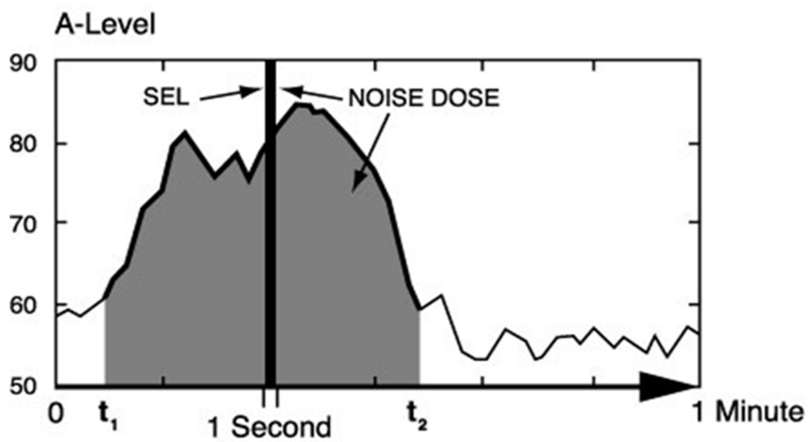
The most frequently used measure of noise exposure for an individual aircraft noise event (and the measure that Part 150[1] specifies for this purpose) is the SEL. SEL is a measure of the total noise energy produced during an event, from the time when the A-weighted sound level first exceeds a threshold level (normally just above the background or ambient noise) to the time that the sound level drops back down

1 "Part 150" refers to Federal Aviation Regulations (FAR) Part 150, discussed in detail in the Regulatory Framework Section of this Appendix.

below the threshold. To allow comparison of noise events with very different durations, SEL "normalizes" the duration in every case to one second; that is, it is expressed as the steady noise level with just a one-second duration that includes the same amount of noise energy as the actual longer duration, time-varying noise. In lay terms, SEL "squeezes" the entire noise event into one second.

Figure I-4 depicts this transformation. The shaded area represents the energy included in an SEL measurement for the noise event, where the threshold is set to 60 dBA. The dark shaded vertical bar, which is 90 dBA high and just one-second-long (wide), contains the same sound energy as the full event.

Figure I-4 Sound Exposure Level (SEL)



Source: HMMH.

Because the SEL is normalized to one second, it will always be larger than the L_{max} for an event longer than one second. In this case, the SEL is 90 dB; the L_{max} is approximately 85 dBA. For most aircraft overflights, the SEL is normally on the order of 7 to 12 dB higher than L_{max}. Because SEL considers duration, longer exposure to relatively slow, quiet aircraft, such as propeller models, can have the same or higher SEL than shorter exposure to faster, louder planes, such as corporate jets.

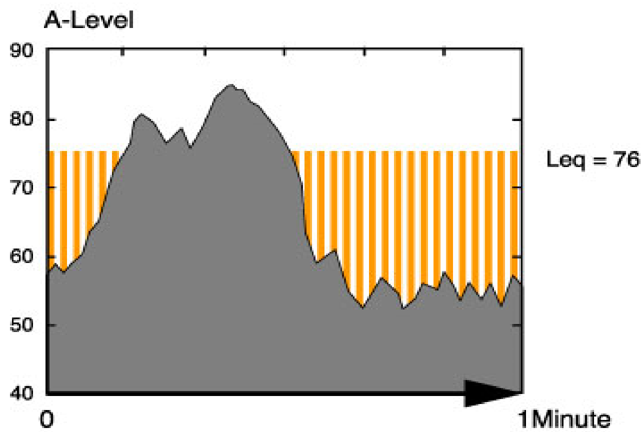
I.1.2.4 Equivalent Sound Level (L_{eq})

The L_{max} and SEL quantify the noise associated with individual events. The remaining metrics in this section describe longer-term cumulative noise exposure that can include many events.

The Equivalent Sound Level (L_{eq}) is a measure of exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest (e.g., an hour, an eight-hour school day, nighttime, or a full 24-hour day). Because the length of the period can differ, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example $L_{eq(8)}$ or $L_{eq(24)}$.

L_{eq} is equivalent to the constant sound level over the period of interest that contains as much sound energy as the actual time-varying level. This is illustrated in **Figure I-5**. Both the solid and striped shaded areas have a one-minute L_{eq} value of 76 dB. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different in real life. Also, be aware that the "average" sound level suggested by L_{eq} is not an arithmetic value, but a logarithmic, or "energy-averaged" sound level. Thus, loud events dominate L_{eq} measurements.

Figure I-5 Example of a One-Minute Equivalent Sound Level (L_{eq})



Source: HMMH.

In airport noise studies, L_{eq} is often presented for consecutive one-hour periods to illustrate how the exposure rises and falls throughout a 24-hour period, and how individual hours are affected by unusual activity, such as rush hour traffic or a few loud aircraft.

I.1.2.5 Time Above (TA)

TA is a metric that gives the duration, in minutes, for which aircraft-related noise exceeds a specified A--weighted sound level during a given period. The measure is referred to generally as TA. For this *2022 ESPR*, three threshold sound levels are used in the analysis: 65, 75, and 85 dBA. These times are computed using the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT).

I.1.2.6 Time Above Night (TAN)

TAN is identical to TA, except it is computed for only the 9-hour period between 10:00 PM and 7:00 AM. The TAN is also developed using three threshold sound levels 65, 75, and 85 dBA.

I.1.2.7 Day-Night Average Sound Level (DNL)

Virtually all studies of aircraft noise rely on a slightly more complicated measure of noise exposure that describes cumulative noise exposure during an average annual day: the DNL. (EPA identified DNL as the most appropriate means of evaluating airport noise based on the following considerations:[2]

1. The measure should be applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods.
2. The measure should correlate well with known effects of the noise environment and on individuals and the public.
3. The measure should be simple, practical, and accurate. In principal, it should be useful for planning as well as for enforcement or monitoring purposes.
4. The required measurement equipment, with standard characteristics, should be commercially available.
5. The measure should be closely related to existing methods currently in use.
6. 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.
7. 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 and DNL was reaffirmed again by the Federal Interagency Committee on Aircraft Noise (FICAN) in 2018. 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."

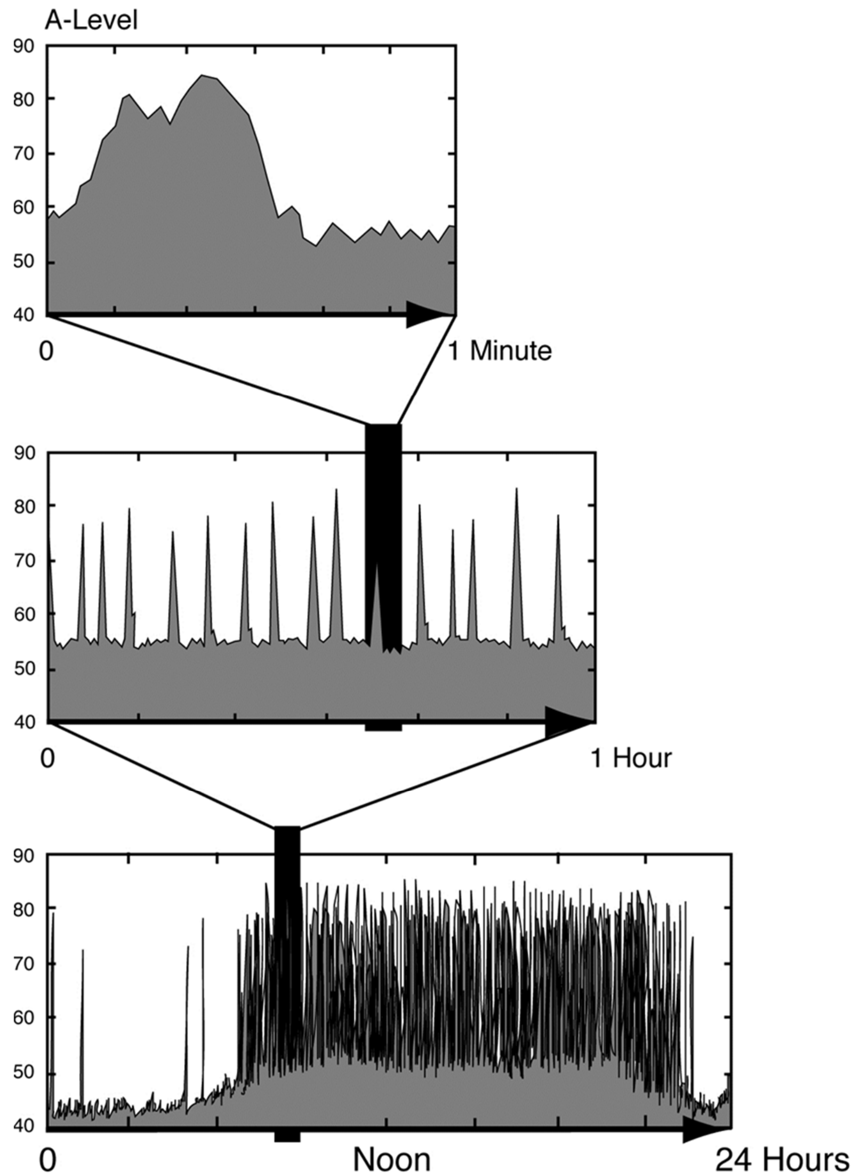
The DNL represents noise as it occurs over a 24-hour period, with one important exception: DNL treats nighttime noise differently from daytime noise. In determining DNL, it is assumed that the A-weighted levels occurring at night (defined as 10:00 PM to 7:00 AM) are 10 dB louder than they really are. This 10-dB penalty is applied to account for greater sensitivity to nighttime noise, and the fact that events at night are often perceived to be more intrusive because nighttime ambient noise is less than daytime ambient noise.

Figure I-4 illustrated the A-weighted sound level due to an aircraft fly-over as it changed with time. The top frame of **Figure I-6** repeats this figure. The shaded area reflects the noise dose that a listener receives during the one-minute period of the sample. The center frame of **Figure I-6** includes this one-minute sample within a full hour. The shaded area represents the noise during that hour with 16 noise events, each producing an SEL. Similarly, the bottom frame includes the one-hour interval within a full 24 hours. Here the shaded area represents the listener's noise dose over a complete day. Note that several overflights occur at a time when the background noise drops some 10 dB, to approximately 45 dBA.

2 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.

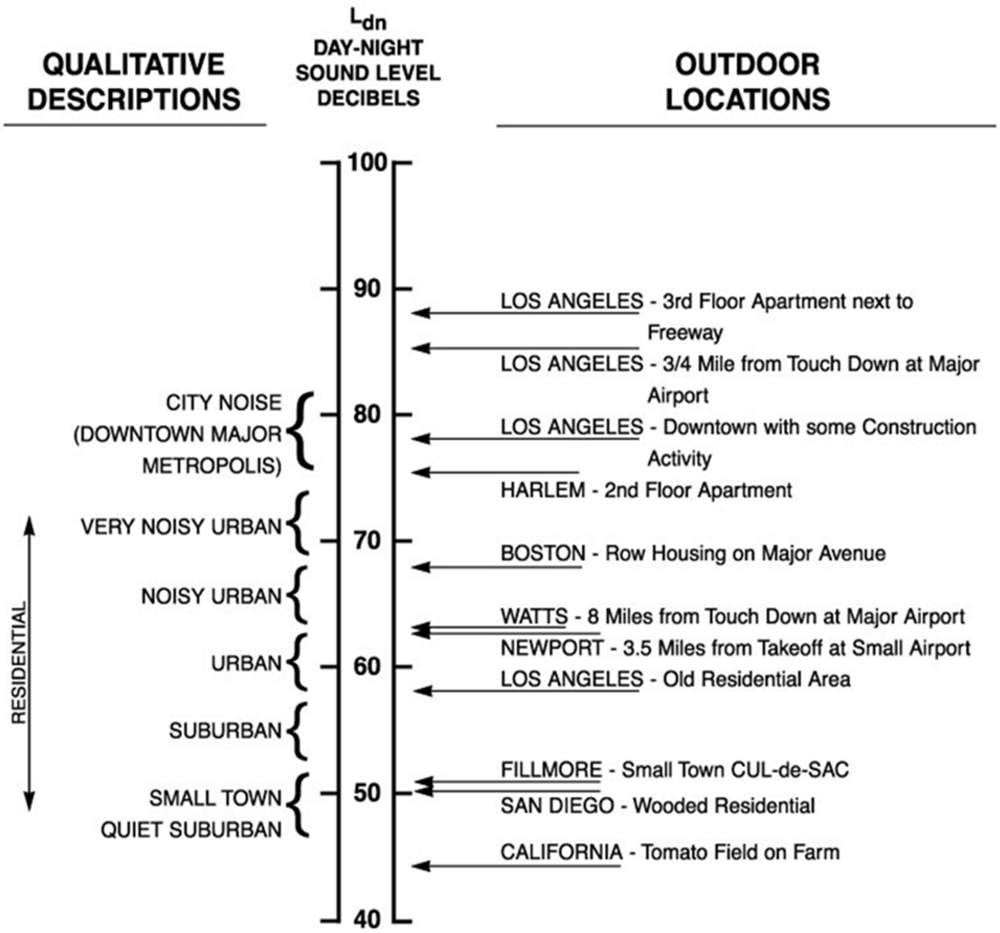
DNL can be measured or estimated. Measurements are practical only for obtaining DNL values for relatively limited numbers of points, and, in the absence of a permanently installed monitoring system, only for relatively short time periods. Most airport noise studies are based on computer-generated DNL estimates, determined by accounting for all the SELs from individual events, which comprise the total noise dose at a given location. Computed DNL values are often depicted in terms of equal-exposure noise contours (much as topographic maps have contours of equal elevation). **Figure I-7** depicts typical DNL values for a variety of noise environments.

Figure I-6 **Daily Noise Dose**



Source: HMMH.

Figure I-7 Examples of Day-Night Average Sound Levels (DNL)



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

In 2015, the FAA began a multi-year effort to update the scientific evidence on the relationship between aircraft noise exposure and its effects on communities around airports.[3] This was the most comprehensive study using a single noise survey ever undertaken in the United States, polling communities surrounding 20 airports nationwide.

For detailed information on the survey, please review the survey introduction and read the survey report[4]. Further information on FAA's aircraft noise research program, can also be found on a Federal Register

3 Federal Aviation Administration. Press Release – FAA To Re-Evaluate Method for Measuring Effects of Aircraft Noise. https://www.faa.gov/news/press_releases/news_story.cfm?newsId=18774

4 Federal Aviation Administration. Analysis of the Neighborhood Environmental Survey. https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/ArtMID/3682/ArticleID/2845/Analysis-of-NES

notice published on January 13, 2021[5]. This notice invited comments on the FAA's aircraft noise research program, including the survey, through a 90-day total period which closed on April 14, 2021. The FAA is currently reviewing the over 4,000 comments received to this docket (FAA-2021-0037-001).

The FAA will not make any determinations based on the findings of these research programs for the FAA's noise policies, including any potential revised use of the DNL noise metric, until it has carefully considered public and other stakeholder input along with any additional research needed to improve the understanding of the effects of aircraft noise exposure on communities.

The FAA Reauthorization Act of 2018 under Section 188 and 173, required FAA to complete the evaluation of alternative metrics to the DNL standard within one year. The Section 188 and 173 Report to Congress was delivered on April 14, 2020[6] and concluded that while no single noise metric can cover all situations, DNL provides the most comprehensive way to consider the range of factors influencing exposure to aircraft noise. In addition, use of supplemental metrics is both encouraged and supported to further disclose and aid in the public understanding of community noise impacts.

I.1.3 The Effects of Aircraft Noise on People

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

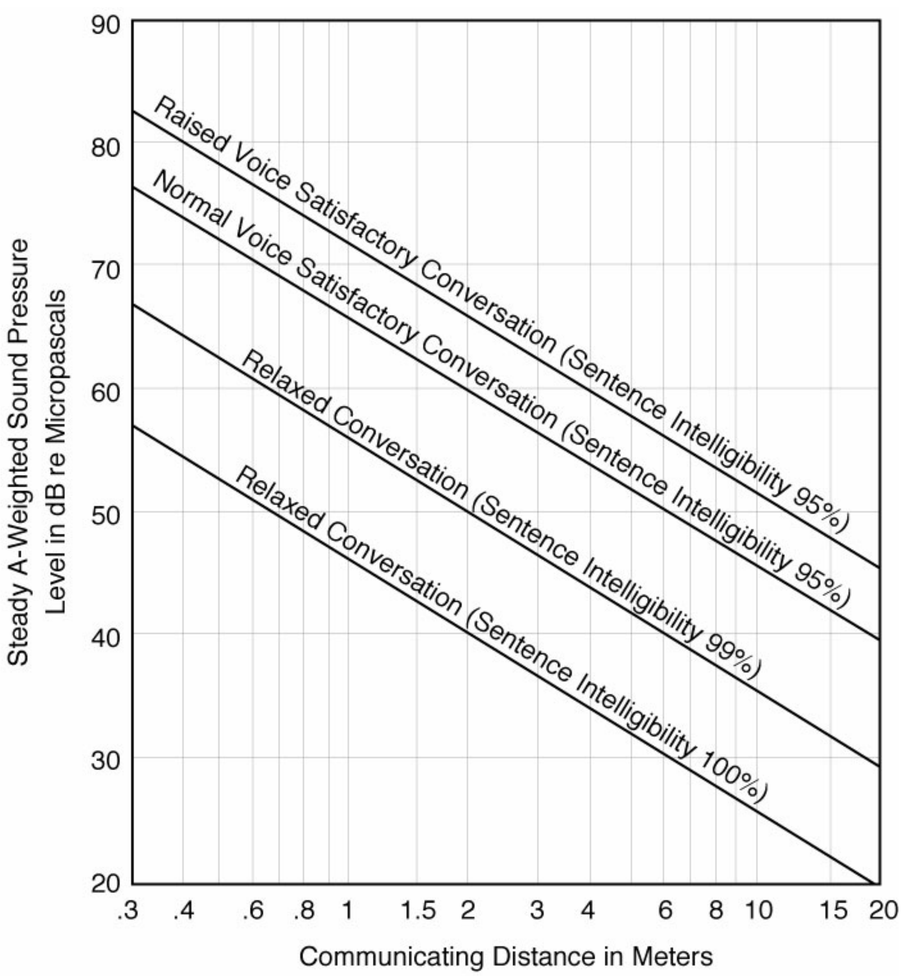
I.1.3.1 Speech Interference

A primary effect of aircraft noise is its tendency to drown out or "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 I-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 their voice, or the individuals must get closer together to continue talking.

5 Federal Aviation Administration. Overview of FAA Aircraft Noise Policy and Research Efforts: Request for Input on Research Activities to Inform Aircraft Noise Policy. https://www.federalregister.gov/documents/2021/01/13/2021-00564/overview-of-faa-aircraft-noise-policy-and-research-efforts-request-for-input-on-research-activities

6 Federal Aviation Administration. Report to Congress on an evaluation of alternative noise metrics. https://www.faa.gov/about/plans_reports/congress/media/Day-Night_Average_Sound_Levels_COMPLETED_report_w_letters.pdf

Figure I-8 Outdoor Speech Intelligibility



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

As indicated in the figure, "satisfactory conversation" does not always require hearing every word; 95 percent intelligibility is acceptable for many conversations. Listeners can infer a few unheard words when they occur in a familiar context. However, in relaxed conversation, we have higher expectations of hearing speech and generally require closer to 100 percent intelligibility. Any combination of talker-listener distances and background noise that falls below the bottom line in **Figure I-8** (thus assuring 100 percent intelligibility) represents an ideal environment for outdoor speech communication and is considered necessary for acceptable indoor conversation as well.

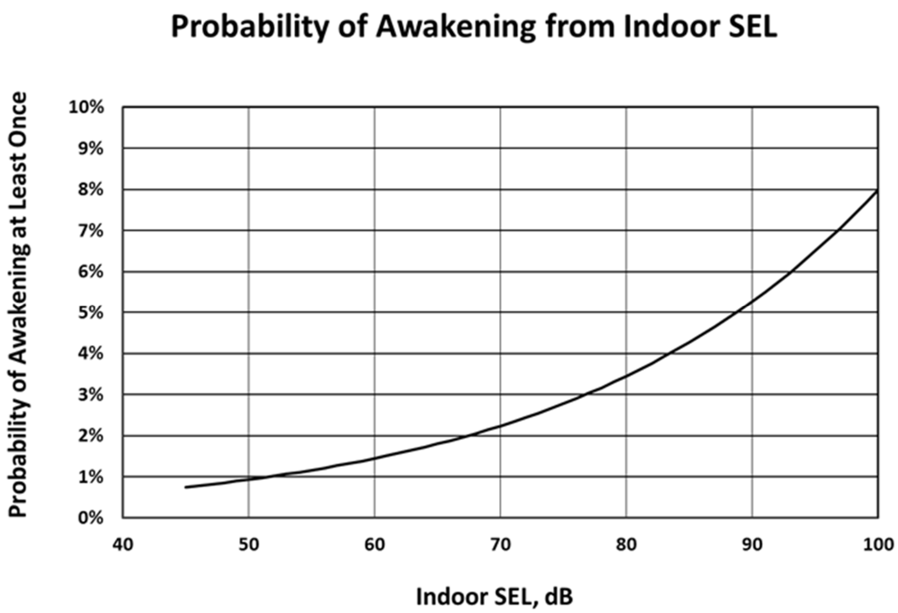
One implication of the relationships in **Figure I-8** is that for typical communication at distances of 3 or 4 feet (1 to 1.5 meters), acceptable outdoor conversations can be carried on in a normal voice as long as the background noise outdoors is less than about 65 dBA. If the noise exceeds this level, 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 dBA. With windows partly open, housing generally provides about 12 dBA of interior-to-exterior noise level reduction. Thus, if the outdoor sound level is 60 dBA or less, there is a reasonable chance that the resulting indoor sound level will afford acceptable conversation inside. With windows closed, 24 dB of attenuation is typical.

I.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, and (3) the tendency to awaken increases with age, and other factors. **Figure I-9** shows one such relationship from recent research conducted in the U.S. – the probability that a group of people will be awakened at least once when exposed to a given indoor SEL.

Figure I-9 Probability of Awakening at Least Once from Indoor Noise Event



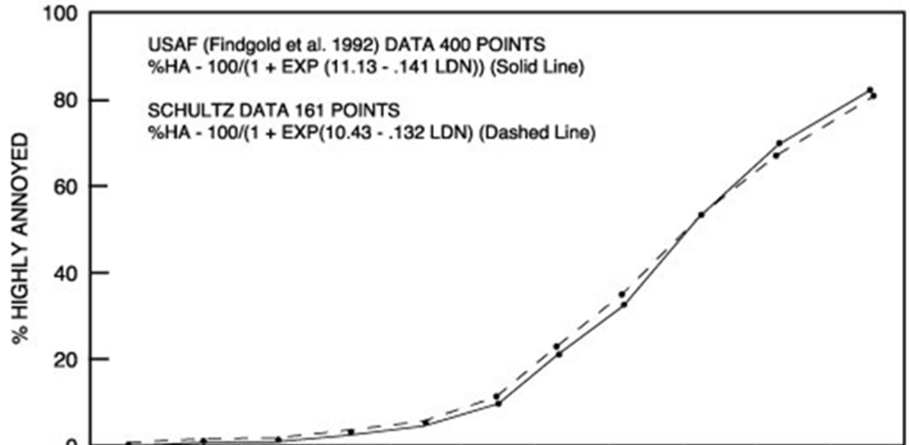
Source: American National Standards Institute (ANSI) S12.9-2008/Part 6, Quantities and Procedures for Description and Measurement of Environmental Sound — Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes; Equation 1.

For example, an indoor SEL of 80 dB results in approximately 3.5 percent of the exposed population being awakened. If windows are open in the bedroom on a warm evening and a house provides a typical outside-to-inside noise level reduction of around 15 dB, which suggests it takes an SEL of about 95 dB outdoors to awaken 3.5 percent of the population. The American National Standards Institute (ANSI) has extended this concept further and developed a standard (ANSI S12.9-2008/Part 6) for computing the percentage of the population that is likely to be awakened by multiple noise events occurring throughout the night. The FICAN subsequently endorsed the standard as the best available means of estimating behavioral awakenings from aircraft noise.

I.1.3.3 Community Annoyance

Social survey data make it clear that individual reactions to noise vary widely for a given noise level. Nevertheless, as a group, people's aggregate response is predictable and relates well to measures of cumulative noise exposure such as DNL. **Figure I-10** shows a widely recognized relationship between environmental noise and annoyance. Based on data from 18 surveys conducted worldwide, the curve indicates that at levels as low as DNL 55, approximately 5.0 percent of the people will still be highly annoyed, with the percentage increasing more rapidly as exposure increases above DNL 65 dB.

Figure I-10 Percentage of People Highly Annoyed

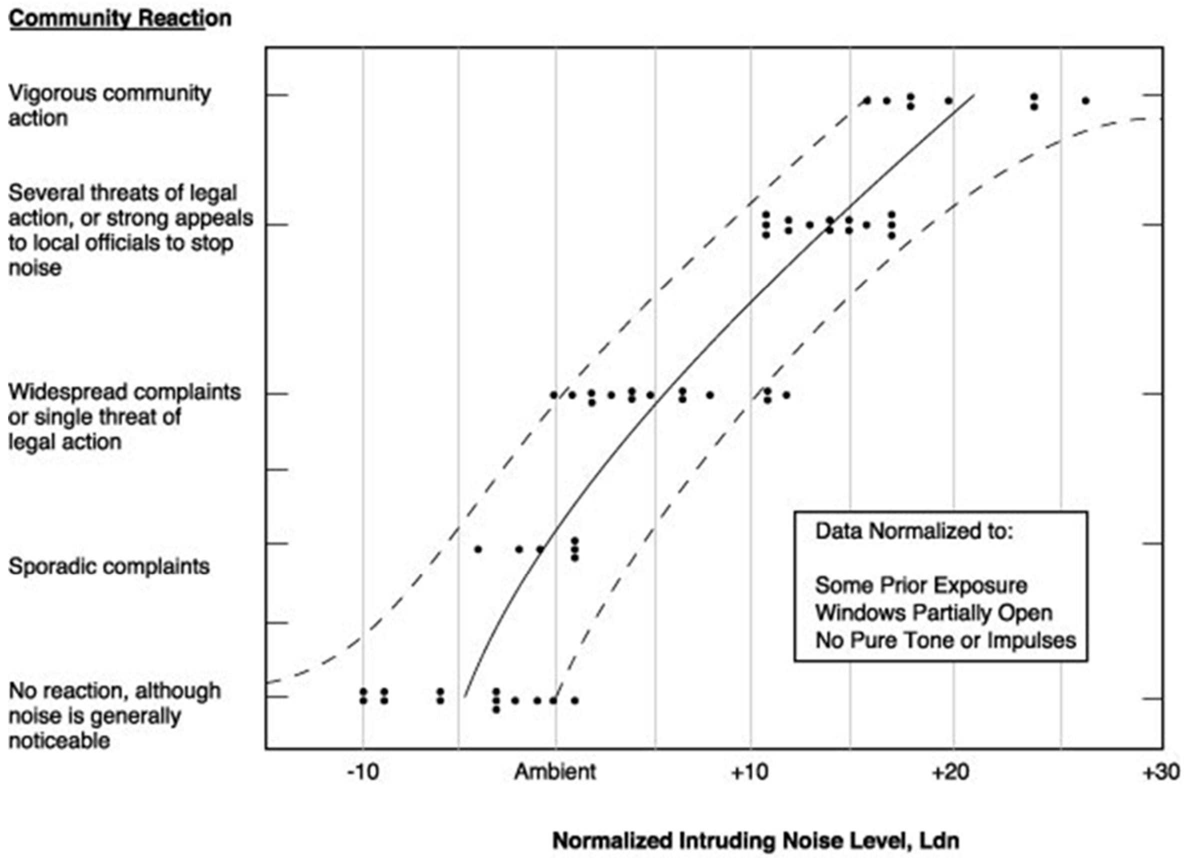


Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	100
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Source: Federal Interagency Committee on Aviation Noise (FICAN). "Federal Agency Review of Selected Airport Noise Analysis Issues." August 1992. (From data provided by USAF Armstrong Laboratory). pp. 3-6.

Separate work by the U.S. EPA has shown that overall community reaction to a noise environment can also be related to DNL. This relationship is shown in **Figure I-11**. Levels have been normalized to the same set of exposure conditions to permit valid comparisons between ambient noise environments. Data summarized in **Figure I-11** 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 5 dB. Vigorous action is likely when the background is exceeded by 20 dB.

Figure I-11 Community Reaction as a Function of Outdoor DNL



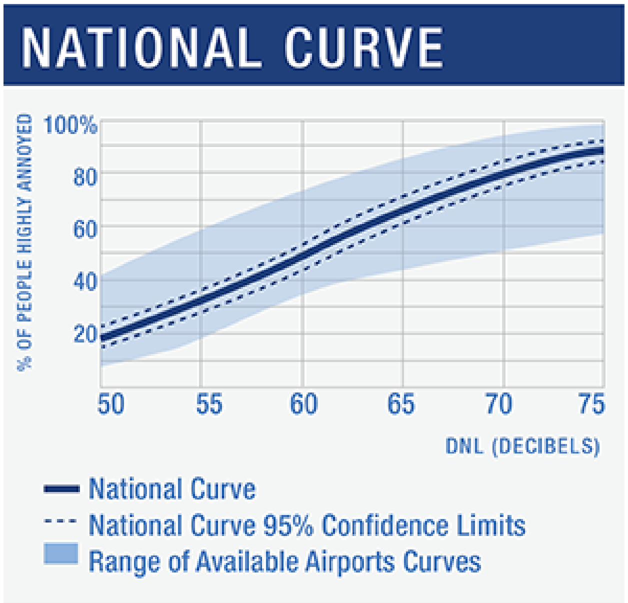
Source: Wyle Laboratories, "Community Noise," prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., December 1971, pg. 63.

Note: DNL - Day-Night Average Sound Level.

While the Schultz Curve remains the accepted standard for describing transportation noise exposure-annoyance relationships, its original supporting scientific evidence and social survey data were based on information that was available in the 1970s. The last in-depth review and revalidation of the Schultz Curve was conducted in 1992. More recent analyses have shown that aviation noise results in higher annoyance than other modes of transportation. Recent international social surveys have also generally shown higher annoyance than the Schultz Curve. These analyses and survey data indicate that the Schultz Curve may not reflect the current U.S. public perception of aviation noise.

To ensure that FAA's continued efforts to reduce the effects of aircraft noise exposure on communities is based upon accurate information, FAA conducted a nationwide survey to measure the relationship between aircraft noise exposure and annoyance in communities near airports. This survey captured the community response to a modern fleet of aircraft as they are being flown today and used best practices in terms of noise analysis and data collection. The responses from the survey have been used to create a new National Curve, shown in **Figure I-12**. The survey results show that there has been a substantial change in the public perception of aviation noise, relative to the Schultz Curve, which will ultimately inform future FAA noise initiatives. Compared with the existing Schultz Curve, the new National Curve shows a substantial increase in the percentage of people who are highly annoyed by aircraft noise over the entire range of aircraft noise levels considered, including at lower noise levels.

Figure I-12 National Curve: Percent Highly Annoyed as a Function of DNL



I.1.4 Regulatory Framework

I.1.4.1 Federal Aviation Regulation (FAR) Part 36

Logan Airport operates within a framework of federal aviation regulations that limits an airport operator's ability to control noise. For example, FAA's FAR Part 36[7] sets noise limits for aircraft certification and the procedures by which aircraft noise emission levels must be measured to determine compliance. The regulation defines noise emission limits for turbojets, turboprops, and helicopters, classifying turbojets into categories referred to as stages based on noise levels at each of three locations: takeoff, landing, and to the side of the runway during takeoff (sideline). The categories are:

- Stage 1 aircraft are the oldest and usually have the loudest operations, having preceded the existence of any noise emission regulation. Rare examples include old, restored civil or military aircraft. There are no Stage 1 aircraft operating at Logan Airport.
- Stage 2 aircraft are less old and less noisy than Stage 1; they were the first aircraft types required to meet a noise limit. A subsequent regulation, FAR Part 91 (described below), prohibits the operation of a Stage 2 aircraft in the continental U.S. unless its takeoff weight is 75,000 pounds or less. The FAA

7 14 CFR Part 36, "Noise Standards: Aircraft Type and Air Worthiness Certification."

Reauthorization bill of 2012 also mandated the phase out of Stage 2 aircraft with a takeoff weight less than 75,000 pounds by the end of 2015. Thus, there are no longer any Stage 2 aircraft operating at Logan Airport.

- Stage 3 aircraft were certified for service before 2006 and have relatively quiet jets, although some are Stage 2 aircraft that have been re-engined, or have been fitted with hushkits, enabling them to meet Stage 3 noise limits.
- Stage 4 aircraft are required to operate with a cumulative noise level at least 10 dB quieter than Stage 3 aircraft at three prescribed measurement points. Jet aircraft certificated after January 1, 2006 must meet the Stage 4 limits. Although not required, the majority of aircraft in the 2022 Logan Airport fleets would also meet the Stage 4 noise limits if they were recertificated.
- Stage 5 aircraft are the newest and quietest aircraft. All aircraft certificated after January 1, 2018 must meet Stage 5 limits, which are a cumulative 7 dB below Stage 4 and 17 dB below Stage 3 aircraft. The Boeing 787, 747-8, and Airbus A350 and A380 are examples of aircraft that meet the new limits. About 29 percent of aircraft in the 2022 Logan Airport fleets would meet Stage 5 noise limits.

I.1.4.2 Logan Airport Noise Abatement Rules and Regulations

For decades, Massport's primary mechanism for reducing noise impacts from Logan Airport's operations was the Noise Rules.[8] The Noise Rules were designed to reduce noise impacts by encouraging use of quieter aircraft by requiring decreased use of noisier aircraft and by limiting nighttime activity by louder Stage 2 types. Many secondary goals aimed at limiting noise in specific areas also were stated.

Specific provisions of the Noise Rules, which continue to serve these goals, include:

- Limiting cumulative noise exposure at Logan Airport (as measured by Massport's cumulative noise index [CNI]) to a maximum of 156.5 Effective Perceived Noise Decibels (EPNdB)
- Maximizing use of Stage 3 aircraft
- Restricting nighttime operations by Stage 2 aircraft
- Placing limitations on times and locations of engine run-ups and use of auxiliary power units (APU)
- Restricting use of certain runways by noisier aircraft and time of day

These restrictions and limitations are subject to FAA implementation and safe operation of the Airport and airspace. While the specific language applying to Stage 2 and Stage 3 aircraft is no longer applicable, due to aircraft fleet modernizations, CNI continues to be calculated and monitored annually.

8 The Logan International Airport Noise Abatement Rules and Regulations, effective July 1, 1986, are codified at 740 Code of Massachusetts Regulations (CMR) 24.01 et seq (also known as the Noise Rules).

I.1.4.3 FAR Part 150

First implemented in February 1981, FAR Part 150[9] defines procedures that an airport operator must follow if it chooses to conduct and implement an airport noise and land use compatibility plan. Part 150 Noise Compatibility studies require the use of DNL to evaluate the airport noise environment. FAR Part 150 identifies noise compatibility guidelines for different land uses depending on their sensitivity. Key values include a DNL of 75 dB, above which no residences, schools, hospitals, or churches are considered compatible, and a DNL of 65 dB, above which those land uses are considered compatible only if they are sound insulated.

Noise abatement or mitigation measures that an airport operator must consider in a Part 150 study include acquisition of incompatible land, construction of noise barriers, sound insulation of buildings, implementation of a preferential runway program, use of noise abatement flight tracks, implementation of airport use restrictions, and any other actions that would have a beneficial effect on the public.

While Massport has implemented variations of these and additional measures at Logan Airport, Massport has not filed an official Part 150 noise compatibility study with FAA because all of Logan Airport's program elements, while regularly reviewed and updated, preceded the promulgation of Part 150 and are effectively grandfathered under the regulation.

In 2021, Massport submitted a 2020 Noise Exposure Map prepared in accordance with Part 150 to FAA in order to update the Residential Sound Insulation Program. The Noise Exposure Map was accepted by the FAA in December 2021 and Massport was subsequently able to re-start the sound insulation program When the 2021 annual noise analysis was complete, Massport submitted a 2021 Noise Exposure Map to FAA in December, 2022; that contour set was accepted on April 11, 2023, and is being used in the next phase of the program.

I.1.4.4 FAR Parts 91 and 161

The Airport Noise and Capacity Act of 1990 (ANCA)[10] directed the U.S. Secretary of Transportation to undertake three key noise-related actions:

- Establish a schedule for a phase out of Part 36 Stage 2 aircraft by the year 2000
- Establish a program for FAA review of all new airport noise and access restrictions limiting operations of Stage 2 aircraft
- Establish a program for FAA review and approval of any restriction that limits operations of Stage 3 aircraft, including public notice requirements

9 14 CFR Part 150, "Airport Noise Compatibility Planning."

10 Pub. L. No. 101-508, 104 Stat. 1388, as recodified at 49 United States Code 47521- 47533.

FAA addressed these requirements through amendment of an existing federal regulation, "Part 91,"[11] and establishment of a new regulation, "Part 161."[12] ANCA effectively ended Massport's pursuit of any additional operational restrictions outside of this program.

I.1.4.5 Amendment to Part 91

FAA establishes and regulates operating noise limits for civil aircraft operation in Subpart I, "Operating Noise Limits," of 14 CFR Part 91, "General Operating and Flight Rules." The noise limits are based on aircraft noise certification criteria set forth in 14 CFR Part 36, described above.

In 1976, FAA ordered a phase out of all Stage 1 aircraft with a maximum gross takeoff weight (MGTOW) over 75,000 pounds, to be completed on January 1, 1985. After that date, Stage 1 civil aircraft over 75,000 pounds MGTOW were banned from operating in the U.S. (with limited exemptions related to commercial service at "small communities," which has since expired in 1988). ANCA required a similar phase out of Stage 2 aircraft over 75,000 pounds by December 31, 1999. The 75,000-pound weight limit exempted most "business" (or "corporate") jets and a very small number of the very smallest "air carrier" type jets until December 31, 2015, when a full ban took effect.[13] Aircraft operators responded to the Stage 1 and 2 phase-outs by retiring their non-compliant aircraft or modifying some of their aircraft to meet the more stringent standards. The modifications undertaken include installation of quieter engines, noise-reducing physical modifications to the airframe and/or existing engines, and limitation of operating weights and procedures to meet the applicable Part 36 limits. Some former Stage 2 aircraft that were "recertificated" as Stage 3 with these modifications may still operate at Logan Airport, but only on an occasional basis as general aviation aircraft. Aircraft with these modifications are no longer operating as part of the commercial fleet at Logan Airport.

From 2006 to 2017, as airlines added new aircraft, Stage 4 aircraft were added to their fleets. The Stage 4 noise standard applies to any new jet aircraft type designs over 12,500 pounds requiring FAA approval after January 1, 2006. The International Civil Aviation Organization (ICAO) has also adopted the same regulation for international operators, but neither FAA nor ICAO have indicated there will be restrictions on the remaining recertificated Stage 3 aircraft from carrier fleets.

ICAO and FAA adopted a higher standard of noise classification called Stage 5 (Chapter 14 for ICAO) which was effective for new aircraft type certification after December 31, 2017 and December 31, 2020, depending on the weight of the aircraft.[14] Many aircraft currently operating at Logan Airport meet Stage 5 noise standards.

11 14 CFR Part 91, "General Operating and Flight Rules."

12 14 CFR Part 161, "Notice and Approval of Airport Noise and Access Restrictions."

13 FAA Modernization and Reform Act of 2012 sets a January 1, 2016 ban of Stage 2 aircraft less than 75,000 lbs.

14 The Final Rule was published on October 4, 2017.

I.1.4.6 Part 161

FAA implemented the ANCA requirements related to notice, analysis, and approval of use restrictions affecting Stage 2 and 3 aircraft through the establishment of a new regulation, 14 CFR Part 161, "Notice and Approval of Airport Noise and Access Restrictions." In simple terms, Part 161 requires an airport operator that proposes to implement a restriction on Stage 2 or 3 aircraft operations to undertake, document, and publicize certain benefit-cost analyses, comparing the noise benefits of the restriction to its economic costs. Operators must obtain specific FAA approvals of the analysis, documentation, and notice processes, and – for Stage 3 restrictions – approval of the restriction itself.

Part 161 and ANCA define more demanding requirements and explicit guidance for Stage 3 restrictions. To implement a Stage 3 restriction, formal FAA approval is required. FAA's role for Stage 2 restrictions is limited to commenting on compliance with Part 161 notice and analysis procedural requirements. Part 161 provides guidance regarding appropriate information to provide in support of these findings. While Part 161 does not require this information for a Stage 2 restriction, Part 161 states that it would be "useful." Moreover, FAA has required airports to provide this same information for Stage 2 restrictions (and even for Stage 1 restrictions pursued under FAR Part 150), on the grounds that they are required for airports to comply with grant assurance 22(a), "Economic Nondiscrimination," which states that an airport operator "will make its airport available as an airport for public use on reasonable terms and without unjust discrimination to all types, kinds, and classes of aeronautical activities, including commercial aeronautical activities offering services to the public at the Airport."[15]

Although several (on the order of a dozen) airports have embarked on efforts to adopt both Stage 2 and 3 restrictions in the past two decades, FAA has found that only one, Naples Municipal Airport, a general aviation (GA) airport in Naples, Florida, has fully complied with Part 161 analysis, notice, and documentation requirements for a ban on Stage 2 jet operations. FAA found the airport was in violation of prior to FAA grant assurances. The airport operator successfully sued FAA to overturn that ruling and has implemented the restriction.

ANCA and Part 161 specifically exempt Stage 3 use restrictions that were effective on or before October 1, 1990, and Stage 2 restrictions that were proposed before that date. The Logan Airport Noise Rules were promulgated in 1986; therefore, ANCA and Part 161 have no bearing on their continued implementation in their current form. Any future proposals to make the rules more stringent regarding Stage 2 operations or to restrict Stage 3 operations in any way would almost certainly trigger Part 161 notice, analysis, and approval processes for Stage 3 restrictions. In 2006, Massport requested an opinion from FAA regarding the pursuit of a Part 161 waiver or exemption to allow Massport to implement a

15 FAA Order 5190.6(b), "Airport Compliance Manual" Chapter 13, Section 14, paragraph (a). To be approved, restrictions must meet the following six statutory criteria: 1) The proposed restriction is reasonable, nonarbitrary, and nondiscriminatory. 2) The proposed restriction does not create an undue burden on interstate or foreign commerce. 3) The proposed restriction maintains safe and efficient use of the navigable airspace. 4) The proposed restriction does not conflict with any existing federal statute or regulation. 5) The applicant has provided adequate opportunity for public comment on the proposed restriction. 6) The proposed restriction does not create an undue burden on the national aviation system.

curfew of nighttime operations of hush-kitted Stage 3 aircraft. FAA informed Massport that a waiver or exemption from the requirements of Part 161 is not authorized under, or consistent with, federal statutory and regulatory requirements. A copy of FAA's letter to Massport was provided in Appendix H, *Noise Abatement* in the *2005 ESPR*.

I.2 Logan Airport Noise Modeling

To relate portions of the foregoing discussion to the specific noise environment around Logan Airport for this *2022 ESPR*, Massport has developed DNL noise contours, TA noise metrics, and population counts for 2022 using the latest version of the FAA's AEDT, version 3e, and a proprietary AEDT pre-processor. The pre-processor software takes radar data from individual flights occurring throughout the year, and structures it into a form usable as input to the AEDT. The AEDT serves as the computational "engine" for calculating noise. Prior to 2016, Massport used the FAA's Integrated Noise Model (INM) with a pre-processor called RealContours™ which operated in a similar manner.

Standard AEDT input methodology involves development of operational inputs and calculation of the DNL for a prototypical average annual day.[16] This approach requires manually collecting, refining, and entering the enormous amount of data averaged over a full year of activity at an airport. Typically, the model inputs may include an aircraft fleet mix with several dozen representative aircraft types, on the order of 100 to 300 representative flight tracks (common for a facility the size of Logan Airport), and runway use and flight track use percentages for three or four categories of aircraft types with similar performance characteristics. This normal approach to noise modeling meets accepted professional standards and reduces the effort and cost that would be associated with manually entering the parameters for every actual operation. However, it represents a significant simplification of the extraordinary diversity of actual aircraft operations over a year.

Instead of relying on consolidated data summaries, Massport takes maximum possible advantage of both AEDT's capabilities and the investment that Massport has made in its Noise and Operations Management System (NOMS). The AEDT pre-processor improves the precision of modeling by utilizing operations monitoring results in these key areas:

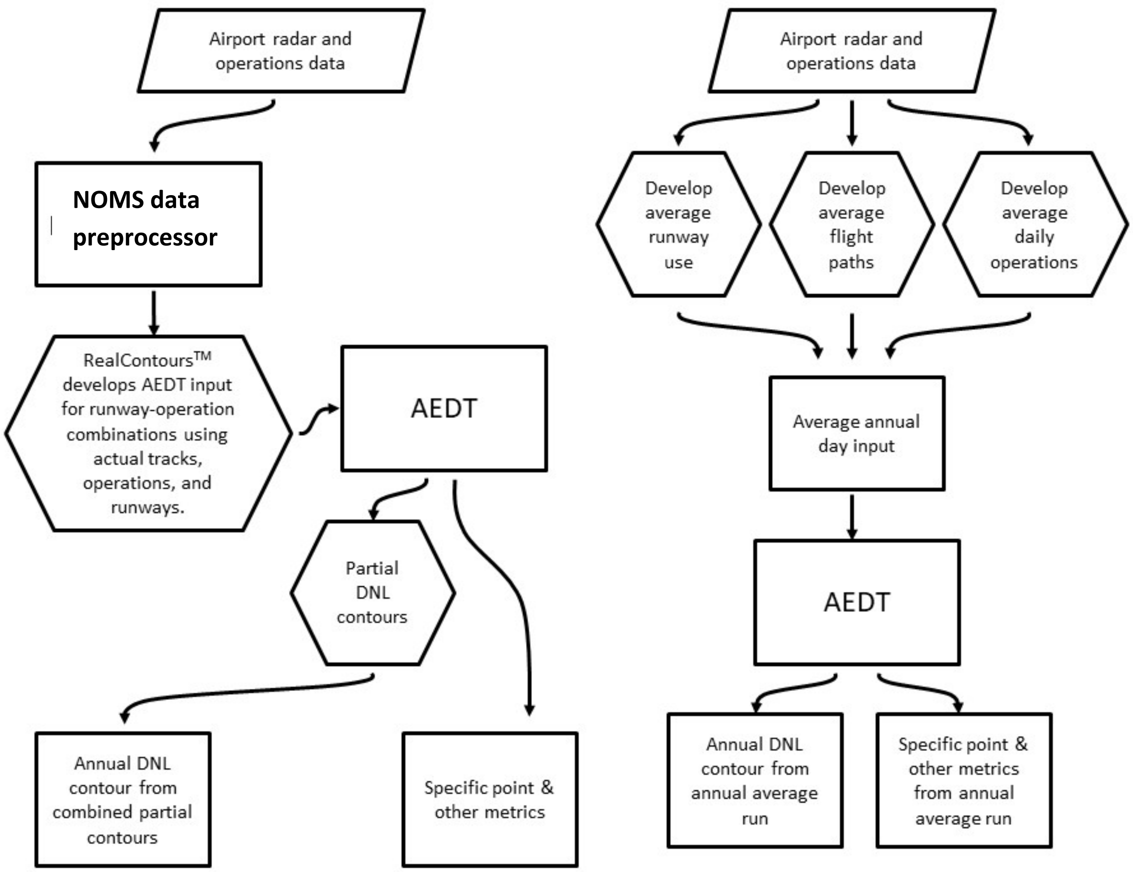
- Directly converts the flight track for every identified aircraft operation to an AEDT track, rather than assigning multiple operations to a limited number of prototypical tracks
- Models each operation on the specific runway that it actually used, rather than applying a generalized distribution to broad ranges of aircraft types
- Models each operation in the time period that it occurred, which realistically represent delays that occur during the year, rather than relying on scheduled flight times

16 Guidance on Using the Aviation Environmental Design Tool (AEDT) to Conduct Environmental Modeling for FAA Actions Subject to NEPA, October 27, 2017, Section 3.2, p. 13

- Selects the specific airframe and engine combination to model, on an operation-by-operation basis, based on the registration data for each flight wherever possible; otherwise, based on the published compositions of the fleets of the specific airlines operating at Logan Airport

Figure I-13 provides a schematic representation of Massport's annual noise modeling process compared to the standard AEDT process. The flow chart on the left depicts data from the NOMS system being used as noise model inputs, while the flow chart on the right illustrates the development of a simplified average annual day that would be otherwise necessary.

Figure I-13 Schematic Noise Modeling Process (using NOMS data pre-processor vs. standard AEDT use)



Source: Federal Aviation Administration (FAA), HMMH.

I.2.1 AEDT Noise Analysis

Logan Airport presents a set of unique challenges to modeling software, and over the course of many years, Massport addressed these challenges by developing a series of adjustments and customizations to better represent the operations, conditions, and terrain that affect noise at Logan Airport. The following adjustments were historically incorporated into INM analyses:

- ***Custom profiles***. The analysis has developed custom climbing and descent profiles based on radar altitude data, rather than using default profiles built into INM. This results in more accurate aircraft thrust calculations, which in turn affects an aircraft's noise emissions.
- ***Daily weather data***. Noise calculations have used average weather conditions for each day to determine aircraft performance and sound propagation.
- ***Hill effect adjustment***. Due to discrepancies between noise monitor data and INM calculations in the Orient Heights area close to the Airport, adjustments have been included to improve the accuracy of calculations in areas with direct line-of-sight exposure to the airfield.
- ***Over-water adjustment***. The INM calculations assume that noise is absorbed as it propagates over ground. However, Logan Airport is mostly surrounded by water, which reflects rather than absorbs the sound. This results in higher noise levels in areas near the Airport. An adjustment has been used that allows the INM to assume higher aircraft noise emissions when they are close to the ground.

In 2015, FAA released its next-generation environmental analysis software, the AEDT version 2B.[17] AEDT incorporates the computational engines of the legacy tools INM and the Emissions and Dispersion Modeling System (EDMS) and provides a unified database back end and graphical user interface. With a common set of aircraft and airport data that are updated regularly, AEDT ensures that noise and emissions analyses can be performed with up-to-date information.

Massport first explored the use of AEDT for the *2015 EDR* and adopted AEDT as its ongoing noise model beginning with the *2016 EDR*. In transitioning from INM to AEDT, Massport has investigated how to implement the historical adjustments in the new software. While the Massachusetts state EDR/Environmental Status and Planning Report (ESPR) process does not require FAA approval, Massport wishes to perform analysis to FAA standards. Massport has held numerous meetings with FAA since the release of AEDT to get approval for adjustments to AEDT. The following is a summary of the proposed measures to address the adjustments previously implemented in INM, and FAA's response.

- ***Altitude control codes***. This feature of AEDT performs a similar function to the custom profiles used previously, using altitude data to more accurately calculate aircraft thrust levels. Since this is a capability built into AEDT, **FAA approval is implicit** and was not requested.
- ***Aircraft weight adjustment***. It has been determined that some aircraft takeoff weights, based on Department of Transportation T-100 data, do not always match the weight assumptions (stage length) made by AEDT. Consequently, an adjustment was developed to more accurately represent takeoff

17 AEDT 2A was released in 2013 and replaced the NIRS model for airspace analysis. AEDT 2B replaces, AEDT 2A, INM and EDMS.

weight, and therefore aircraft thrust during takeoff. **FAA concurs with this approach but required that the analysis evaluate all aircraft departures.** The weight analysis resulted in some aircraft increasing stage length and some aircraft decreasing in stage length. This resulted in essentially no modification to the noise contours; therefore, Massport decided to no longer include this adjustment in the modeling process.

- ***Annual weather***. AEDT by default used 10-year average weather for the Airport. Massport has proposed using an annual average for the year under study to better capture year-to-year variations in weather.[18] **FAA concurs with this approach**. AEDT 3 allows for the use of annual average weather in the model so this approach no longer needs FAA approval.
- ***Hill effects***. Massport has proposed including the adjustments previously used in INM. **FAA does not concur with this approach**. There are ongoing research studies to develop modifications to the AEDT model and FAA recommends waiting until those methods are available.
- ***Over water adjustment***. Massport explored other options including the existing INM adjustment method. Massport proposed including the adjustments previously used in INM. **FAA does not concur with this approach**. There are ongoing research studies to develop modifications to the AEDT model and FAA recommends waiting until those methods are available.

Massport will continue to work with FAA to address these issues and to incorporate enhancements to AEDT as they become available. In March 2017, the Airport Cooperative Research Program (ACRP) published an FAA-sponsored study entitled "Improving AEDT Noise Modeling of Ground Surfaces." The study recommends a methodology and provides guidance for implementation in AEDT, however at the time of this study, FAA has not recommended the method for use with AEDT or incorporated the ACRP study information into the AEDT.

In March 2018, ACRP published "Enhanced AEDT Modeling of Aircraft Arrival and Departure Profiles Volume 1: Guidance."[19] It highlights new data with alternate default profiles for specific aircraft and new methodology available to model users to customize flight profiles in greater detail than was previously available. The study recommends a methodology and provides guidance for implementation in AEDT. Modified profiles have been added to the AEDT database, however, these profiles are not standard data and Massport would have to demonstrate the need to use the profiles and seek approval for each study.

At this time, FAA has concurred with adjustments for annual average weather and the adjustment of aircraft stage length (both adjustments are no longer used), but disapproved adjustments for over-water effects and elevated terrain line-of-sight exposure. Massport has performed the AEDT analyses for 2022 using only FAA standard methods.

18 Daily weather is currently not an option in AEDT modeling inputs, however Massport will continue to request that FAA allow for such an option.

19 Airport Cooperative Research Program Web-Only Document 36: Enhanced AEDT Modeling of Aircraft Arrival and Departure Profiles, Volume 1: Guidance. http://www.trb.org/Main/Blurbs/178074.aspx.

FAA guidance states that an airport noise modeling project should use the most current model version available at the time the project begins. FAA's AEDT version 2c Service Pack 2 (AEDT 2c SP2) was released for general use on March 13, 2017; it was the version used to generate the 2016 DNL contours and accompanying noise analyses. AEDT version 2d was released on September 27, 2017. Massport used AEDT 2d for the 2017 DNL calculations. AEDT version 3b was released on September 24, 2019, followed by AEDT version 3c (originally released on March 6, 2020, and re-released with corrections on June 19, 2020). Massport used the re-released AEDT version 3c for the 2018 and 2019 analyses. AEDT version 3d was released on March 29, 2021. Massport used AEDT version 3d for the 2020 and 2021 analyses. Version 3e was released on May 9, 2022 and was used for the 2022 noise modeling contained in this ESPR.

As with the previous upgrade from version 3c to 3d, the most significant changes in the model from AEDT 3d to AEDT 3e are improvements to emissions and dispersion modeling. The differences between AEDT 3d and AEDT 3e with regard to noise calculations are minimal. Two new aircraft types, the 747400RN and 7879, were added to the AEDT version 3e database; both are specific engine adjustments to the Boeing 747-400 and the 787-9 respectively. The BD-700-1A11 aircraft which was already in the AEDT database received nose/performance updates.. The following sections of this appendix provide several tables describing the AEDT input data for 2022. Where possible, the data for 2019 are included for comparison.

I.2.2 2022 Radar Data

Logan Airport's radar data are the basis for Massport's annual noise calculations. The Passive Surveillance Radar System (PASSUR) radar dataset was used for the *2004 ESPR* through the *2008 EDR*. For the *2009 EDR* through the *2014 EDR*, Massport used the radar data from its Harris NOMS system. These radar data were obtained from a multilateration system of eight sensors deployed around the Airport. The positioning data from these sensors were correlated to provide better, more accurate coverage of aircraft (in areas where the traditional FAA radar has limitations) and provide a more complete set of points to define each track. Traditional radar provides points every four to five seconds where the multilateration system provides data every second.

In 2015, the Massport system switched to FAA's NextGen data feed, which integrates the Automatic Dependent Surveillance Broadcast (ADS-B) feed with multiple redundant real-time FAA surveillance sources into a single fused data feed. The NextGen data is a "multisensory-based" subscription data source that aggregates all available surveillance sources, including:

- FAA En Route Radars;
- FAA Terminal Radars;
- FAA Airport Surface Detection Equipment X Band (ASDE-X) Systems;
- FAA Aircraft Situational Display to Industry (ASDI) Oceanic and Canadian Tracks only; and
- Harris ADS-B Data Feed.

Logan Airport is supported by an FAA ASDE-X system which provides highly accurate one-second data points for aircraft situational awareness on the Airport and within at least 5 miles of the Airport. These data are fused with the other sources and provided to the Massport NOMS system in a geo-referenced data format. The geo-referenced radar data are imported into the AEDT model, which is built on a geo-referenced platform to retain accuracy of the data for modeling.

For 2022, a total of 376,575 flight records from the NOMS contained suitable data for modeling, which is over 99.9 percent of the recorded flight records. These operations were scaled slightly by category and airline to match the 378,613 annual flights in Massport records.

I.2.3 Fleet Mix

Table I-1 (2022), **Table I-2** (2021), and **Table I-3** (2019 for comparison) provide the scaled annual operations, listed by Aircraft Noise and Performance (ANP) aircraft type. Each ANP type listed in **Table I-1** and **Table I-2** is also mapped to a Runway use group based on its weight and performance characteristics described in the Runway Use section below.

Regional jets (RJ) are defined as those aircraft with 90 or fewer seats, consistent with the categorization in Chapter 3, *Activity Levels and Forecasting*.[20] For years prior to 2010, the RJs in this report were classified as aircraft with less than 100 seats. When RJs first started gaining popularity, the aircraft types available were typically 50 seats or less, while the traditional air carrier jet has over 100 seats. As newer aircraft types have become available, the smaller 35- to 50-seat types have been replaced by 70- to 99-seat types, with the types having 90 or more seats flying many of the traditional air carrier routes. The majority of the newer types fall into two categories: the 70- to 75-seat category, which remain categorized as RJs, and the 91- to 99-seat category, which are categorized as air carrier jets. The Embraer 190 falls into this second category and is now classified in the Light Jet B group.

20 U.S. Code, 2006 Edition, Supplement 3, Title 49 – Transportation Subtitle VII – Aviation Programs Part A – Air Commerce and Safety, Subpart II, Economic Regulation, Chapter 417 - Operations or Carriers, Subchapter III - Regional Air Service Incentive Program, Sec. 41762 – Definitions – defines RJ air carrier service to be aircraft with a maximum of 75 seats. Therefore, this report categorizes aircraft with 70-75 seats and below as RJ and aircraft with 90 seats and higher aircraft as air carrier (Note: there are no types with 75 to 90 seats).

Table I-1 2022 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
Commercial Jet Operations						
747400	Heavy Jet A	205	0	203	2	410
7478	Heavy Jet A	5	1	6	0	12
A340-211	Heavy Jet A	167	0	96	71	334
A340-642	Heavy Jet A	254	2	238	18	512
A380-841	Heavy Jet A	172	0	171	1	344
A380-861	Heavy Jet A	2	0	1	1	4
767300	Heavy Jet B	178	36	6	208	429
7673ER	Heavy Jet B	3,307	984	2,290	2,000	8,581
767400	Heavy Jet B	264	3	193	74	534
767CF6	Heavy Jet B	28	11	8	31	78
767JT9	Heavy Jet B	24	5	2	27	58
777200	Heavy Jet B	503	31	413	121	1,069
7773ER	Heavy Jet B	701	141	377	465	1,685
7878R	Heavy Jet B	20	79	90	9	198
7879	Heavy Jet B	866	43	633	276	1,818
A300-622R	Heavy Jet B	67	253	199	121	640
A330-301	Heavy Jet B	2,345	22	1,965	402	4,734
A330-343	Heavy Jet B	1,552	137	860	830	3,379
A350-941	Heavy Jet B	736	28	383	380	1,527
DC1030	Heavy Jet B	1	0	0	1	2
MD11GE	Heavy Jet B	61	4	36	29	130
MD11PW	Heavy Jet B	41	0	18	23	82
717200	Light Jet A	4	2	5	1	12
737400	Light Jet B	23	6	17	12	58
737700	Light Jet B	12,059	2,938	13,379	1,618	29,994
737800	Light Jet B	11,678	5,210	14,585	2,303	33,775
7378MAX	Light Jet B	3,581	1,493	4,205	869	10,148
757300	Light Jet B	54	5	54	5	118
757PW	Light Jet B	1,902	987	2,643	246	5,778
757RR	Light Jet B	460	56	499	17	1,032

Table I-1 2022 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
A319-131	Light Jet B	6,905	918	7,304	519	15,647
A320-211	Light Jet B	1,349	35	1,285	99	2,769
A320-232	Light Jet B	8,591	2,503	9,699	1,395	22,187
A320-271N	Light Jet B	1,004	431	1,137	298	2,870
A321-232	Light Jet B	23,065	7,690	26,386	4,368	61,509
EMB190	Light Jet B	17,871	2,056	17,824	2,103	39,854
BD-700-1A10	RJ	0	0	0	0	1
CL600	RJ	13	2	13	1	29
Commercial Jet Operations						
CL601	RJ	1	0	1	0	3
CNA750	RJ	1	0	0	0	2
CRJ9-ER	RJ	2,129	183	2,071	241	4,625
CRJ9-LR	RJ	158	3	160	1	323
EMB145	RJ	1	1	1	1	4
EMB14L	RJ	1,446	31	1,367	110	2,955
EMB170	RJ	1,100	126	1,128	99	2,453
EMB175	RJ	23,199	2,056	23,362	1,892	50,508
G650ER	RJ	1	0	1	0	3
GIV	RJ	11	2	11	2	26
GV	RJ	4	0	4	1	9
Commercial Jets Subtotal		128,111	28,514	135,332	21,293	313,250
Commercial Non-Jet Operations						
BEC58P	Non-jet	14,578	48	14,620	7	29,253
CNA208	Non-jet	859	6	858	7	1,729
DHC830	Non-jet	1	13	14	0	27
SF340	Non-jet	1,852	72	1,913	11	3,848
Commercial Non-Jet Operations Subtotal		17,290	139	17,403	25	34,857
Commercial Aircraft Total		145,401	28,653	152,736	21,318	348,107
General Aviation Operations						
A340-211	Heavy Jet A	2	0	1	1	4
A340-642	Heavy Jet A	1	0	1	0	2

Table I-1 2022 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
777300	Heavy Jet B	2	1	2	1	6
7878R	Heavy Jet B	2	0	2	0	4
A330-343	Heavy Jet B	1	0	1	0	2
737700	Light Jet B	14	4	11	7	36
737800	Light Jet B	2	0	2	0	4
757PW	Light Jet B	1	0	1	0	2
757RR	Light Jet B	1	0	1	0	2
A319-131	Light Jet B	7	0	7	0	14
A320-211	Light Jet B	5	3	6	2	16
A320-232	Light Jet B	4	7	12	0	24
A320-271N	Light Jet B	1	0	1	0	2
A321-232	Light Jet B	29	4	22	12	67
EMB190	Light Jet B	14	0	13	1	28
BD-700-1A10	RJ	466	52	466	52	1,037
BD-700-1A11	RJ	170	16	177	9	373
CIT3	RJ	18	1	17	2	38
CL600	RJ	1,600	147	1,650	97	3,495
CL601	RJ	511	34	510	36	1,091
CNA500	RJ	5	1	4	2	12
CNA510	RJ	17	0	15	2	34
CNA525C	RJ	375	63	386	52	877
CNA55B	RJ	1,290	85	1,299	76	2,751
CNA560E	RJ	1	0	1	0	2
CNA560U	RJ	118	13	118	13	262
CNA560XL	RJ	799	52	812	38	1,702
CNA680	RJ	1,894	163	1,952	105	4,114
CNA750	RJ	972	65	971	65	2,073
CRJ9-ER	RJ	2	0	2	0	4
ECLIPSE500	RJ	67	13	67	13	161
EMB145	RJ	44	4	45	4	97
EMB175	RJ	1	0	1	0	2

Table I-1 2022 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
FAL20	RJ	5	0	3	2	10
FAL900EX	RJ	221	14	216	19	470
G650ER	RJ	296	33	301	28	659
GII	RJ	1	0	1	0	2
GIIB	RJ	1	0	1	0	2
GIV	RJ	428	51	433	46	958
GV	RJ	447	55	461	41	1,004
IA1125	RJ	76	4	70	10	161
LEAR35	RJ	883	131	897	117	2,029
MU3001	RJ	209	17	213	12	450
1900D	Non-jet	1	0	1	0	2
BEC58P	Non-jet	318	20	319	19	676
CNA172	Non-jet	10	0	10	0	20
CNA182	Non-jet	28	0	28	0	56
CNA206	Non-jet	4	0	4	0	8
CNA208	Non-jet	1,187	76	1,186	77	2,527
CNA441	Non-jet	38	5	37	6	85
COMSEP	Non-jet	220	3	217	6	446
DHC6	Non-jet	499	50	488	60	1,097
DHC830	Non-jet	2	0	2	0	4
GASEPF	Non-jet	13	1	13	1	28
GASEPV	Non-jet	173	5	177	2	357
HS748A	Non-jet	1	0	1	0	2
PA30	Non-jet	4	0	4	0	8
PA42	Non-jet	1	0	1	0	2
A109	Helo	8	0	8	0	16
B206L	Helo	22	0	22	0	44
B407	Helo	9	2	9	2	22
B427	Helo	2	0	2	0	4
B429	Helo	22	57	19	60	157
EC130	Helo	15	10	17	8	50

Table I-1 2022 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
R44	Helo	22	0	22	0	44
S76	Helo	143	10	144	9	305
SA330J	Helo	193	4	192	5	395
SA350D	Helo	23	1	25	0	50
SA355F	Helo	12	0	12	0	24
General Aviation Total		13,975	1,278	14,131	1,122	30,506
Grand Total		159,376	29,931	166,867	22,440	378,613

Source: HMMH, 2023
Notes: ANP - Aircraft Noise and Performance.

Table I-2 2021 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
Commercial Jet Operations						
747400	Heavy Jet A	2	0	2	0	4
A340-211	Heavy Jet A	101	1	99	3	204
A380-861	Heavy Jet A	1	0	1	0	2
767300	Heavy Jet B	137	35	27	145	344
7673ER	Heavy Jet B	2,097	827	1,636	1,288	5,848
767400	Heavy Jet B	34	0	5	29	68
777200	Heavy Jet B	572	128	599	101	1,400
767CF6	Heavy Jet B	79	32	11	100	223
767JT9	Heavy Jet B	6	9	9	6	30
7773ER	Heavy Jet B	256	3	29	230	518
7878R	Heavy Jet B	1,253	0	1,126	127	2,506
A300-622R	Heavy Jet B	265	358	357	266	1,247
A330-301	Heavy Jet B	770	5	674	101	1,551
A330-343	Heavy Jet B	678	175	510	343	1,705
A350-941	Heavy Jet B	528	22	184	365	1,099
DC1010	Heavy Jet B	3	1	1	3	8

Table I-2 2021 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
DC1030	Heavy Jet B	7	2	3	6	18
MD11GE	Heavy Jet B	103	9	58	54	224
MD11PW	Heavy Jet B	38	5	29	14	86
717200	Light Jet A	5	1	6	0	12
737800	Light Jet B	9,671	4,239	12,551	1,360	27,820
7378MAX	Light Jet B	1,011	494	1,362	143	3,010
737300	Light Jet B	1	0	1	0	2
737400	Light Jet B	25	7	19	13	64
737500	Light Jet B	0	1	1	0	2
737700	Light Jet B	4,116	1,635	4,917	833	11,500
757300	Light Jet B	8	2	8	2	20
757PW	Light Jet B	1,510	669	1,952	227	4,358
757RR	Light Jet B	379	66	418	27	890
A319-131	Light Jet B	4,858	1,027	5,415	470	11,770
A320-211	Light Jet B	1,802	752	2,406	148	5,108
A320-232	Light Jet B	10,494	3,039	12,377	1,155	27,065
A320-271N	Light Jet B	640	202	771	71	1,685
A321-232	Light Jet B	13,049	5,003	15,662	2,391	36,105
EMB190	Light Jet B	10,666	1,485	11,303	849	24,304
BD-700-1A10	RJ	4	0	4	0	9
CL600	RJ	13	1	14	0	28
CNA55B	RJ	1	0	1	0	2
CRJ9-ER	RJ	1,356	143	1,288	211	2,997
CRJ9-LR	RJ	729	3	719	13	1,463
EMB14L	RJ	707	14	664	57	1,441
EMB170	RJ	2,227	126	2,215	138	4,708
EMB175	RJ	12,496	1,001	12,563	934	26,994
GIV	RJ	1	0	1	0	2
Commercial Jets Subtotal		82,698	21,524	91,997	12,224	208,443
Commercial Non-Jet Operations						
BEC58P	Non-jet	15,525	28	15,536	18	31,107

Table I-2 2021 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
CNA208	Non-jet	879	9	874	14	1,777
DHC6	Non-jet	7	8	15	0	30
DHC830	Non-jet	308	9	318	0	635
Commercial Non-Jet Operations Subtotal		16,720	55	16,742	32	33,549
Commercial Aircraft Total		99,417	21,579	108,740	12,256	241,992
General Aviation Operations						
A109	Helicopter	6	0	6	0	12
B206L	Helicopter	40	0	40	0	79
B407	Helicopter	18	1	18	1	38
B429	Helicopter	10	30	8	32	79
EC130	Helicopter	30	5	31	5	72
R44	Helicopter	16	0	15	1	32
S76	Helicopter	99	8	88	19	215
SA330J	Helicopter	100	3	101	2	207
SA350D	Helicopter	55	7	55	7	123
SA355F	Helicopter	12	0	12	0	24
SA365N	Helicopter	2	0	2	0	4
74720B	Heavy Jet A	1	0	1	0	2
747400	Heavy Jet A	2	0	1	1	4
7673ER	Heavy Jet B	3	0	3	0	6
737700	Light Jet B	8	0	7	1	16
757PW	Light Jet B	1	0	0	1	2
A319-131	Light Jet B	3	0	2	1	6
EMB190	Light Jet B	0	1	1	0	2
MD81	Light Jet B	2	1	0	3	6
BD-700-1A10	RJ	305	31	298	39	673
BD-700-1A11	RJ	123	12	121	14	270
CIT3	RJ	16	0	16	0	32
CL600	RJ	1,290	113	1,334	68	2,805
CL601	RJ	362	19	360	21	763
CNA500	RJ	45	2	45	2	93

Table I-2 2021 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
CNA510	RJ	21	1	21	1	44
CNA525C	RJ	233	45	234	44	556
CNA55B	RJ	934	68	945	57	2,004
CNA560U	RJ	140	10	135	15	300
CNA560XL	RJ	630	43	640	32	1,345
CNA680	RJ	1,451	105	1,486	70	3,113
CNA750	RJ	637	67	658	46	1,408
ECLIPSE500	RJ	35	5	37	3	79
EMB145	RJ	45	4	44	5	97
FAL20	RJ	6	1	4	3	14
FAL900EX	RJ	183	14	184	12	393
G650ER	RJ	121	13	121	13	268
GIV	RJ	424	39	418	45	926
GV	RJ	261	22	252	31	566
IA1125	RJ	45	15	54	6	119
LEAR35	RJ	781	84	794	71	1,730
MU3001	RJ	229	11	226	14	481
BEC58P	Non-jet	317	23	319	21	679
CNA172	Non-jet	20	0	20	0	40
CNA182	Non-jet	24	0	24	0	48
CNA206	Non-jet	4	0	4	0	8
CNA208	Non-jet	1,047	57	1,038	66	2,207
CNA441	Non-jet	32	4	31	5	73
COMSEP	Non-jet	260	13	259	14	546
DHC6	Non-jet	461	34	460	35	989
GASEPV	Non-jet	199	3	199	3	405
PA28	Non-jet	13	2	14	1	30
PA30	Non-jet	5	0	5	0	10
General Aviation Total		11,106	915	11,189	832	24,042
Grand Total		110,523	22,494	119,929	13,088	266,034

Source: HMMH, 2022.
Notes: ANP - Aircraft Noise and Performance.BEC58P is the AEDT substitution for the Cessna 402. Some totals may not match due to rounding

Table I-3 2019 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
Commercial Jet Operations						
7478	Heavy Jet A	210	0	209	1	419
747400	Heavy Jet A	277	3	274	6	559
A340-211	Heavy Jet A	358	4	146	216	725
A340-642	Heavy Jet A	308	4	295	16	623
A380-841	Heavy Jet A	201	0	201	0	402
A380-861	Heavy Jet A	160	0	3	157	320
767300	Heavy Jet B	14	1	11	4	30
767400	Heavy Jet B	50	1	49	2	102
777200	Heavy Jet B	1,058	295	1,003	350	2,707
777300	Heavy Jet B	1	0	1	0	2
767CF6	Heavy Jet B	87	40	6	121	254
767JT9	Heavy Jet B	120	17	3	134	273
7773ER	Heavy Jet B	848	127	40	935	1,949
7878R	Heavy Jet B	1,867	42	1,396	514	3,819
A300-622R	Heavy Jet B	410	665	615	460	2,151
A330-301	Heavy Jet B	2,082	4	1,709	377	4,172
A330-343	Heavy Jet B	1,576	445	1,224	797	4,043
A350-941	Heavy Jet B	250	1	242	9	502
DC1010	Heavy Jet B	30	10	24	16	81
DC1030	Heavy Jet B	18	13	14	17	63
MD11GE	Heavy Jet B	38	6	44	1	89
MD11PW	Heavy Jet B	13	3	15	1	32
U_7673ER	Heavy Jet B	2,455	841	2,147	1,148	6,590
717200	Light Jet A	1,656	390	1,482	564	4,093
737800	Light Jet A	15,886	6,442	18,296	4,033	44,658
MD9025	Light Jet A	3	0	3	0	6
MD9028	Light Jet A	1	1	1	1	4
737300	Light Jet B	1	0	1	0	2
737400	Light Jet B	24	12	24	12	71
737700	Light Jet B	5,763	1,973	6,263	1,474	15,473
757300	Light Jet B	289	20	278	31	618

Table I-3 2019 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
737MAX8	Light Jet B	192	191	228	154	765
737N17	Light Jet B	1	0	0	1	2
757PW	Light Jet B	2,842	1,098	3,113	826	7,879
757RR	Light Jet B	1,767	598	2,128	237	4,730
A319-131	Light Jet B	6,840	1,220	6,820	1,241	16,121
A320-211	Light Jet B	3,642	1,047	4,252	437	9,380
A320-232	Light Jet B	17,864	6,681	20,414	4,131	49,090
A320-271N	Light Jet B	507	206	508	204	1,425
A321-232	Light Jet B	17,276	6,158	19,398	4,036	46,868
EMB190	Light Jet B	29,533	6,367	29,873	6,027	71,800
MD83	Light Jet B	5	0	4	1	10
CL600	RJ	783	19	745	58	1,605
CNA750	RJ	1	0	1	0	2
CRJ9-ER	RJ	5,246	560	5,159	646	11,610
CRJ9-LR	RJ	733	30	625	138	1,526
EMB145	RJ	18	0	17	1	36
EMB14L	RJ	1,655	119	1,763	11	3,549
EMB170	RJ	5,264	375	5,204	436	11,279
EMB175	RJ	8,863	1,033	8,972	924	19,792
FAL20	RJ	1	1	2	0	3
G650ER	RJ	1	0	1	0	2
GV	RJ	2	0	2	0	3
LEAR35	RJ	7	5	8	3	24
Commercial Jets Subtotal		139,096	37,071	145,257	30,910	352,334
Commercial Non-Jet Operations						
BEC58P	Non-jet	17,514	165	17,608	71	35,358
CNA208	Non-jet	1,126	12	1,118	20	2,276
DHC6	Non-jet	5	12	16	0	33
DHC830	Non-jet	3,764	152	3,727	189	7,833
GASEPV	Non-jet	2	0	2	0	4
SF340	Non-jet	208	0	208	0	416
Commercial Non-Jet Operations Subtotal		22,619	341	22,681	279	45,920

Table I-3 2019 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
Commercial Aircraft Total		161,715	37,412	167,938	31,189	398,254
General Aviation Operations						
A109	Helicopter	7	0	7	0	14
B206L	Helicopter	11	0	11	0	21
B407	Helicopter	22	2	20	4	48
B427	Helicopter	1	0	1	0	2
B429	Helicopter	8	14	11	11	43
B430	Helicopter	3	1	4	0	8
EC130	Helicopter	34	2	30	6	72
H500D	Helicopter	2	0	2	0	4
R44	Helicopter	20	1	19	2	43
S76	Helicopter	148	28	135	41	351
SA330J	Helicopter	193	24	191	26	434
SA350D	Helicopter	3	0	2	1	6
SA355F	Helicopter	31	1	32	0	64
SA365N	Helicopter	5	1	5	1	12
747400	Heavy Jet A	1	0	1	0	2
747SP	Heavy Jet A	1	0	1	0	2
A340-211	Heavy Jet A	1	0	0	1	2
A340-642	Heavy Jet A	2	0	2	0	4
777300	Heavy Jet B	2	1	3	0	6
7773ER	Heavy Jet B	0	1	0	1	2
7878R	Heavy Jet B	1	0	1	0	2
A330-301	Heavy Jet B	1	0	1	0	2
A330-343	Heavy Jet B	1	0	1	0	2
C17	Heavy Jet B	1	0	1	0	2
U_7673ER	Heavy Jet B	1	0	1	0	2
737800	Light Jet A	0	1	1	0	2
727EM1	Light Jet A	1	0	0	1	2
737400	Light Jet B	23	4	18	9	54
737700	Light Jet B	5	0	5	0	10
757PW	Light Jet B	0	1	0	1	2
757RR	Light Jet B	1	0	1	0	2

Table I-3 2019 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
A319-131	Light Jet B	4	0	3	1	8
A321-232	Light Jet B	0	1	1	0	2
EMB190	Light Jet B	1	0	1	0	2
MD81	Light Jet B	1	0	1	0	2
BD-700-1A10	RJ	325	36	319	41	720
BD-700-1A11	RJ	140	17	143	14	314
CIT3	RJ	25	0	25	0	50
CL600	RJ	1,506	139	1,535	110	3,290
CL601	RJ	278	25	279	23	604
CNA500	RJ	46	3	43	6	97
CNA510	RJ	195	9	191	13	407
CNA525C	RJ	388	60	383	65	897
CNA55B	RJ	904	79	920	63	1,966
CNA560E	RJ	2	1	3	0	6
CNA560U	RJ	679	50	687	42	1,458
CNA560XL	RJ	334	14	334	14	695
CNA680	RJ	1,104	72	1,126	51	2,353
CNA750	RJ	873	70	889	54	1,886
CRJ9-ER	RJ	0	1	1	0	2
ECLIPSE500	RJ	11	1	11	1	23
EMB145	RJ	29	3	29	3	64
FAL20	RJ	4	0	3	1	8
FAL900EX	RJ	283	21	278	26	608
G650ER	RJ	174	28	190	12	405
GIIB	RJ	6	1	7	0	14
GIV	RJ	564	77	568	73	1,282
GV	RJ	398	42	400	40	879
IA1125	RJ	180	21	185	15	401
LEAR25	RJ	1	0	1	0	2
LEAR35	RJ	837	135	861	110	1,942
MU3001	RJ	314	22	311	25	672
1900D	Non-jet	1	0	1	0	2
BEC58P	Non-jet	426	26	426	26	904

Table I-3 2019 Annual Modeled Operations

Aircraft Noise and Performance (ANP)	Group	Arrivals		Departures		Total
		Day	Night	Day	Night	
C130	Non-jet	4	0	4	0	8
CNA172	Non-jet	24	2	26	0	52
CNA182	Non-jet	75	0	75	0	149
CNA206	Non-jet	5	0	5	0	10
CNA208	Non-jet	1,137	99	1,138	99	2,473
CNA441	Non-jet	17	3	16	4	41
COMSEP	Non-jet	317	34	335	17	703
DHC6	Non-jet	780	81	749	112	1,722
DHC8	Non-jet	2	0	2	0	4
EMB120	Non-jet	0	1	0	1	2
GASEPF	Non-jet	15	0	15	0	29
GASEPV	Non-jet	204	12	209	8	434
HS748A	Non-jet	2	0	2	0	4
PA28	Non-jet	23	2	25	0	50
PA30	Non-jet	1	0	1	0	2
PA31	Non-jet	26	0	25	1	52
PA42	Non-jet	2	1	2	1	6
General Aviation Total		13,191	1,270	13,286	1,175	28,922
Grand Total		174,907	38,681	181,224	32,364	427,176

Source: HMMH, 2020.
Notes: ANP - Aircraft Noise and Performance.
BEC58P is the AEDT substitution for the Cessna 402.
The CRJ9-ER in the RJ category is the CRJ700 aircraft.
Some totals may not match due to rounding

In the calculation of DNL, annual operations data are scaled to represent an average annual day by dividing by the 365 days in a year (or, in the case of a leap year like 2020, by the 366 days). To compare operations between years, it is simpler to look at category totals. **Table I-4, Table I-5, Table I-6,** and **Table I-7** summarize the numbers of average daily operations by categories of aircraft operating at Logan Airport from 1990 through 2022. Operations are summarized by operator category (commercial/GA), aircraft category, and day or night operation (night defined as 10:00 PM to 7:00 AM, consistent with the definition of DNL). GA operations were not included in the noise modeling prior to 1998 and commercial jet operations were not separated until 1999.

Table I-4 Modeled Daily Operations[1] by Commercial and GA Aircraft – 1990 to 1997

		1990	1991	1992	1993	1994	1995	1996	1997
Commercial Aircraft									
Stage 2 Jets[2]	Day	312.40	N/A	228.89	203.34	189.40	156.90	132.40	108.46
	Night	19.99	N/A	13.13	7.44	10.10	5.50	4.79	7.75
	Total	332.39	N/A	242.02	210.78	199.50	162.40	137.19	116.21
Stage 3 Jets	Day	288.89	N/A	384.49	418.99	425.70	429.40	439.81	505.08
	Night	57.25	N/A	58.29	65.47	62.80	69.00	80.16	85.06
	Total	346.14	N/A	442.78	484.46	488.50	498.40	519.97	590.14
Air Carrier Jets	Day	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]
	Night	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]
	Total	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]
Regional Jets[5]	Day	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]
	Night	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]
	Total	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]
Non-jets	Day	444.41	N/A	411.84	598.16	541.97	526.85	505.31	514.7
	Night	11.72	N/A	69.32	46.84	13.59	11.14	13.73	27.27
	Total	456.13	N/A	481.16	645.00	555.56	537.99	519.04	541.97
Total Commercial Operations									
Operations	Day	1045.70	N/A	1,025.22	1,220.49	1,157.07	1,113.15	1,077.52	1,128.24
	Night	88.96	N/A	140.74	119.75	86.49	85.64	98.68	120.08
	Total	1,134.66	N/A	1,165.96	1,340.24	1,243.56	1,198.79	1,176.20	1,248.32
GA Aircraft									
Stage 2 Jets[2]	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Total	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
Stage 3 Jets	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Total	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
Non-jets	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Total	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]

Table I-4 Modeled Daily Operations[1] by Commercial and GA Aircraft – 1990 to 1997

		1990	1991	1992	1993	1994	1995	1996	1997
Total GA Operations									
Operations	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
	Total	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
Overall Totals									
Day		1,045.70	N/A	1,025.22	1,220.49	1,157.07	1,113.15	1,077.52	1,128.24
Night		88.96	N/A	140.74	119.75	86.49	85.64	98.68	120.08
Total		1,134.66	N/A	1,165.96	1,340.24	1,243.56	1,198.79	1,176.20	1,248.32

Table I-5 Modeled Daily Operations[1] by Commercial and GA Aircraft – 1998 to 2005

		1998	1999	2000	2001	2002	2003	2004	2005
Commercial Aircraft									
Stage 2 Jets[2]	Day	84.93	83.30	5.13	1.18	0.05	0.08	0.03	0.05
	Night	5.92	6.66	0.26	0.05	0.00	0.00	0.01	0.01
	Total	90.85	89.96	5.39	1.23	0.05	0.08	0.05	0.06
Stage 3 Jets	Day	541.43	597.28	727.09	756.24	740.75	717.85	772.39	765.76
	Night	95.54	98.59	103.66	109.77	97.04	92.69	113.24	113.66
	Total	636.97	695.87	830.75	866.01	837.79	810.54	885.63	879.42
Air Carrier Jets	Day	N/A[3]	569.18	648.95	569.99	500.70	461.06	518.96	505.48
	Night	N/A[3]	96.21	99.79	101.30	83.52	72.69	89.24	91.99
	Total	N/A[3]	665.39	748.74	671.29	584.22	533.75	608.20	597.47
Regional Jets[5]	Day	N/A[3]	28.10	78.14	186.25	240.05	256.80	253.43	260.34
	Night	N/A[3]	2.38	3.87	8.47	13.52	19.99	24.00	21.68
	Total	N/A[3]	30.48	82.01	194.72	253.57	276.79	277.43	282.01
Non-jets	Day	552.56	448.82	409.62	317.62	165.45	135.18	133.24	148.77
	Night	21.86	16.63	21.58	10.97	3.45	2.41	3.03	3.02
	Total	574.42	465.45	431.20	328.58	168.89	137.59	136.28	151.79
Total Commercial Operations									
Operations	Day	1,178.92	1,129.90	1,141.84	1,075.04	906.25	853.10	905.66	914.59
	Night	123.32	121.88	125.51	120.79	100.49	95.10	116.29	116.68
	Total	1,302.24	1,251.78	1,267.35	1,195.82	1,006.73	948.20	1,021.95	1,031.27

Table I-5 Modeled Daily Operations[1] by Commercial and GA Aircraft – 1998 to 2005

		1998	1999	2000	2001	2002	2003	2004	2005
GA Aircraft									
Stage 2 Jets[2]	Day	5.25	9.89	7.29	5.15	3.65	2.84	0.94	2.29
	Night	0.40	0.74	0.64	0.50	0.41	0.26	0.14	0.25
	Total	5.65	10.63	7.93	5.65	4.08	3.10	1.08	2.54
Stage 3 Jets	Day	30.54	48.46	40.08	34.23	37.83	46.21	53.72	58.84
	Night	4.21	6.55	3.21	3.28	6.42	6.98	8.37	9.33
	Total	34.75	55.01	43.29	37.51	44.25	53.19	62.09	68.16
Non-jets	Day	37.29	19.36	34.57	37.31	17.36	17.81	16.95	14.00
	Night	16.28	18.89	1.83	1.92	4.45	4.40	5.20	4.75
	Total	53.57	38.25	36.40	39.23	21.81	22.21	22.14	18.75
Total GA Operations									
Operations	Day	73.08	77.71	81.94	76.68	58.84	66.88	71.60	75.12
	Night	20.89	26.17	5.68	5.71	11.29	11.64	13.71	14.33
	Total	93.97	103.88	87.62	82.39	70.13	78.52	85.31	89.46
Overall Totals									
Day		1,252.00	1,207.61	1,223.78	1,151.72	965.09	919.98	977.27	989.71
Night		144.21	148.05	131.19	126.50	111.78	106.74	130.00	131.02
Total		1,396.21	1,355.66	1,354.97	1,278.21	1,076.86	1,026.72	1,107.26	1,120.73

Table I-6 Modeled Daily Operations[1] by Commercial and GA Aircraft – 2006 to 2013

		2006	2007	2008	2009	2010	2011	2012	2013	2014
Commercial Aircraft										
Stage 2 Jets[2]	Day	0.03	0.03	0.01	0.00	0.01	0.01	0.01	0.01	0.00
	Night	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00
	Total	0.03	0.04	0.02	0.00	0.02	0.01	0.01	0.01	0.00
Stage 3 Jets	Day	767.55	748.13	699.39	667.45	674.25	684.19	649.22	667.65	670
	Night	114.81	118.29	114.30	103.05	107.92	109.38	106.55	115.91	123.6
	Total	882.36	866.42	813.69	770.50	782.17	793.57	755.77	783.56	793.61
Air Carrier Jets	Day	490.63	472.39	443.15	422.92	521.64	571.03	530.76	546.27	556.59
	Night	92.71	96.28	89.89	82.21	93.98	99.17	98.68	107.17	115.84
	Total	583.34	568.66	533.04	505.14	615.62	670.2	629.44	653.44	672.43

Table I-6 Modeled Daily Operations[1] by Commercial and GA Aircraft – 2006 to 2013

		2006	2007	2008	2009	2010	2011	2012	2013	2014
Regional Jets[5]	Day	276.95	275.77	256.24	244.53	152.61	113.16	118.46	121.38	113.41
	Night	22.11	22.03	24.40	20.84	13.94	10.21	7.87	8.74	7.77
	Total	299.06	297.80	280.64	265.37	166.55	123.37	126.33	130.12	121.18
Non-jets	Day	140.81	145.27	132.52	136.43	138.53	135.18	133.92	132.33	128.45
	Night	3.26	3.47	4.00	5.56	5.21	4.73	3.06	3.21	2.28
	Total	144.07	148.73	136.52	141.99	143.74	139.91	136.98	135.54	130.73
Total Commercial Operations										
Operations	Day	908.41	893.43	831.92	804.77	812.78	819.39	783.14	799.99	798.45
	Night	118.09	121.77	118.31	108.65	113.13	114.11	109.62	119.12	125.88
	Total	1,026.51	1,015.19	950.23	913.42	925.91	933.5	892.76	919.12	924.33
GA Aircraft										
Stage 2 Jets[2]	Day	1.90	1.24	0.36	0.09	0.27	0.08	0.25	0.31	0.00
	Night	0.17	0.19	0.03	0.01	0.04	0.00	0.04	0.02	0.00
	Total	2.07	1.43	0.38	0.10	0.30	0.08	0.29	0.33	0.00
Stage 3 Jets	Day	61.08	54.82	43.98	22.31	27.80	52.51	52.93	51.21	52.64
	Night	6.57	6.39	4.52	2.28	3.21	5.35	7.20	5.10	4.65
	Total	67.65	61.21	48.49	23.59	31.01	57.87	60.13	56.31	57.29
Non-jets	Day	15.05	11.98	15.13	8.19	8.19	18.18	15.16	13.06	13.95
	Night	1.39	3.61	1.08	0.74	0.72	1.29	1.29	1.15	1.13
	Total	16.44	15.58	16.20	8.93	8.92	19.48	16.45	14.22	15.08
Total GA Operations										
Operations	Day	78.03	68.04	59.46	30.46	36.26	70.78	68.35	64.58	66.59
	Night	8.13	10.19	5.62	3.08	3.97	6.65	8.52	6.28	5.78
	Total	86.15	78.22	65.05	33.54	40.22	77.43	76.86	70.85	72.37
Overall Totals										
Day		986.43	961.46	891.39	834.33	849.03	890.16	851.49	864.57	865.05
Night		126.22	131.96	123.93	111.70	117.10	120.76	118.13	125.40	131.66
Total		1,112.66	1,093.42	1,015.31	946.03	966.13	1,010.92	969.61	989.97	996.70

Table I-7 Modeled Daily Operations[1] by Commercial and GA Aircraft – 2014 to 2022

		2015	2016	2017	2018	2019	2020	2021	2022	Change 2019 to 2022
Commercial Aircraft										
Stage 2 Jets[2]	Day	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Night	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stage 3 Jets	Day	685.92	713.65	734.46	770.67	779.05	376.47	478.62	721.76	-57.29
	Night	130.96	142.16	158.49	177.15	186.25	72.20	92.46	136.46	-49.79
	Total	816.88	855.81	892.95	947.82	965.30	448.67	571.08	858.22	-107.08
Air Carrier Jets	Day	585.55	620.45	636.04	657.25	655.57	319.04	382.72	567.82	-87.75
	Night	126.36	134.93	148.75	164.09	174.30	68.41	85.22	123.44	-50.86
	Total	711.92	755.38	784.79	821.34	829.87	387.45	467.94	691.26	-138.61
Regional Jets[5]	Day	100.36	93.20	98.42	113.42	123.48	57.43	95.90	153.94	30.46
	Night	4.6	7.23	9.74	13.06	11.95	3.79	7.24	13.02	1.07
	Total	104.96	100.43	108.16	126.48	135.43	61.22	103.13	166.96	31.53
Non-jets	Day	125.27	125.88	119.03	126.76	124.11	79.33	91.68	95.05	-29.06
	Night	2.41	3.01	2.24	2.36	1.70	0.34	0.24	0.45	-1.25
	Total	127.68	128.89	121.27	129.12	125.81	79.67	91.92	95.50	-30.31
Total Commercial Operations										
Operations	Day	811.19	839.53	853.49	897.44	903.16	455.80	570.29	816.81	-86.35
	Night	133.37	145.17	160.73	179.51	187.95	72.54	92.70	136.91	-51.04
	Total	944.56	984.70	1,014.22	1,076.94	1,091.11	528.34	662.99	953.72	-137.39
GA Aircraft										
Stage 2 Jets[2]	Day	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Night	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stage 3 Jets	Day	51.82	51.82	52.19	55.77	53.17	25.32	45.96	60.76	7.59
	Night	4.28	4.59	4.56	5.08	4.79	2.38	3.69	5.21	0.41
	Total	56.10	56.41	56.75	60.85	57.96	27.70	49.65	65.97	8.01
Non-jets	Day	19.31	25.92	26.43	22.01	19.37	9.52	15.12	16.24	-3.13
	Night	1.46	1.87	2.25	1.91	1.90	0.74	1.10	1.37	-0.54
	Total	20.77	27.79	28.68	23.92	21.28	10.27	16.22	17.61	-3.67

Table I-7 Modeled Daily Operations[1] by Commercial and GA Aircraft – 2014 to 2022

		2015	2016	2017	2018	2019	2020	2021	2022	Change 2019 to 2022
Total GA Operations										
Operations	Day	71.40	77.75	78.61	77.78	72.54	34.85	61.08	77.00	4.46
	Night	5.77	6.46	6.81	6.99	6.70	3.12	4.79	6.57	-0.12
	Total	77.17	84.21	85.43	84.77	79.24	37.97	65.87	83.58	4.34
Overall Totals										
Day		882.59	917.28	932.10	975.22	975.70	490.65	631.37	893.82	-81.89
Night		139.14	151.63	167.54	186.49	194.64	75.66	97.49	143.48	-51.16
Total		1,021.73	1,068.91	1,099.65	1,161.71	1,170.35	566.31	728.86	1037.30	-133.05

I.2.3.1 Commercial Jet Aircraft by Part 36 Stage Category

As described in the Regulatory Framework section of this appendix, jet aircraft are classified into categories referred to as stages based on noise levels. The heavier the aircraft, the more noise it is permitted to make, within limits. Aircraft are allowed to be recertificated to the higher standard when modifications are made to the aircraft engine or design. Because of the substantial differences in noise between Stage 2, recertificated Stage 3, Stage 3, Stage 4, and Stage 5 aircraft, Massport tracks operations by these separate categories to follow their trends. **Table I-3** shows the percentage of commercial jet operations by stage category from 1998 through 2021.

One of the most significant changes occurring after the economic downturn in 2001 was the almost immediate retirement of the re-certificated Stage 3 aircraft from airlines' fleets due to their high operating costs. This type of accelerated retirement was not as prevalent during the 2008 to 2009 economic downturn since the major airlines no longer operated these aircraft.

Table I-8 Percentage of Commercial Jet Operations by Part 36 Stage Category – 1998 to 2022

Year	Stage 5 Requirements[1]	Stage 4 Requirements[2]	Stage 3[3]	Recertificated Stage 3[4]	Stage 2 Greater than 75,000 lbs.	Total
1998	N/A	N/A	65.9%	21.7%	12.4%	100%
1999	N/A	N/A	70.0%	21.0%	9.0%	100%
2000	N/A	N/A	75.0%	24.0%	1.0%	100%
2001	N/A	N/A	86.3%	13.6%	0.1%	100%
2002	N/A	N/A	92.8%	7.2%	0.0%	100%

Table I-8 Percentage of Commercial Jet Operations by Part 36 Stage Category – 1998 to 2022

Year	Stage 5 Requirements[1]	Stage 4 Requirements[2]	Stage 3[3]	Recertificated Stage 3[4]	Stage 2 Greater than 75,000 lbs.	Total
2003	N/A	N/A	95.8%	4.1%	0.0%	100%
2004	N/A	N/A	97.8%	2.2%	0.0%	100%
2005	N/A	N/A	98.0%	2.0%	0.0%	100%
2006	N/A	N/A	98.6%	1.4%	0.0%	100%
2007	N/A	N/A	98.9%	1.1%	0.0%	100%
2008	N/A	N/A	99.1%	0.9%	0.0%	100%
2009	N/A	87.8%	11.3%	0.9%	0.0%	100%
2010	N/A	93.2%	5.7%	1.1%	0.0%	100%
2011	N/A	95.5%	4.0%	0.5%	0.0%	100%
2012	N/A	95.8%	4.1%	0.1%	0.0%	100%
2013	N/A	97.4%	2.6%	0.0%	0.0%	100%
2014	N/A	97.4%	2.6%	0.0%	0.0%	100%
2015	N/A	96.7%	3.3%	0.0%	0.0%	100%
2016	17.8%	79.2%	3.0%	0.0%	0.0%	100%
2017	17.7%	79.8%	2.4%	0.0%	0.0%	100%
2018	15.5%	83.0%	1.5%	0.0%	0.0%	100%
2019	15.2%	82.9%	2.0%	0.0%	0.0%	100%
2020	28.5%	68.7%	2.8%	0.0%	0.0%	100%
2021	29.1%	69.2%	1.7%	0.0%	0.0%	100%
2022	33.6%	65.3%	1.1%	0.0%	0.0%	100%

Source: Massport and Federal Aviation Administration (FAA) radar data, HMMH 2022

Notes: N/A – not applicable. Values less than 0.05% appear as 0.0% due to rounding.

1 This column includes operations by aircraft that would qualify as Stage 5 if recertificated. Aircraft with maximum takeoff weight greater than 121,254 pounds that are certificated after January 1, 2018, must meet Stage 5 standards. The percent of Logan Airport operations in aircraft meeting Stage 5 requirements was not determined prior to 2016.

2 This column includes aircraft that are either certificated Stage 4 or would qualify as Stage 4 if recertificated. Certification as Stage 4 was not available until 2006 and the percent of Logan Airport operations in aircraft that meet Stage 4 requirements was not determined prior to 2009.

3 Certificated Stage 3 aircraft are originally manufactured meeting Stage 3 requirements under Federal Regulation Part 36. This column includes only operations by Certificated Stage 3 aircraft that do not meet higher certification standards.

4 Recertificated Stage 3 aircraft are aircraft that were originally manufactured and certified as Stage 1 or 2 under Federal Regulation Part 36, which either have been treated with hushkits or have been re-engineered to meet Stage 3 requirements.

I.2.3.2 Nighttime Operations

Massport tracks flights that operate in the defined nighttime period between the hours of 10:00 PM to 7:00 AM, when each flight is penalized 10 dB in calculations of DNL. **Table I-9** shows this nighttime activity by different groups of aircraft. As in years past, the majority of nighttime operations (between 10:00 PM and 7:00 AM) occurred either before midnight or after 5:00 AM.

Table I-9 Modeled Nighttime Operations at Logan Airport – 1990 to 2022

Year	Commercial Jets	Commercial Non-Jets	General Aviation	Total
1990	77.24	11.72	N/A	88.96
1991	N/A	N/A	N/A	N/A
1992	71.42	69.32	N/A	140.74
1993	72.91	46.84	N/A	119.75
1994	72.90	13.59	N/A	86.49
1995	74.50	11.14	N/A	85.64
1996	84.95	13.73	N/A	98.68
1997	92.81	27.27	N/A	120.08
1998	101.46	21.86	20.89	144.21
1999	105.25	16.63	26.17	148.05
2000	103.92	21.58	5.68	131.19
2001	109.82	10.97	5.71	126.50
2002	97.04	3.45	11.29	111.78
2003	92.69	2.41	11.64	106.74
2004	113.26	3.03	13.71	130.00
2005	113.67	3.02	14.33	131.02
2006	114.81	3.26	8.13	126.22
2007	118.30	3.47	10.19	131.96
2008	114.31	4.00	5.62	123.93
2009	103.05	5.56	3.08	111.70
2010	107.93	5.21	3.97	117.10
2011	109.38	4.73	6.65	120.76
2012	106.55	3.06	8.52	118.13
2013	115.91	3.21	6.28	125.40
2014	123.60	2.28	5.78	131.66
2015	130.96	2.41	5.77	139.14
2016[1]	142.16	3.01	6.48	151.63
2017	158.49	2.24	6.81	167.55
2018	177.15	2.36	6.99	186.49

Table I-9 Modeled Nighttime Operations at Logan Airport – 1990 to 2022

Year	Commercial Jets	Commercial Non-Jets	General Aviation	Total
2019	186.25	1.70	6.70	194.64
2020	72.00	0.34	3.11	75.45
2021	92.46	0.24	4.79	97.49
2022	136.46	0.45	6.57	143.48
Change (2019 to 2022)	-49.79	-1.25	-0.12	-51.16
Percent Change	-38%	-52%	-2%	-26%
Change (2021 to 2022) 2021)	44.00	0.21	1.79	46.00
Percent Change	48%	89%	37%	47%

Source: Massport, HMMH, 2022
Notes: GA – general aviation; N/A - not available. Negative numbers shown in parentheses ( ).
1 Minor errors reported for 2016 data in *2016 EDR* have been corrected in this table.

I.2.4 Runway Use

Using radar data, the AEDT pre-processor determines which runway was used, the specific aircraft type, and time classification (daytime or nighttime) for each flight. Massport compares annual runway use to previous years using a variety of summary tables with different perspectives.

The first summary of daytime and nighttime runway usages presented here is broken into six representative aircraft groups with similar runway requirements. The list below provides example aircraft types from each group:

- Heavy Jet A – B747s, A340s, A380s
- Heavy Jet B – B767s, B777s, B787s, A300s, A310s, A330s, A350s, MD-11s
- Light Jet A – B717s, MD-90s
- Light Jet B – B737s, B757s, A319s, A220s, A320s, MD-80s, E190
- Regional Jet (RJ) – E135, E145, E170, E175, CRJ2, CRJ7, CRJ9, J328 and Corporate Jets
- Turboprops and Piston Aircraft (non-jets)

Since Massport began categorizing aircraft this way, the proportions of aircraft in the Heavy Jet A and Light Jet A categories have diminished, due to changing fleets. The Heavy Jet A category represents only 6 percent of the heavy jets and the Light Jet A category represents less than 1 percent of the lighter large jets.

Table I-10, Table I-11, and **Table I-12** show the runway use summary for the modeled 2022 and 2021 noise conditions, respectively. **Table I-12** shows the corresponding summary from the modeled 2019 noise conditions for comparison. The turbojet aircraft in the table were grouped into the different categories for reporting purposes. Because the DNL contours developed using the radar data with the AEDT pre-processor reflect the actual use of the runways by each flight, they accurately represent Logan Airport's noise environment. The modeled runway usage for a given particular aircraft type may be different from the overall group runway use presented in **Table I-10, Table I-11,** and **Table I-12**.

Table I-10 2022 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
ARRIVALS												
Runway	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
04L	0.2%	-	0.2%	0.1%	-	-	2.2%	<0.1%	5.5%	0.2%	18.5%	0.4%
04R	40.0%	-	34.6%	19.0%	25.0%	-	30.8%	18.0%	28.0%	20.0%	14.0%	10.3%
09	-	-	-	-	-	-	-	-	-	-	-	-
15R	0.1%	-	0.4%	1.5%	-	-	0.6%	1.0%	0.6%	1.0%	4.9%	36.5%
22L	35.2%	-	32.9%	30.2%	50.0%	-	31.0%	40.5%	31.1%	41.8%	31.0%	26.9%
22R	-	-	<0.1%	-	-	-	<0.1%	<0.1%	<0.1%	-	3.4%	1.7%
27	5.3%	-	17.4%	6.5%	25.0%	50.0%	27.2%	16.7%	21.2%	20.5%	9.5%	8.7%
32	-	-	-	-	-	-	1.2%	-	6.2%	-	11.7%	0.2%
33L	19.1%	100.0%	14.6%	42.8%	-	50.0%	7.0%	23.8%	7.4%	16.5%	4.7%	14.8%
33R	-	-	-	-	-	-	-	-	-	-	2.3%	0.4%
Total	99.9	100.0	100.1	100.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9
DEPARTURES												
Runway	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
04L	0.2%	-	0.2%	0.1%	-	-	2.2%	<0.1%	5.5%	0.2%	18.5%	0.4%
04R	40.0%	-	34.6%	19.0%	25.0%	-	30.8%	18.0%	28.0%	20.0%	14.0%	10.3%
09	-	-	-	-	-	-	-	-	-	-	-	-
15R	0.1%	-	0.4%	1.5%	-	-	0.6%	1.0%	0.6%	1.0%	4.9%	36.5%
22L	35.2%	-	32.9%	30.2%	50.0%	-	31.0%	40.5%	31.1%	41.8%	31.0%	26.9%
22R	-	-	<0.1%	-	-	-	<0.1%	<0.1%	<0.1%	-	3.4%	1.7%
27	5.3%	-	17.4%	6.5%	25.0%	50.0%	27.2%	16.7%	21.2%	20.5%	9.5%	8.7%
32	-	-	-	-	-	-	1.2%	-	6.2%	-	11.7%	0.2%
33L	19.1%	100.0%	14.6%	42.8%	-	50.0%	7.0%	23.8%	7.4%	16.5%	4.7%	14.8%

Table I-10 2022 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
33R	-	-	-	-	-	-	-	-	-	-	2.3%	0.4%
Total	99.9%	100.0%	100.1%	100.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%

Source: Massport, HMMH, 2023

Notes: Nighttime for noise modeling is defined as 10:00 PM to 7:00 AM.
Values may not add exactly to 100 percent due to rounding.

Table I-11 2021 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
ARRIVALS												
Runway	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
04L	-	-	<0.1%	-	-	-	0.6%	<0.1%	1.8%	<0.1%	6.1%	0.8%
04R	31.1%	100.0%	27.7%	16.9%	57.1%	100.0%	27.0%	19.1%	26.4%	19.9%	20.7%	13.2%
9	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15L	-	-	-	-	-	-	-	-	-	-	0.5%	-
15R	0.9%	-	3.8%	1.9%	-	-	4.1%	1.4%	3.7%	1.6%	5.6%	2.0%
22L	28.3%	-	33.1%	26.0%	21.4%	-	31.4%	33.3%	32.2%	36.9%	30.0%	45.1%
22R	-	-	-	-	-	-	<0.1%	-	<0.1%	<0.1%	3.6%	2.4%
27	17.0%	-	13.3%	3.4%	21.4%	-	19.6%	14.3%	15.9%	16.7%	9.3%	7.5%
32	-	-	-	-	-	-	0.4%	-	2.4%	-	3.6%	-
33L	22.6%	-	22.1%	51.7%	-	-	16.9%	31.9%	17.6%	24.8%	17.6%	29.0%
33R	-	-	-	-	-	-	-	-	-	-	3.1%	-
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
DEPARTURES												
Runway	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
04L	-	-	-	-	-	-	-	-	-	-	12.6%	3.5%
04R	26.9%	25.0%	10.1%	4.9%	-	-	5.0%	4.2%	0.8%	0.6%	6.4%	5.5%
9	3.8%	-	17.4%	11.3%	33.3%	-	23.8%	14.5%	30.5%	19.2%	17.7%	8.0%
14	-	-	-	-	-	-	-	-	-	-	-	-
15L	-	-	-	-	-	-	-	-	-	-	-	-
15R	8.7%	50.1%	7.3%	27.6%	-	-	3.9%	22.9%	1.6%	19.9%	3.1%	44.4%
22L	17.3%	-	6.8%	2.2%	-	-	2.8%	2.2%	0.1%	0.3%	0.1%	0.8%

Table I-11 2021 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
22R	7.7%	24.9%	26.0%	15.8%	50.0%	-	29.5%	18.0%	34.6%	25.1%	35.3%	14.3%
27	-	-	10.2%	3.9%	16.7%	-	13.9%	13.9%	15.4%	11.8%	7.0%	6.4%
32	-	-	-	-	-	-	-	-	-	-	-	-
33L	35.6%	-	22.1%	34.3%	-	-	21.1%	24.4%	17.1%	23.0%	17.8%	17.0%
33R	-	-	-	-	-	-	-	-	-	-	-	-
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Massport, HMMH, 2022
Notes: Nighttime for noise modeling is defined as 10:00 PM to 7:00 AM.
Values may not add exactly to 100 percent due to rounding.

Table I-12 2019 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
ARRIVALS												
Runway	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
04L	0.1%	-	0.3%	0.2%	2.5%	0.2%	4.1%	0.4%	8.3%	0.8%	25.5%	3.2%
04R	43.4%	18.3%	41.1%	23.4%	33.7%	21.2%	28.0%	18.3%	28.4%	23.2%	12.6%	19.2%
9	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15L	-	-	-	-	-	-	-	-	-	-	0.1%	-
15R	0.4%	-	0.5%	0.2%	0.5%	0.2%	0.6%	0.2%	0.4%	0.2%	2.2%	11.3%
22L	29.5%	54.5%	27.0%	35.6%	22.8%	39.3%	28.8%	38.7%	24.8%	40.3%	25.9%	30.1%
22R	-	-	-	-	<0.1%	<0.1%	<0.1%	-	<0.1%	0.1%	3.0%	4.0%
27	4.4%	9.3%	15.2%	3.6%	31.4%	17.7%	24.2%	16.5%	19.9%	22.1%	4.0%	11.4%
32	-	-	-	-	-	-	1.8%	-	5.7%	-	12.9%	-
33L	22.2%	18.0%	16.0%	37.0%	9.1%	21.5%	12.4%	25.9%	12.5%	13.4%	7.6%	16.1%
33R	-	-	-	-	-	-	-	-	-	-	6.0%	4.7%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
DEPARTURES												
Runway	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
04L	-	-	-	-	-	-	-	-	-	-	20.5%	12.3%
04R	16.3%	10.1%	11.9%	4.0%	8.8%	5.8%	3.3%	2.2%	0.2%	0.4%	2.9%	2.3%

Table I-12 2019 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
9	5.7%	0.8%	18.9%	15.1%	26.5%	16.3%	33.0%	20.5%	38.5%	26.3%	18.7%	8.0%
14	-	-	-	-	-	-	-	-	-	-	-	-
15L	-	-	-	-	-	-	-	-	-	-	0.0%	-
15R	30.9%	44.3%	10.4%	18.8%	3.5%	14.3%	2.1%	10.6%	0.5%	6.3%	2.2%	23.7%
22L	6.5%	3.9%	4.7%	2.0%	3.5%	3.5%	1.5%	1.3%	0.1%	0.6%	0.1%	0.2%
22R	14.3%	11.4%	24.6%	32.6%	25.8%	20.5%	28.8%	29.4%	30.4%	33.0%	29.6%	29.6%
27	0.1%	-	6.8%	1.9%	10.6%	23.1%	11.6%	20.3%	11.3%	20.6%	5.2%	3.6%
32	-	-	-	-	-	-	-	-	-	-	-	-
33L	26.2%	29.6%	22.6%	25.6%	21.3%	16.5%	19.8%	15.6%	19.1%	12.7%	20.7%	20.5%
33R	-	-	-	-	-	-	-	-	-	-	-	-
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Massport, HMMH, 2020.
Notes: Nighttime for noise modeling is defined as 10:00 PM to 7:00 AM.
Values may not add exactly to 100 percent due to rounding.

While previous tables present runway use by aircraft groups, **Table I-13, Table I-14,** and **Table I-15** present the total runway use (jets and non-jets) by runway and time of day. The first section of each table displays the number of operations on each runway by time period for an average day. The second section displays the same information for the entire year and the last section displays the percent that each runway is used for a given operation type and time of day.

Table I-13 shows that on an average day in 2022, Runway 22R had the most departures (about 174, per day and night combined) and Runway 22L had the most arrivals (about 169 per day and night combined). This usage pattern was also seen in 2021 and in 2019, although in 2019, Runway 9 handled as many departures in 2019 as Runway 22R did.

Table I-13 Summary of Jet and Non-Jet Aircraft Runway Use: 2022

	Runway												
	4L	4R	9	14	15L	15R	22L	22R	27	32	33L	33R	Total
2022 Daily Operations Counts													
Dep Day	9.8	18.7	122.0	0	0	9.7	8.4	160.4	26.0	0.0	102.3	0.0	457.2
Dep Night	0.0	2.2	11.9	0	0	13.7	0.9	13.9	4.4	0.0	14.5	0.0	61.5
Arr Day	21.9	123.5	0.0	0	0	3.7	136.6	1.9	99.4	16.2	32.1	1.3	436.6
Arr Night	0.1	14.9	0.0	0	0	1.0	32.7	0.0	13.5	0.0	19.7	0.0	82.0
Total Daily Operations	31.7	159.4	133.9	0	0	28.1	178.6	176.2	143.2	16.2	168.6	1.3	1037.3
2022 Annual Operations Counts													
Dep Day	3,564	6,827	44,525	0	0	3,545	3,060	58,541	9,478	0	37,327	0	166,867
Dep Night	10	813	4,342	0	0	4,996	321	5,060	1,604	0	5,292	0	22,440
Arr Day	7,977	45,083	0	0	0	1,337	49,871	710	36,283	5,912	11,729	473	159,376
Arr Night	21	5,444	0	0	0	382	11,952	9	4,920	1	7,200	2	29,931
Total Annual Operations	11,573	58,166	48,867	0	0	10,261	65,204	64,321	52,285	5,913	61,548	475	378,613
2022 Percentage Operations													
Dep Day	2%	4%	27%	0%	0%	2%	2%	35%	6%	0%	22%	0%	100%
Dep Night	<1%	4%	19%	0%	0%	22%	1%	23%	7%	0%	24%	0%	100%
Arr Day	5%	28%	0%	0%	0%	1%	31%	<1%	23%	4%	7%	<1%	100%
Arr Night	<1%	18%	0%	0%	0%	1%	40%	<1%	16%	<1%	24%	<1%	100%

Source: Massport radar data and HMMH 2022

Notes: Arr – Arrivals, Dep - Departures

These data reflect actual counts or percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.

Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32.

Values may not add to 100 percent due to rounding.

Table I-14 Summary of Jet and Non-Jet Aircraft Runway Use: 2021

	Runway												
	4L	4R	9	14	15L	15R	22L	22R	27	32	33L	33R	Total
2021 Daily Operations Counts													
Dep Day	6.7	14.9	78.8	0.0	0.0	11.3	6.4	103.1	42.4	0.0	65.0	0.0	328.6
Dep Night	0.0	1.4	5.1	0.0	0.0	8.6	0.7	6.6	3.9	0.0	9.5	0.0	35.9
Arr Day	5.5	78.2	0.0	0.0	0.2	12.8	95.2	2.0	50.0	4.3	52.9	1.6	302.8
Arr Night	0.0	11.7	0.0	0.0	0.0	1.0	20.3	0.0	8.4	0.0	20.1	0.0	61.6
Total Daily Operations	12.2	106.2	83.9	0.0	0.2	33.8	122.6	111.7	104.8	4.3	147.5	1.6	728.9
2021 Annual Operations Counts													
Dep Day	2,455	5,447	28,763	0	0	4,129	2,327	37,630	15,466	0	23,713	0	119,929
Dep Night	8	509	1,871	0	0	3,137	243	2,417	1,440	0	3,463	0	13,088
Arr Day	2,002	28,534	0	0	89	4,683	34,746	715	18,252	1,584	19,318	601	110,523
Arr Night	5	4,261	0	0	0	380	7,420	7	3,080	0	7,341	0	22,494
Total Annual Operations	4,470	38,751	30,634	0	89	12,329	44,735	40,769	38,238	1,584	53,835	601	266,034
2021 Percentage Operations													
Dep Day	2%	5%	24%	0%	0%	3%	2%	31%	13%	0%	20%	0%	100%
Dep Night	<1%	4%	14%	0%	0%	24%	2%	18%	11%	0%	26%	0%	100%
Arr Day	2%	26%	0%	0%	<1%	4%	31%	1%	17%	1%	17%	1%	100%
Arr Night	<1%	19%	0%	0%	0%	2%	33%	<1%	14%	0%	33%	0%	100%

Source: Massport radar data and HMMH 2022

Notes: Arr – Arrivals, Dep – Departures

These data reflect actual counts or percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.

Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32.

Values may not add to 100 percent due to rounding.

Table I-15 Summary of Jet and Non-Jet Aircraft Runway Use: 2019

	Runway												
	4L	4R	9	14	15L	15R	22L	22R	27	32	33L	33R	Total
2019 Daily Operations Counts													
Dep Day	14.8	18.9	150.7	0.0	0.0	12.6	7.1	141.9	50.6	0.0	100.0	0.0	496.5
Dep Night	0.2	2.6	17.0	0.0	0.0	11.2	1.5	25.5	15.4	0.0	15.3	0.0	88.6

Table I-15 Summary of Jet and Non-Jet Aircraft Runway Use: 2019

	Runway												
	4L	4R	9	14	15L	15R	22L	22R	27	32	33L	33R	Total
Arr Day	36.8	131.2	0.0	0.0	0.1	3.8	129.4	2.2	98.1	18.7	56.2	4.3	480.6
Arr Night	0.5	20.4	0.0	0.0	0.0	0.4	40.4	0.1	16.9	0.0	25.8	0.1	104.5
Total Daily Operations	52.2	173.1	167.7	0.0	0.1	27.9	178.3	169.7	181.0	18.7	197.3	4.4	1,170.3
2019 Annual Operations Counts													
Dep Day	5,384	6,882	55,019	0	1	4,593	2,586	51,805	18,452	0	36,511	0	181,234
Dep Night	79	953	6,197	0	0	4,087	530	9,303	5,624	0	5,581	0	32,354
Arr Day	13,417	47,882	0	0	23	1,375	47,237	791	35,794	6,822	20,506	1,581	175,429
Arr Night	172	7,450	0	0	0	138	14,733	31	6,180	0	9,422	32	38,159
Total Annual Operations	19,052	63,167	61,216	0	24	10,193	65,087	61,930	66,050	6,822	72,020	1,614	427,176
2019 Percentage Operations													
Dep Day	3%	4%	30%	0%	<1%	3%	1%	29%	10%	0%	20%	0%	100%
Dep Night	<1%	3%	19%	0%	0%	13%	2%	29%	17%	0%	17%	0%	100%
Arr Day	8%	27%	0%	0%	<1%	1%	27%	<1%	20%	4%	12%	1%	100%
Arr Night	<1%	20%	0%	0%	0%	<1%	39%	<1%	16%	0%	25%	<1%	100%

Source: Massport radar data and HMMH 2020.
Notes: Arr – Arrivals, Dep - Departures
These data reflect actual counts or percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.
Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32.
Values may not add to 100 percent due to rounding.

Runway use can also be presented in terms of percent of total operations. **Table I-6** presents the 2022, 2021 and 2019 runway use for all operations which use Logan Airport, supplementing the information in **Table I-10, Table I-11,** and **Table I-12** that separate runway use by aircraft group and time of day, and the data in **Table I-13, Table I-14,** and **Table I-15** which total the runway use by operation type and time of day.

For 2022, Runways 22L and 22R were the most active, with 22R handling the most Departures and 22L handling the most arrivals. Overall, the usage rates were similar to those seen in 2019 than in 2020 or 2021. For 2019 through 2021, Runway 33L was the most active, with primarily jet departures. Runways 4R, 9, 22L, 22R and 27 handled the majority of the rest of the traffic. Some year-to-year shifts can be seen in the data in **Table I-6**.

Table I-16 Total 2022, 2021, and 2019 Modeled Runway Use by All Operations

Runway	Jet Arrivals		Non-Jet Arrivals		Jet Departures		Non-Jet Departures		All Operations
	Day	Night	Day	Night	Day	Night	Day	Night	
2022 Operations									
4L	1.1%	<0.1%	1.0%	<0.1%	0.0%	0.0%	0.9%	<0.1%	3.1%
4R	11.1%	1.4%	0.8%	<0.1%	1.4%	0.2%	0.4%	<0.1%	15.4%
9	0.0%	0.0%	0.0%	0.0%	10.9%	1.1%	0.9%	<0.1%	12.9%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15L	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15R	0.2%	0.1%	0.1%	<0.1%	0.8%	1.3%	0.1%	<0.1%	2.7%
22L	11.5%	3.1%	1.7%	<0.1%	0.8%	0.1%	<0.1%	<0.1%	17.2%
22R	<0.1%	<0.1%	0.2%	<0.1%	13.5%	1.3%	2.0%	<0.1%	17.0%
27	9.1%	1.3%	0.5%	<0.1%	2.3%	0.4%	0.2%	<0.1%	13.8%
32	0.9%	0.0%	0.6%	<0.1%	0.0%	0.0%	0.0%	0.0%	1.6%
33L	2.8%	1.9%	0.3%	<0.1%	9.0%	1.4%	0.9%	<0.1%	16.3%
33R	0.0%	0.0%	0.1%	<0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Total	36.7%	7.8%	5.4%	0.1%	38.7%	5.9%	5.4%	0.1%	100.0%
2021 Operations									
4L	0.3%	<0.1%	0.4%	<0.1%	0.0%	0.0%	0.9%	<0.1%	1.7%
4R	9.2%	1.6%	1.5%	<0.1%	1.6%	0.2%	0.5%	<0.1%	14.6%
9	0.0%	0.0%	0.0%	0.0%	9.5%	0.7%	1.3%	<0.1%	11.5%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15L	0.0%	0.0%	<0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	<0.1%
15R	1.4%	0.1%	0.4%	<0.1%	1.3%	1.1%	0.2%	<0.1%	4.6%
22L	10.9%	2.8%	2.2%	<0.1%	0.9%	0.1%	<0.1%	<0.1%	16.8%
22R	<0.1%	<0.1%	0.3%	<0.1%	11.6%	0.9%	2.6%	<0.1%	15.3%
27	6.2%	1.2%	0.7%	<0.1%	5.3%	0.5%	0.5%	<0.1%	14.4%
32	0.3%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
33L	6.0%	2.7%	1.3%	<0.1%	7.6%	1.3%	1.3%	<0.1%	20.2%
33R	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Total	34.2%	8.4%	7.3%	0.1%	37.8%	4.8%	7.3%	0.1%	100.0%
2019 Operations									
4L	1.6%	<0.1%	1.6%	<0.1%	0.0%	0.0%	1.3%	<0.1%	4.5%
4R	10.4%	1.7%	0.8%	<0.1%	1.4%	0.2%	0.2%	<0.1%	14.8%

Table I-16 Total 2022, 2021, and 2019 Modeled Runway Use by All Operations

Runway	Jet Arrivals		Non-Jet Arrivals		Jet Departures		Non-Jet Departures		All Operations
	Day	Night	Day	Night	Day	Night	Day	Night	
9	0.0%	0.0%	0.0%	0.0%	11.7%	1.4%	1.1%	<0.1%	14.3%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15L	0.0%	0.0%	<0.1%	0.0%	0.0%	0.0%	<0.1%	0.0%	<0.1%
15R	0.2%	<0.1%	0.1%	<0.1%	0.9%	0.9%	0.1%	<0.1%	2.4%
22L	9.5%	3.4%	1.6%	<0.1%	0.6%	0.1%	<0.1%	<0.1%	15.2%
22R	<0.1%	<0.1%	0.2%	<0.1%	10.3%	2.1%	1.8%	<0.1%	14.5%
27	8.1%	1.4%	0.2%	<0.1%	4.0%	1.3%	0.3%	<0.1%	15.5%
32	0.8%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	1.6%
33L	4.3%	2.2%	0.5%	<0.1%	7.3%	1.3%	1.3%	<0.1%	16.9%
33R	0.0%	0.0%	0.4%	<0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
Total	34.9%	8.8%	6.1%	0.2%	36.3%	7.4%	6.1%	0.2%	100.0%

Source: Massport radar data and HMMH, 2022
Notes: Night for noise modeling is defined as 10:00 PM to 7:00 AM.
Nighttime runway restrictions are from 11:00 PM to 6:00 AM.
Values may not add to exactly 100 percent due to rounding.

Table I-17 presents a historical summary of runway use by jets. Since 2009, the radar data have been analyzed with Massport's Harris NOMS. Data from 2001 through 2008 were compiled with Massport's PreFlight™ software, an analysis package used to access fleet, day/night splits, and runway use information from radar data. Data prior to 2001 were derived from Massport's original noise monitoring system, supplemented with field records.

Note that Logan Airport Noise Rules prevent arrivals to Runway 22R and departures from Runway 4L by jet aircraft except for certain circumstances.

Table I-17 Summary of Jet Aircraft Runway Use – 1990 to 2022

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
1990										
Departures	0%[2]	3%	21%	N/A	10%	2%	36%	20%	N/A	7%
Arrivals	1%	25%	0%	N/A	2%	14%	0%	28%	N/A	29%
1992[2]										
Departures	0%	6%	31%	N/A	7%	2%	38%	10%	N/A	6%
Arrivals	1%	37%	0%	N/A	3%	12%	0%	30%	N/A	17%

Table I-17 Summary of Jet Aircraft Runway Use – 1990 to 2022

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
1993										
Departures	0%	9%	33%	N/A	7%	3%	40%	4%	N/A	4%
Arrivals	2%	44%	0%	N/A	1%	11%	0%	28%	N/A	15%
1994										
Departures	0%	9%	33%	N/A	4%	3%	32%	12%	N/A	5%
Arrivals	3%	42%	0%	N/A	1%	8%	0%	27%	N/A	19%
1995										
Departures	0%	8%	36%	N/A	5%	5%	29%	11%	N/A	5%
Arrivals	3%	41%	0%	N/A	2%	8%	0%	27%	N/A	17%
1996										
Departures	0%	8%	32%	N/A	5%	6%	33%	12%	N/A	5%
Arrivals	2%	38%	0%	N/A	2%	11%	0%	29%	N/A	18%
1997										
Departures	0%	8%	30%	N/A	5%	6%	31%	15%	N/A	5%
Arrivals	2%	36%	0%	N/A	2%	9%	0%	30%	N/A	20%
1998										
Departures	0%	8%	35%	N/A	6%	5%	28%	14%	N/A	5%
Arrivals	2%	41%	0%	N/A	2%	7%	0%	28%	N/A	19%
1999										
Departures	0%	8%	31%	N/A	5%	4%	30%	15%	N/A	6%
Arrivals	3%	37%	0%	N/A	2%	10%	0%	28%	N/A	21%
2000										
Departures	0%	8%	35%	N/A	4%	3%	30%	15%	N/A	6%
Arrivals	4%	40%	0%	N/A	1%	7%	0%	28%	N/A	20%
2001										
Departures	0%	7%	34%	N/A	4%	3%	35%	12%	N/A	5%
Arrivals	5%	36%	0%	N/A	1%	8%	0%	32%	N/A	18%
2002										
Departures	0%	4%	31%	N/A	6%	3%	35%	16%	N/A	6%
Arrivals	6%	31%	0%	N/A	1%	12%	0%	30%	N/A	21%

Table I-17 Summary of Jet Aircraft Runway Use – 1990 to 2022

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
2003										
Departures	0%	4%	33%	N/A	7%	2%	34%	14%	N/A	6%
Arrivals	7%	33%	0%	N/A	1%	14%	0%	28%	N/A	18%
2004										
Departures	0%	5%	34%	N/A	10%	4%	24%	18%	N/A	6%
Arrivals	6%	34%	0%	N/A	1%	12%	0%	24%	N/A	23%
2005										
Departures	0%	5%	36%	N/A	7%	1%	31%	13%	N/A	7%
Arrivals	8%	33%	0%	N/A	1%	11%	0%	29%	N/A	17%
2006										
Departures	0%	4%	33%	0%	3%	1%	40%	13%	0%	6%
Arrivals	7%	29%	0%	0%	1%	14%	0%	33%	0.2%	16%
2007										
Departures	0%	5%	31%	0%	4%	1%	33%	7%	0%	19%
Arrivals	5%	31%	0%	0%	1%	15%	0%	36%	2%	11%
2008										
Departures	0%	6%	33%	<1%	3%	<1%	36%	6%	0%	16%
Arrivals	6%	30%	0%	0%	2%	17%	0%	33%	2%	11%
2009[3]										
Departures	0%	7%	32%	0%	3%	2%	34%	6%	0%	16%
Arrivals	7%	31%	0%	0%	3%	17%	0%	30%	1%	11%
2010										
Departures	0%	4%	28%	<1%	8%	2%	31%	10%	0%	17%
Arrivals	5%	28%	0%	0%	1%	15%	0%	32%	1%	16%
2011[4]										
Departures	0%	6%	36%	<1%	5%	2%	36%	7%	0%	7%
Arrivals	7%	37%	0%	0%	<1%	16%	0%	28%	1%	11%
2012[4]										
Departures	0%	6%	33%	<1%	5%	3%	38%	6%	0%	9%
Arrivals	6%	34%	0%	0%	1%	16%	0%	33%	<1%	9%

Table I-17 Summary of Jet Aircraft Runway Use – 1990 to 2022

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
2013										
Departures	<1%	5%	30%	<1%	5%	2%	35%	12%	0%	12%
Arrivals	6%	29%	0%	0%	1%	16%	<1%	32%	1%	15%
2014										
Departures	0%	5%	31%	<1%	5%	2%	28%	13%	0%	17%
Arrivals	5%	30%	0%	0%	2%	25%	<1%	21%	1%	16%
2015										
Departures	0%	4%	29%	<1%	5%	2%	32%	12%	0%	15%
Arrivals	5%	29%	0%	0%	2%	25%	<1%	23%	1%	16%
2016[5]										
Departures	0%	4%	30%	0%	6%	2%	27%	13%	0%	18%
Arrivals	4%	31%	0%	0%	1%	24%	<1%	23%	1%	16%
2017[6]										
Departures	0%	2%	25%	0%	5%	1%	28%	15%	0%	23%
Arrivals	5%	21%	0%	0%	5%	23%	<1%	27%	2%	18%
2018										
Departures	<1%	4%	30%	0%	5%	2%	34%	10%	0%	16%
Arrivals	4%	30%	0%	0%	<1%	32%	<1%	21%	1%	12%
2019										
Departures	0%	4%	30%	0%	4%	2%	28%	12%	0%	20%
Arrivals	4%	28%	0%	0%	<1%	29%	<1%	22%	2%	15%
2020[7]										
Departures	0%	5%	19%	0%	7%	2%	33%	13%	0%	21%
Arrivals	1%	23%	0%	0%	4%	36%	<1%	16%	1%	19%
2021										
Departures	0%	4%	24%	0%	6%	2%	29%	14%	0%	21%
Arrivals	1%	25%	0%	0%	3%	32%	<1%	17%	1%	20%

Table I-17 Summary of Jet Aircraft Runway Use – 1990 to 2022

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
2022										
Departures	0%	4%	27%	0%	5%	2%	33%	6%	0%	23%
Arrivals	2%	28%	0%	0%	1%	33%	<1%	23%	2%	11%

Source: Massport radar data and HMMH 2023

Notes: These data reflect actual percentages of jet aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway. Effective runway percentages include a factor of 10 applied to nighttime operations so that use of a runway at night more closely reflects its effect on total noise exposure.
Jet aircraft are not able to use Runway 15L or 33R due to its length of only 2,557 feet.
Values may not add to exactly 100 percent due to rounding.
N/A - not available.

1 Runway 14-32 opened in late November 2006. (Runway 14-32 is unidirectional with no arrivals to Runway 14 and no departures from Runway 32.)

2 The *1990 Final Generic Environmental Impact Report* was published and submitted to the Secretary of Environmental Affairs in July 1993. It included modeled operations and resulting noise contours for 1987, 1990, and a 1996 forecast year. The *1993 Annual Update* published in July 1994 included operations and contours for 1992 and 1993. 1991 data are not available.

3 Runway 9-27 had extended weekend closings for resurfacing during 2009.

4 Runway 15R-33L was closed for 3 months in 2011 and in 2012.

5 Runway 4L-22R was closed for 31 days in 2016.

6 Runway 4R-22L was closed for 35 days in 2017, with limited availability for Runway 4R arrivals for about 80 additional days.

7 Runway 9-27 was closed for almost 3 months in the summer of 2020, during an unprecedented period of low levels of aircraft activity due to the pandemic.

Since runway use plays such a key role in determining noise the aircraft noise distribution in the Airport's environment, Massport also tracks the level of traffic off each runway end by combining counts of operations that overfly the same general area. The total operations and percentages shown for 2019, 2021, and 2022 in **Table I-18** represent the amount of activity experienced off each runway end for a given year.

Table I-18 Runway Usage by Runway End

Runway End	Operation(s)[1]	2019		2021		2022	
		Total Flights	% of Total[2]	Total Flights	% of Total[2]	Total Flights	% of Total[2]
04L	R4L A + R22R D	74,697	17.5%	42,054	15.8%	71,600	26.9%
04R	R4R A + R22L D	58,449	13.7%	35,365	13.3%	53,908	20.3%
9	R9 A + R27 D	24,076	5.6%	16,906	6.4%	11,082	4.2%
14	N/A	0	0.0%	0	0.0%	0	0.0%
15L	R15L A + R33R D	23	0.0%	89	0.0%	0	0.0%
15R	R15R A + R33L D	43,606	10.2%	32,240	12.1%	44,338	16.7%
22L	R22L A + R4R D	69,805	16.3%	48,121	18.1%	69,463	26.1%
22R	R22R A + R4L D	6,285	1.5%	3,185	1.2%	4,293	1.6%

Table I-18 Runway Usage by Runway End

Runway End	Operation(s)[1]	2019		2021		2022	
		Total Flights	% of Total[2]	Total Flights	% of Total[2]	Total Flights	% of Total[2]
27	R27 A + R9 D	103,191	24.2%	51,966	19.5%	90,070	33.9%
32	R32 A + R14 D	6,822	1.6%	1,584	0.6%	5,913	2.2%
33L	R33L A + R15R D	38,607	9.0%	33,924	12.8%	27,471	10.3%
33R	R33R A + R15L D	1,615	0.4%	601	0.2%	475	0.2%
All		427,176	100.0%	266,034	100.0%	378,613	142.3%

Source: Massport radar data and HMMH 2023

Notes: N/A – not applicable.

Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32. The 15 operations shown in this row for 2016 are non-jet departures which were most likely erroneously associated with Runway 32 by the computer algorithm.

1 A=Arrivals; D=Departures.

2 Percentages are rounded to the nearest tenth.

I.2.5 Flight Tracks

The AEDT pre-processor converts each radar track to an AEDT model track and then models the scaled aircraft operation on that track. This method keeps the modeled lateral and vertical dispersion of the aircraft types consistent with the radar data and ensures that anomalies in the departure paths are captured in the pre-processor system. **Table I-19** lists the number of flight tracks used in the modeling process for 2021 and 2022. A sample of flight tracks from 2021 and 2022 are displayed in **Figure 7-5** through **Figure 7-11** in Chapter 7, *Noise*.

Table I-19 Total Count of Flight Tracks Modeled with AEDT (2021 and 2022)

	Runway											
	4L	4R	9	14	15L	15R	22L	22R	27	32	33L	33R
2022												
Departures	3,579	7,614	48,62	0	0	8,469	3,366	63,30	11,028	0	42,40	0
Arrivals	7,975	50,21	0	0	0	1,696	61,45	715	40,93	5,892	18,817	474
2021												
Departures	2,369	5,886	30,35	0	0	7,225	2,560	39,61	16,76	0	26,92	0
Arrivals	1,989	32,63	0	0	88	4,959	41,94	713	21,23	1,574	26,51	596
2019												
Departures	5,392	7,660	60,00	0	1	8,481	3,042	59,89	23,54	0	41,22	0
Arrivals	13,149	52,05	0	0	23	1,421	58,33	819	39,151	6,634	28,22	1,610

Source: Massport's Harris Noise and Operational Monitoring System (NOMS) data and HMMH, 2023

I.3 Annual Noise Model Results

I.3.1 Noise Exposed Population

Table I-20 presents the noise-exposed population by community through 2022. This table includes population within the DNL 60 to 65 dB contour interval, although DNL 65 dB is the federally defined noise criterion used as a guideline to identify when residential land use is considered incompatible with aircraft noise. The population assessments for 2022 use 2020 U.S. Census data.

As noted in the *2017 Environmental Status and Planning Report* (*2017 ESPR*), the method for calculating population impact was refined for the 2017 analysis. Historically, the population calculations were developed by the noise model (AEDT or INM) or by GIS software by adding the populations of U.S. Census blocks within each contour level. A block was considered to be within the contour if the center location (or centroid) was within the DNL contour. The weakness of that method arises from the fact that the population of a U.S. Census block is distributed throughout the block, not clustered at its centroid. Blocks on the edge of the contour were either entirely included or entirely excluded from the count, but in reality, some fraction of the block's population resides within the contour.

The updated method (adopted for the *2017 ESPR* and continued since) determines the fraction of the area of the U.S. Census block that is within the contour and multiplies the block population by this fraction to determine the population exposed to DNL 65 dB or greater for that block. This more accurately represents the included population within U.S. Census blocks that are on the DNL contour boundary. This proportional method, while still an approximation, also better addresses the more obscure problem of oddly shaped blocks whose centroid is outside the block boundary.

When comparing population impact assessment across multiple years, it should be noted that the population estimation is affected by the noise model used to create the contours. As discussed in the *2016 EDR*, AEDT-modeled contours are smaller than the INM-modeled contours, which included FAA-approved over-water effects, hill effects, and custom altitude profiles. Consequently, population calculations based on AEDT contours result in smaller exposed populations.

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
BOSTON[2]							
1990	1980	0	0	1,778	28,970	30,748	N/A
1992	1980	0	0	800	4,316	5,116	N/A
1993	1980	0	0	264	2,820	3,084	N/A
1994	1990	0	106	265	7,698	8,069	30,895
1995	1990	0	106	851	8,815	9,772	33,765
1996	1990	0	106	374	8,775	9,255	40,992
1997	1990	0	106	719	13,857	14,682	54,804
1998	1990	0	58	580	10,877	11,515	52,201
1999 [3]	1990	0	58	364	11,632	12,054	45,948
2000	2000	0	0	234	9,014	9,248	35,785
2001	2000	0	0	315	6,515	6,700	27,778
2002	2000	0	0	132	2,625	2,757	23,225
2003	2000	0	0	164	1,730	1,894	21,763
2004 [4]	2000	0	65	192	4,142	4,399	24,473
2005 [4]	2000	0	65	104	2,020	2,189	17,661
2006 [4]	2000	0	65	99	1,054	1,218	14,866
2007 [4,5]	2000	0	0	169	4,094	4,263	21,446
2008 [4,5]	2000	0	5	0	3,487	3,492	18,890
2009 [4,5]	2000	0	5	67	937	1,009	12,284
2010 [4,5]	2010	0	0	0	689	689	17,646
2011 [4,5]	2010	0	0	0	331	331	11,600
2012 [4,5]	2010	0	0	0	421	421	11,037
2013 [4,5]	2010	0	0	0	612	612	14,835
2014 [4,5]	2010	0	0	34	4,151	4,185	23,343
2015 [4,5]	2010	0	0	110	7,225	7,365	32,309
2016 [4,5]	2010	0	0	0	4,031	4,031	20,806

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
2017 [4,5]	2010	0	0	14	4,720	4,734	24,595
2018 [4,5]	2010	0	0	11	2,228	2,239	23,445
2019 [4,5]	2010	0	0	7	4,029	4,036	25,163
2020 [4,5]	2020	0	0	0	60	60	7,946
2021 [4,5]	2020	0	0	0	885	885	9,473
2022 [4,5]	2020	0	0	0	3,862	3,862	17,804
CHELSEA							
1990	1980	0	0	0	4,813	4,813	N/A
1992	1980	0	0	0	3,952	3,952	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	8,510
1995	1990	0	0	0	95	95	9,750
1996	1990	0	0	0	0	0	8,744
1997	1990	0	0	0	0	0	10,001
1998	1990	0	0	0	0	0	9,222
1999	1990	0	0	0	95	95	9,249
2000	2000	0	0	0	0	0	7,361
2001	2000	0	0	0	0	0	4,508
2002	2000	0	0	0	0	0	3,995
2003	2000	0	0	0	0	0	3,591
2004 [4]	2000	0	0	0	0	0	7,756
2005 [4]	2000	0	0	0	0	0	5,772
2006 [4]	2000	0	0	0	0	0	2,477
2007 [4,5]	2000	0	0	0	0	0	9,774
2008 [4,5]	2000	0	0	0	0	0	7,793
2009 [4,5]	2000	0	0	0	0	0	5,462
2010 [4,5]	2010	0	0	0	0	0	4,897
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	3,485
2014 [4,5]	2010	0	0	0	0	0	9,236
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	12,110
2017 [4,5]	2010	0	0	0	65	65	13,900
2018 [4,5]	2010	0	0	0	0	0	10,526

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
2019 [4,5]	2010	0	0	0	0	0	12,650
2020 [4,5]	2020	0	0	0	0	0	721
2021 [4,5]	2020	0	0	0	0	0	4,708
2022 [4,5]	2020	0	0	0	0	0	13,683
EVERETT							
1990	1980	0	0	0	0	0	N/A
1992	1980	0	0	0	0	0	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	0
2001	2000	0	0	0	0	0	0
2002	2000	0	0	0	0	0	0
2003	2000	0	0	0	0	0	0
2004 [4]	2000	0	0	0	0	0	0
2005 [4]	2000	0	0	0	0	0	0
2006 [4]	2000	0	0	0	0	0	0
2007 [4,5]	2000	0	0	0	0	0	0
2008 [4,5]	2000	0	0	0	0	0	0
2009 [4,5]	2000	0	0	0	0	0	0
2010 [4,5]	2010	0	0	0	0	0	0
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	0
2014 [4,5]	2010	0	0	0	0	0	0
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	0
2017 [4,5]	2010	0	0	0	0	0	924
2018 [4,5]	2010	0	0	0	0	0	0
2019 [4,5]	2010	0	0	0	0	0	0
2020 [4,5]	2020	0	0	0	0	0	0

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
2021 [4,5]	2020	0	0	0	0	0	0
2022 [4,5]	2020	0	0	0	0	0	0
MEDFORD							
1990	1980	0	0	0	0	0	N/A
1992	1980	0	0	0	0	0	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	0
2001	2000	0	0	0	0	0	0
2002	2000	0	0	0	0	0	0
2003	2000	0	0	0	0	0	0
2004 [4]	2000	0	0	0	0	0	0
2005 [4]	2000	0	0	0	0	0	0
2006 [4]	2000	0	0	0	0	0	0
2007 [4,5]	2000	0	0	0	0	0	0
2008 [4,5]	2000	0	0	0	0	0	0
2009 [4,5]	2000	0	0	0	0	0	0
2010 [4,5]	2010	0	0	0	0	0	0
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	0
2014 [4,5]	2010	0	0	0	0	0	0
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	0
2017 [4,5]	2010	0	0	0	0	0	0
2018 [4,5]	2010	0	0	0	0	0	0
2019 [4,5]	2010	0	0	0	0	0	0
2020 [4,5]	2020	0	0	0	0	0	0
2021 [4,5]	2020	0	0	0	0	0	0
2022 [4,5]	2020	0	0	0	0	0	0

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
QUINCY							
1990	1980	0	0	0	0	0	N/A
1992	1980	0	0	0	0	0	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	636
2001	2000	0	0	0	0	0	610
2002	2000	0	0	0	0	0	610
2003	2000	0	0	0	0	0	610
2004 [4]	2000	0	0	0	0	0	610
2005 [4]	2000	0	0	0	0	0	610
2006 [4]	2000	0	0	0	0	0	610
2007 [4,5]	2000	0	0	0	0	0	0
2008 [4,5]	2000	0	0	0	0	0	0
2009 [4,5]	2000	0	0	0	0	0	0
2010 [4,5]	2010	0	0	0	0	0	0
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	0
2014 [4,5]	2010	0	0	0	0	0	0
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	0
2017 [4,5]	2010	0	0	0	0	0	0
2018 [4,5]	2010	0	0	0	0	0	0
2019 [4,5]	2010	0	0	0	0	0	0
2020 [4,5]	2020	0	0	0	0	0	0
2021 [4,5]	2020	0	0	0	0	0	0
2022 [4,5]	2020	0	0	0	0	0	0

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
REVERE							
1990	1980	0	0	0	4,274	4,274	N/A
1992	1980	0	0	0	3,848	3,848	N/A
1993	1980	0	0	0	4,617	4,617	N/A
1994	1990	0	0	0	3,569	3,569	2,099
1995	1990	0	0	0	3,364	3,364	2,304
1996	1990	0	0	172	3,292	3,464	2,505
1997	1990	0	0	0	3,293	3,293	2,047
1998	1990	0	0	0	3,168	3,168	2,132
1999	1990	0	0	128	3,165	3,293	2,047
2000	2000	0	0	0	2,496	2,496	3,100
2001	2000	0	0	0	2,496	2,496	3,100
2002	2000	0	0	0	2,822	2,822	2,399
2003	2000	0	0	0	2,994	2,994	2,227
2004 [4]	2000	0	0	82	2,969	3,051	2,678
2005 [4]	2000	0	0	82	2,540	2,622	2,731
2006 [4]	2000	0	0	82	2,540	2,622	2,698
2007 [4,5]	2000	0	0	0	2,450	2,450	2,853
2008 [4,5]	2000	0	0	0	2,434	2,434	1,802
2009 [4,5]	2000	0	0	0	2,512	2,512	1,452
2010 [4,5]	2010	0	0	0	2,413	2,413	2,473
2011 [4,5]	2010	0	0	0	2,547	2,547	3,123
2012 [4,5]	2010	0	0	0	2,762	2,762	3,191
2013 [4,5]	2010	0	0	0	2,505	2,505	2,791
2014 [4,5]	2010	0	0	0	2,832	2,832	3,829
2015 [4,5]	2010	0	0	0	3,789	3,789	3,385
2016 [4,5]	2010	0	0	0	2,376	2,376	3,508
2017 [4,5]	2010	0	0	0	2,362	2,362	2,899
2018 [4,5]	2010	0	0	0	2,362	2,362	2,899
2019 [4,5]	2010	0	0	0	3,484	3,484	3,733
2020 [4,5]	2020	0	0	0	641	641	3,983
2021 [4,5]	2020	0	0	0	1,260	1,260	3,669
2022 [4,5]	2020	0	0	0	3,416	3,416	3,904

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
WINTHROP							
1990	1980	0	676	1,211	2,420	4,307	N/A
1992	1980	0	626	1,146	2,488	4,262	N/A
1993	1980	0	648	1,211	1,773	3,632	N/A
1994	1990	0	417	1,343	5,154	6,914	7,512
1995	1990	0	482	1,611	5,757	7,850	7,077
1996	1990	0	417	1,376	5,930	7,723	7,333
1997	1990	0	417	1,659	6,386	8,462	6,839
1998	1990	0	519	1,522	6,572	8,613	6,507
1999	1990	0	353	1,408	5,946	7,707	7,135
2000	2000	0	247	1,070	4,684	6,001	7,776
2001	2000	0	244	683	4,123	5,050	8,104
2002	2000	0	2	481	2,247	2,730	7,921
2003	2000	0	0	339	1,956	2,295	7,386
2004 [4]	2000	0	2	337	1,649	1,988	6,508
2005 [4]	2000	0	39	347	1,280	1,666	6,353
2006 [4]	2000	0	39	416	1,288	1,743	6,845
2007 [4,5]	2000	0	0	247	1,139	1,386	6,749
2008 [4,5]	2000	0	0	244	1,409	1,653	6,547
2009 [4,5]	2000	0	0	171	643	814	4,221
2010 [4,5]	2010	0	0	130	598	728	3,720
2011 [4,5]	2010	0	0	130	939	1069	4,303
2012 [4,5]	2010	0	0	200	1,186	1,386	5,305
2013 [4,5]	2010	0	0	130	1,060	1,190	5,466
2014 [4,5]	2010	0	0	130	1,775	1,905	6,456
2015 [4,5]	2010	0	0	320	2,623	2,943	6,375
2016 [4,5]	2010	0	0	130	913	1,403	5,062
2017 [4,5]	2010	0	0	125	647	772	4,656
2018 [4,5]	2010	0	0	51	1,170	1,221	5,586
2019 [4,5]	2010	0	0	96	1,152	1,248	5,621
2020 [4,5]	2020	0	0	0	103	103	1,901
2021 [4,5]	2020	0	0	0	352	352	2,106
2022 [4,5]	2020	0	0	27	880	907	4,848

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
All Communities							
1990	1980	0	676	2,989	40,477	44,142	NA
1992	1980	0	628	2,352	14,604	17,584	NA
1993	1980	0	648	1,475	9,210	11,333	NA
1994	1990	0	523	1,608	16,421	18,552	49,016
1995	1990	0	588	2,462	18,031	21,081	52,896
1996	1990	0	523	1,922	17,997	20,442	59,574
1997	1990	0	523	2,378	23,536	26,437	73,691
1998	1990	0	577	2,102	20,617	23,296	70,062
1999[3]	1990	0	411	1,900	20,838	23,149	64,379
2000	2000	0	247	1,304	16,194	17,745	54,190
2001	2000	0	244	998	13,004	14,246	43,616
2002	2000	0	2	613	7,694	8,309	38,150
2003	2000	0	0	503	6,680	7,183	35,577
2004 [4]	2000	0	67	611	8,760	9,438	41,975
2005 [4]	2000	0	104	533	5,840	6,477	33,127
2006 [4]	2000	0	104	597	4,882	5,583	27,496
2007 [4,5]	2000	0	0	416	7,683	8,099	40,822
2008 [4,5]	2000	0	5	244	7,330	7,579	35,122
2009 [4,5]	2000	0	5	238	4,092	4,335	23,419
2010 [4,5]	2010	0	0	130	3,700	3,830	28,736
2011 [4,5]	2010	0	0	130	3,817	3,947	19,026
2012 [4,5]	2010	0	0	200	4,369	4,569	19,533
2013 [4,5]	2010	0	0	130	4,177	4,307	26,577
2014 [4,5]	2010	0	0	164	8,758	8,922	42,864
2015 [4,5]	2010	0	0	430	13,667	14,097	52,748
2016 [4,5]	2010	0	0	130	7,320	7,450	41,486
2017 [4,5]	2010	0	0	139	7,794	7,933	46,974
2018 [4,5]	2010	0	0	62	6,972	7,034	43,270
2019 [4,5]	2010	0	0	103	8,665	8,768	47,167

Table I-20 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
2020 [4,5]	2020	0	0	0	804	804	14,551
2021 [4,5]	2020	0	0	0	2,497	2,497	19,956
2022 [4,5]	2020	0	0	27	8,158	8,185	40,239

Source: Data prepared for Massport by HMMH 2022

Notes: dB – decibel; DNL - Day-Night Average Sound Level; N/A – not available.

1 65 dB DNL is the federally defined noise criterion.

2 Boston includes portions of Dorchester, East Boston, Roxbury, South Boston, and the South End.

3 Boston population by community changed in 1999 due to employment of more accurate hill effects methodology and reporting change.

4 All results from 2004 to 2015 are from the RealContours™ modeling system with INM.
All results from 2016 to 2022 are from AEDT using the proprietary pre-processor.

5 2022 noise analyses used AEDT version 3e, 2020 and 2021 used AEDT version 3d, 2018 and 2019 used AEDT version 3c, 2017 used AEDT version 2d, 2016 used AEDT version 2c SP2, 2015 through 2012 used INM version 7.0d, 2011 used INM version 7.0c, 2008 through 2010 used INM version 7.0b, 2007 used INM version 7.01, and 1990 and 2000 used earlier versions of INM.

I.3.2 Cumulative Noise Index (CNI)

Massport reports total annual fleet noise at Logan Airport, defined in the Logan Airport Noise Rules by a metric referred to as the CNI. The CNI is a single number representing the sum of the entire set of single-event noise levels experienced at the Airport over a full year of operation, weighted similarly to DNL so that activity occurring at night is weighted by adding an extra 10 dB to each event. This weighting is mathematically equivalent to multiplying the number of nighttime events by each aircraft by a factor of ten. The Logan Airport Noise Rules define CNI in terms of Effective Perceived Noise Level (EPNL) and require that the index be computed for the fleet of commercial aircraft operating at Logan Airport throughout the year. In addition, in EDRs and ESPRs, Massport reports partial CNI values of noise at Logan Airport, so that various subsets of the fleet (cargo, night operations, passenger jets, etc.) are identified (see **Table I-21**).

The Noise Rules, adopted by Massport following public hearings held in February 1986, established a CNI limit of 156.5 EPNdB. The CNI generally has decreased since 1990, remaining below that cap, with changes from year to year on the order of a few tenths of a decibel. The 2022 total CNI remains well below the cap of 156.5 EPNL.

Table I-22 shows the relative contribution of each airline to total CNI. The table provides the number of flight operations, the contribution to CNI by airline, and the partial CNI per operation for 2019, 2021 and 2022. The data reflect the contributions of individual aircraft noise levels and the frequency with which they occur. The table is sorted by the partial CNI per operation for 2022 and shows a mix of mostly international carriers and cargo operators at the top of this list. This is due to the higher proportion of nighttime operations among these carriers, as well as the operation of larger and/or older (nosier) aircraft.

JetBlue Airways, with the largest number of operations, has the highest total CNI per airline at 148.1 EPNdB in 2019, 144.3 in 2020, and 146.8 in 2022, but its partial CNI per operation is below the other major airlines, partly due to its use of newer, quieter aircraft. The cargo airline with the most operations at Logan Airport is Federal Express (FedEx). Regional carriers generally contribute the least to the partial CNI per operation whereas the international carriers, which typically operate larger aircraft and generally have more operations at night, are usually at the top of the list. The relative positions for the domestic carriers are due mainly to their fleet characteristics and number of night operations.

Table I-21 Cumulative Noise Index (EPNL) – 1990 to 2022 (limit 156.5)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Full CNI (Entire Commercial Jet Fleet)	156.4	155.8	155.5	155.3	155.4	155.3	155.1	154.8	154.7	154.9	154.7	154.1
Total Passenger Jets	155.2	154.8	154.6	154.4	154.4	154.2	154.1	153.9	153.7	153.9	153.6	152.9
Total Cargo Jets	150.1	148.9	148.0	147.9	148.3	148.8	148.6	147.5	147.9	148.0	148.2	147.8
Total Daytime	152.5	152.1	152.4	152.1	152.1	151.6	151.2	150.8	150.4	150.4	149.5	149.0
Total Nighttime	154.4	153.4	152.6	152.4	152.6	152.9	152.9	152.5	152.7	153.1	153.1	152.4
Total Stage 2 Jets	N/A	N/A	N/A	N/A	151.0	150.2	149.4	149.2	147.7	147.1	124.7	121.5
Total Stage 3 Jets	N/A	N/A	N/A	N/A	153.4	153.8	153.8	153.4	153.8	154.2	154.7	154.1
Daytime Stage 2	N/A	N/A	N/A	N/A	149.0	148.5	147.6	146.5	145.2	144.1	122.6	119.3
Nighttime Stage 2	N/A	N/A	N/A	N/A	146.7	145.1	144.8	145.8	144.1	144.0	120.5	117.3
Daytime Stage 3	N/A	N/A	N/A	N/A	149.1	148.8	148.7	148.8	148.9	149.2	149.5	149.0
Nighttime Stage 3	N/A	N/A	N/A	N/A	151.4	152.1	152.2	151.5	152.1	152.5	153.1	152.4
Passenger Jet Stage 2	N/A	N/A	N/A	N/A	150.5	149.9	149.2	148.9	147.5	146.8	124.2	116.3
Passenger Jet Stage 3	N/A	N/A	N/A	N/A	152.2	152.3	152.3	152.2	152.6	153.0	153.6	152.9
Cargo Jet Stage 2	N/A	N/A	N/A	N/A	141.5	137.4	136.8	137.4	139.0	134.5	114.8	119.9
Cargo Jet Stage 3	N/A	N/A	N/A	N/A	147.3	148.5	148.3	147.0	147.3	147.9	148.2	147.8
Daytime Passenger	N/A	152.0	152.2	152.0	152.0	151.5	151.1	150.6	150.1	150.1	149.3	148.7
Nighttime Passenger	N/A	151.6	150.9	150.6	150.8	151.0	151.0	151.1	151.2	151.6	151.6	150.8
Daytime Cargo	137.1	137.1	137.6	135.2	136.1	138.0	136.7	136.2	138.0	138.2	137.5	137.1
Nighttime Cargo	149.9	148.6	147.6	147.6	148.0	148.4	148.3	147.1	147.5	147.6	147.8	147.4
Daytime Passenger Stage 2	N/A	N/A	N/A	N/A	148.9	148.4	147.6	146.5	145.0	143.9	122.3	115.0

Table I-21 Cumulative Noise Index (EPNL) – 1990 to 2022 (limit 156.5)

Daytime Passenger Stage 3	N/A	N/A	N/A	N/A	149.0	148.5	148.4	148.5	148.6	149.0	149.2	148.7
Nighttime Passenger Stage 2	N/A	N/A	N/A	N/A	149.0	148.5	148.4	148.5	142.8	143.7	119.8	110.2
Nighttime Passenger Stage 3	N/A	N/A	N/A	N/A	149.4	149.9	150.1	149.8	150.5	150.8	151.6	150.8
Daytime Cargo Stage 2	N/A	N/A	N/A	N/A	128.3	126.7	124.6	126.4	131.6	131.5	111.1	117.3
Daytime Cargo Stage 3	N/A	N/A	N/A	N/A	135.3	137.7	136.4	135.7	136.9	137.1	137.5	137.0
Nighttime Cargo Stage 2	N/A	N/A	N/A	N/A	141.3	137.0	136.5	137.0	138.2	131.5	112.3	116.4
Nighttime Cargo Stage 3	N/A	N/A	N/A	N/A	147.0	148.1	148.0	146.6	146.9	147.5	147.8	147.4

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Full CNI (Entire Commercial Jet Fleet)	153.2	152.7	153.4	153.2	152.6	152.7	152.9	152.3	151.9	152.1	152.2
Total Passenger Jets	151.8	151.3	152.2	152.1	151.4	151.5	151.9	151.1	150.9	150.6	151.3
Total Cargo Jets	147.4	147.1	147.0	146.6	146.5	146.4	146.1	145.9	145.1	146.7	144.9
Total Daytime	148.5	148.0	148.5	148.2	147.5	147.2	147.6	147.1	146.8	146.9	147.0
Total Nighttime	151.3	150.9	151.7	151.6	151.0	151.2	151.4	150.7	150.3	150.6	150.6
Total Stage 2 Jets	114.3	114.1	118.1	--	--	--	--	--	113.6	110.8	104.9
Total Stage 3 Jets	153.2	152.7	153.4	153.2	152.0	152.7	152.9	152.3	151.9	152.1	152.2
Daytime Stage 2	111.2	113.7	109.4	--	--	--	--	--	103.6	N/A	104.9
Nighttime Stage 2	111.4	103.2	117.5	--	--	--	--	--	113.1	110.8	--
Daytime Stage 3	148.5	148.0	148.5	148.2	147.5	147.2	147.6	147.1	146.8	146.9	147.0
Nighttime Stage 3	151.3	150.9	151.7	151.6	151.0	151.2	151.4	150.7	150.3	150.6	150.6
Passenger Jet Stage 2	--	--	--	--	--	--	--	--	--	--	104.9
Passenger Jet Stage 3	151.8	151.3	152.2	152.1	151.4	151.5	151.9	151.1	150.9	150.6	151.3
Cargo Jet Stage 2	114.3	114.1	118.1	--	--	--	--	--	113.6	110.8	--
Cargo Jet Stage 3	147.4	147.1	147.0	146.6	146.5	146.4	146.1	145.9	145.1	146.7	144.9

Table I-21 Cumulative Noise Index (EPNL) – 1990 to 2022 (limit 156.5)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Daytime Passenger	148.2	147.7	148.2	147.9	147.2	146.9	147.3	146.8	146.6	146.5	146.8
Nighttime Passenger	149.4	148.8	150.0	150.1	149.3	149.7	150.0	149.1	149.0	148.5	149.4
Daytime Cargo	137.0	136.2	135.7	135.8	135.5	135.8	135.8	135.2	134.5	136.6	134.0
Nighttime Cargo	147.0	146.8	146.7	146.2	146.1	146.0	145.6	145.5	144.7	146.3	144.5
Daytime Passenger Stage 2	--	--	--	--	--	--	--	--	--	--	104.9
Daytime Passenger Stage 3	148.2	147.7	148.2	147.9	147.2	146.9	147.3	146.8	146.6	146.5	146.8
Nighttime Passenger Stage 2	--	--	--	--	--	--	--	--	--	--	--
Nighttime Passenger Stage 3	149.4	148.8	150.0	150.1	149.3	149.7	150,.0	149.1	149.0	148.5	149.4
Daytime Cargo Stage 2	111.2	113.7	109.4	--	--	--	--	--	103.6	--	--
Daytime Cargo Stage 3	137.0	136.1	135.7	135.8	135.5	135.8	135.8	135.2	134.4	136.6	134.0
Nighttime Cargo Stage 2	111.4	103.2	117.5	--	--	--	--	--	113.1	110.8	--
Nighttime Cargo Stage 3	147.0	146.8	146.7	146.2	146.1	146.0	145.6	145.5	144.7	146.3	144.5
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Diff '19-'22**
Full CNI (Entire Commercial Jet Fleet)	152.3	152.9	152.7	152.6	153.1	153.4	153.5	150.3	151.5	152.8	-0.7
Total Passenger Jets	151.4	151.7	152.0	152.0	152.6	153.0	153.1	149.4	150.9	152.5	-0.6
Total Cargo Jets	145.1	144.5	144.2	143.8	143.4	142.9	143.0	143.1	142.7	142.2	-0.8
Total Daytime	147.0	147.1	147.2	147.0	147.5	147.6	147.7	144.9	145.8	147.6	-0.1
Total Nighttime	150.8	151.0	151.2	151.2	151.7	152.1	152.2	148.9	150.1	151.3	-0.9
Total Stage 2 Jets	111.3	--	--	--	--	--	--	--	--	N/A	N/A
Total Stage 3 Jets	152.3	152.5	152.7	152.6	153.1	153.4	153.5	150.3	151.5	152.8	-0.7
Daytime Stage 2	101.4	--	--	--	--	--	--	--	--	#N/A	N/A

Table I-21 Cumulative Noise Index (EPNL) – 1990 to 2022 (limit 156.5)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Diff '19-'22
Nighttime Stage 2	110.8	--	--	--	--	--	--	--	--	#N/A	N/A
Daytime Stage 3	147.0	147.1	147.2	147.0	147.5	147.6	147.7	144.9	145.8	147.6	-0.1
Nighttime Stage 3	150.8	151.0	151.2	151.2	151.7	152.1	152.2	148.9	150.1	151.3	-0.9
Passenger Jet Stage 2	101.4	--	--	--	--	--	--	--	--	N/A	N/A
Passenger Jet Stage 3	151.4	151.7	152.0	152.0	152.6	153.0	153.1	149.4	150.9	152.5	-0.6
Cargo Jet Stage 2	110.8	--	--	--	--	--	--	--	--	N/A	N/A
Cargo Jet Stage 3	145.1	144.5	144.2	143.8	143.4	142.9	143.0	143.1	142.7	142.2	-0.8
Daytime Passenger	146.8	146.9	147.0	146.8	147.3	147.5	147.6	144.5	145.4	147.4	-0.2
Nighttime Passenger	149.6	150.0	150.3	150.4	151.1	151.6	151.7	147.7	149.4	150.8	-0.9
Daytime Cargo	133.6	134.9	134.4	133.8	133.9	133.6	133.4	133.8	134.9	134.3	0.9
Nighttime Cargo	144.8	144.0	143.7	143.4	142.8	142.3	142.5	142.6	142.0	141.4	-1.1
Daytime Passenger Stage 2	101.4	--	--	--	--	--	--	--	--	N/A	N/A
Daytime Passenger Stage 3	146.8	146.9	147.0	146.8	147.3	147.5	147.6	144.5	145.4	147.4	-0.2
Nighttime Passenger Stage 2	--	--	--	--	--	--	--	--	--	0.0	N/A
Nighttime Passenger Stage 3	149.6	150.0	150.3	150.4	151.1	151.6	151.7	147.7	149.4	150.8	-0.9
Daytime Cargo Stage 2	--	--	--	--	--	--	--	--	--	0.0	N/A
Daytime Cargo Stage 3	133.6	134.9	134.4	133.8	133.9	133.6	133.4	133.8	134.9	134.3	0.9
Nighttime Cargo Stage 2	110.8	--	--	--	--	--	--	--	--	0.0	N/A
Nighttime Cargo Stage 3	144.8	144.0	143.7	143.4	142.8	142.3	142.5	142.6	142.0	141.4	-1.1

Source: HMMH, 2022

Notes: CNI – cumulative noise index; EPNL - Effective Perceived Noise Level; N/A indicates information not available; dashes indicate no aircraft in that category General aviation (GA) aircraft and non-jet aircraft are not included in the calculations. Negative numbers are shown in parentheses ( ).

Table I-22 Annual Operations and Partial CNI by Airline and per Operation, 2019, 2021, and 2022

Airlines with more than 100 flights in 2022	Airline Group	Operations			Total Airline CNI (EPNdB)			Partial CNI (EPNdB) per Operation		
		2019	2020	2022	2019	2020	2022	2019	2020	2022
El Al Israel Airlines Ltd.	International	296	N/A	164	131.4	N/A	128.6	106.7	N/A	106.5
ABX Air, Inc.	Cargo	N/A	10	147	N/A	0.0	126.5	N/A	0.0	104.8
United Parcel Service, Inc.	Cargo	2,096	2,183	2,114	138.9	138.2	137.7	105.7	104.8	104.5
Federal Express Corporation	Cargo	3,775	4,892	4,722	140.3	140.2	139.9	104.5	103.3	103.1
British Airways, PLC	International	2,650	991	1,703	135.0	128.0	134.6	100.8	98.1	102.3
Kalitta Air (Cargo)	Cargo	N/A	316	349	N/A	128.8	127.3	N/A	103.8	101.9
Hawaiian Airlines	Domestic	426	380	422	132.2	129.5	128.1	105.9	103.7	101.8
Emirates	International	N/A	456	702	N/A	128.4	130.3	N/A	101.8	101.8
IBERIA, Líneas Aéreas de España, S.A.	International	859	158	696	127.1	121.0	128.2	97.7	99.1	99.8
Lufthansa German Airlines	International	1,703	867	1,446	131.3	124.3	131.3	99.0	94.9	99.7
KLM Royal Dutch Airlines	International	263	304	364	123.1	123.8	125.0	98.9	98.9	99.4
Delta Air Lines, Inc.	Domestic	42,218	28,826	46,893	144.6	144.2	145.9	98.3	99.6	99.1
Southwest Airlines Co.	Domestic	19,907	8,916	10,535	141.7	138.1	139.1	98.7	98.6	98.9
Virgin Atlantic Airways, Ltd.	International	N/A	391	670	N/A	122.9	126.9	N/A	97.0	98.7
Turk Hava Yollari A.O.	International	N/A	500	742	N/A	126.3	127.4	N/A	99.3	98.7
Compañía Panameña de Aviación S.A.	International	962	283	228	124.3	118.8	122.2	94.5	94.3	98.6

Table I-22 Annual Operations and Partial CNI by Airline and per Operation, 2019, 2021, and 2022

Airlines with more than 100 flights in 2022	Airline Group	Operations			Total Airline CNI (EPNdB)			Partial CNI (EPNdB) per Operation		
		2019	2020	2022	2019	2020	2022	2019	2020	2022
Alaska Airlines, Inc.	Domestic	5,920	2,882	4,404	137.3	134.6	134.8	99.6	100.0	98.4
Swiss International Air Lines Ltd.	International	978	328	804	130.1	123.3	127.4	100.2	98.1	98.3
Condor Flugdienst GmbH	International	N/A	N/A	104	N/A	N/A	118.5	N/A	N/A	98.3
United Air Lines, Inc.	Domestic	N/A	14,393	22,123	N/A	139.6	141.7	N/A	98.0	98.2
American Airlines, Inc.	Domestic	50,333	28,474	41,255	144.7	143.0	144.3	97.7	98.5	98.1
Spirit Airlines, Inc.	Domestic	9,838	5,689	6,717	136.5	136.0	136.4	96.6	98.5	98.1
SATA Internacional	International	809	409	648	125.3	123.3	126.1	96.2	97.2	97.9
Frontier Airlines, Inc.	Domestic	1,211	1,036	1,489	128.1	126.2	129.6	97.3	96.1	97.8
Qatar Airways	International	730	528	728	130.4	124.5	125.8	101.8	97.3	97.2
jetBlue Airways Corporation	Domestic	114,091	61,898	91,803	148.1	145.5	146.8	97.6	97.6	97.2
Aer Lingus Limited	International	1,860	655	1,910	129.5	124.2	130.0	96.8	96.0	97.2
Italia Trasporto Aereo S.p.A.	International	N/A	N/A	484	N/A	N/A	123.9	N/A	N/A	97.0
Transportes Aereos Portugueses S.A.	International	N/A	526	965	N/A	125.4	126.7	N/A	98.1	96.8
Icelandair	International	1,044	1,122	1,450	130.0	127.0	127.8	99.8	96.5	96.2
Korean Air Lines Co., Ltd.	International	367	314	366	121.1	122.1	121.8	95.5	97.1	96.2

Table I-22 Annual Operations and Partial CNI by Airline and per Operation, 2019, 2021, and 2022

Airlines with more than 100 flights in 2022	Airline Group	Operations			Total Airline CNI (EPNdB)			Partial CNI (EPNdB) per Operation		
		2019	2020	2022	2019	2020	2022	2019	2020	2022
Jazz Air Inc.	International	2,922	2,274	4,166	126.2	125.3	131.7	91.6	91.7	95.5
Societe Air France	International	856	616	961	126.5	124.5	125.0	97.2	96.6	95.2
Scandinavian Airlines of North America, Inc.	International	369	N/A	389	123.2	N/A	120.8	97.5	N/A	94.9
Fly Play Corp	International	N/A	N/A	453	N/A	N/A	121.4	N/A	N/A	94.8
Republic Airlines	Domestic	21,832	29,990	46,247	137.7	139.3	141.4	94.4	94.6	94.8
Sun Country Inc	Domestic	288	358	416	118.8	119.5	120.3	94.2	93.9	94.1
Air Canada (Signature)	International	1,908	20	625	126.2	0.0	121.9	93.4	0.0	93.9
WestJet Airlines Ltd.	International	N/A	N/A	144	N/A	N/A	115.4	N/A	N/A	93.8
SkyWest Airlines	Domestic	4,880	250	782	132.9	118.2	122.6	96.0	94.2	93.7
Allegiant Air	Domestic	7	1,063	1,154	0.0	123.6	123.9	0.0	93.3	93.3
Endeavor Air	Domestic	10,520	2,973	4,621	133.9	128.3	129.8	93.7	93.6	93.2
Envoy Airlines	Domestic	396	528	2,039	116.0	119.7	125.7	90.0	92.5	92.7
Japan Airlines Co., Ltd.	International	728	644	730	123.1	125.0	120.8	94.5	97.0	92.2
Piedmont Airlines	Domestic	3,087	1,439	2,955	126.8	122.1	125.2	91.9	90.5	90.5

Source: Massport and HMMH, 2023.
Notes: CNI – Cumulative Noise Index
N/A Not available; airline had no operations at Logan Airport in that year
Operations for some carriers differ to those in Chapter 3, *Activity Levels and Forecasting*, and Chapter 8, *Air Quality and Greenhouse Gas Emissions*, because this table only includes jet aircraft and not turboprops, and because it includes both scheduled and unscheduled air carriers.

I.3.3 Dwell and Persistence Reporting

Dwell and persistence are measured by the number of hours that a given location or area is subject to jet aircraft overflights. The PRAS Advisory Committee designated eight runway end combinations for computing the effects of dwell and persistence on the communities, as shown in **Table I-23**. As required by Massport's commitments for the Logan Airside Improvements Planning Project,[21] this *2022 ESPR* reports on noise dwell and persistence levels. Higher levels of dwell or persistence for over-water areas represent a benefit since this produces a corresponding decrease in total hours overpopulated areas. **Figure I-14** and **Figure I-15** illustrate the annual hours of dwell and persistence by runway end for 2018 through 2022, with 2010 and 2015 hours included for reference. The data accounts for the time the runway configuration was in use and does not necessarily represent operations on those runways.

The graphics indicate that areas to the north of the Airport (Orient Heights and Revere; arrivals to Runways 22L or 22R or departures from Runways 4L or 4R) as well as the peninsula immediately to the east of the Airport (Winthrop; arrivals to Runway 27 or departures from Runway 9) experience prolonged periods of overflights more often than other areas. Evaluating the analysis results against the goal of reducing excessive dwell and persistence as much as possible, the results for 2022 in both graphs show a more equitable distribution than in other recent years.

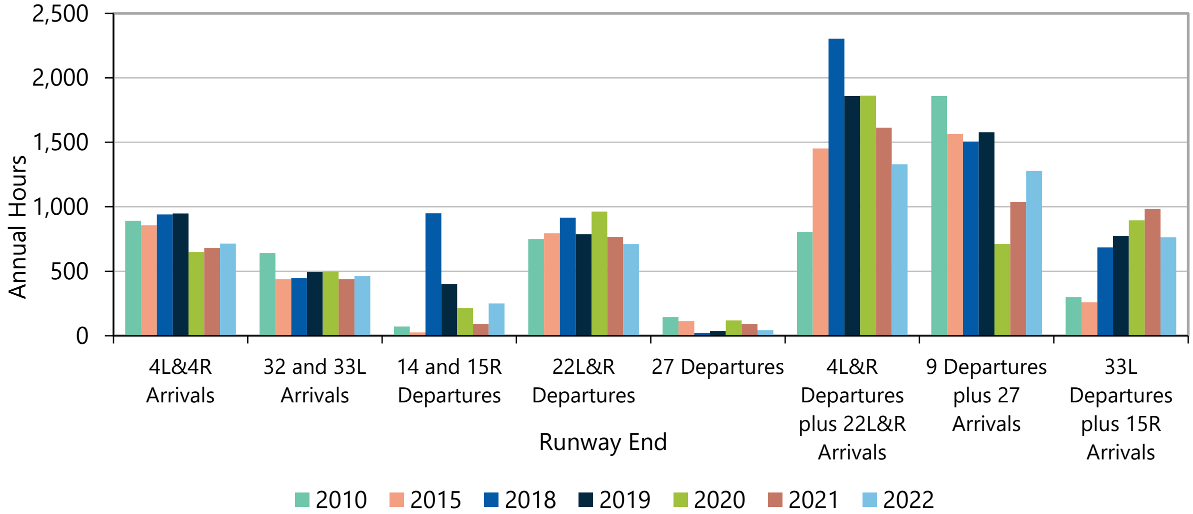
Table I-23 Representative Neighborhoods near Logan Airport Subject to Overflights

Runway	Representative Neighborhoods
4L and 4R Arrivals	South Boston (Farragut St.), Dorchester, Quincy, Milton, Weymouth, and Braintree
32 and 33L Arrivals	Boston Harbor, Hull, Cohasset, Hingham, Scituate, and other South Shore locations
14 and 15R Departures	Boston Harbor, Hull, Cohasset, Hingham, Scituate, and other South Shore locations
22L and 22R Departures	South Boston (Farragut Street), Boston Harbor, Hull, Cohasset, Hingham, Scituate, and other South Shore locations
27 Departures	South Boston (Fan Pier), Roxbury, Jamaica Plain, South End, West Roxbury, Roslindale, Brookline, Hyde Park, and other points South and West
4L/4R Departures, 22L/22R Arrivals	East Boston (Bayswater, Orient Heights), Winthrop (Court Road), Revere, and Nahant
9 Departures and 27 Arrivals	Winthrop (Point Shirley), Boston Harbor, and other points North
33L Departures and 15R Arrivals	East Boston (Eagle Hill), Chelsea, Everett, Medford, Somerville, Arlington, Cambridge, Belmont, and other points South and West

Source: Massport.

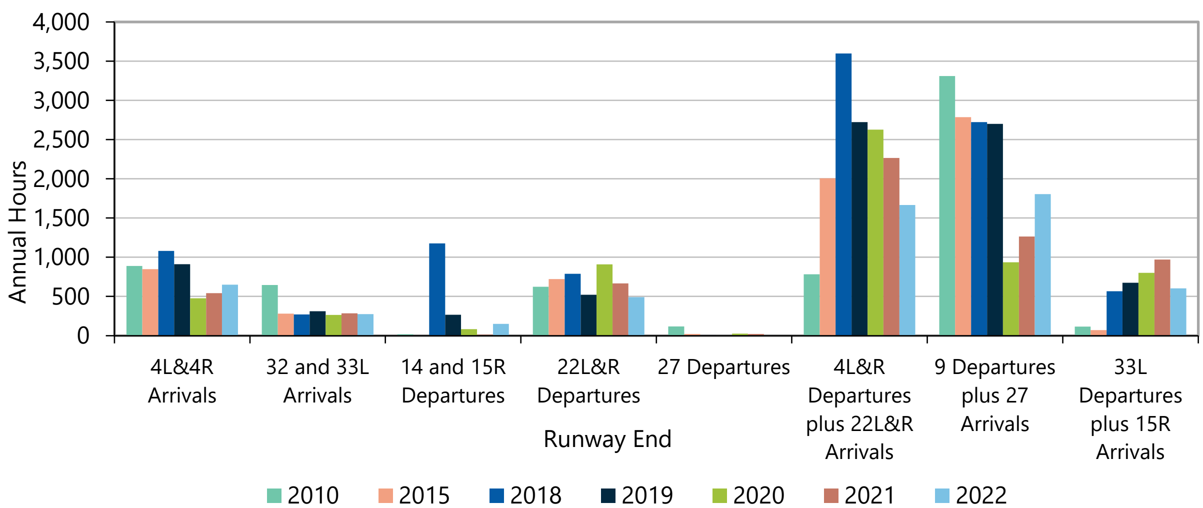
21 U.S. DoT, FAA. 2002. Logan Airside Improvements Planning Project Final Environmental Impact Statement.

Figure I-14 Comparison of Annual Hours of Dwell Exceedance by Runway End



Source: HMMH, 2023.

Figure I-15 Comparison of Annual Hours of Persistence Exceedance by Runway End



Source: HMMH, 2023.

I.3.4 Time Above (TA) and Time Above Night (TAN)

Massport annually reports the amount of time that aircraft noise is above each of three predefined threshold sound levels for each of the thirty community noise monitor locations. The measure is referred to as TA, and the threshold sound levels used in the analysis are 65, 75, and 85 dBA. Like DNL values. These times are computed using the AEDT model for an annual average 24-hour day as well as for the average nine-hour nighttime period (10:00 PM to 7:00 AM). The threshold sound levels of 65, 75, and 85 dBA correlate to levels that may cause speech interference, as discussed in The Effects of Aircraft Noise on People section of this appendix. **Table I-24** and **Table I-25** present a summary of the AEDT-calculated TA values for 2019, 2021, and 2022 at each of the monitor locations.

Table I-24 Time Above (TA) dBA Thresholds in a 24-Hour Period for Average Day

Site[1]	Distance[2] (mi)	Minutes above Threshold									Modeled DNL (dB)[3]		
		2019			2021			2022			2019	2021	2022
		85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA			
1	3.7	0.0	0.1	16.2	0.0	0.1	10.4	0.0	0.0	6.8	56.4	52.2	52.4
2	2.9	0.0	1.6	25.0	0.0	0.8	16.0	0.0	0.9	11.3	59.7	55.5	56.2
3	2.5	0.0	2.7	72.7	0.0	0.4	38.5	0.0	1.8	71.8	61.8	58.0	60.5
4	1.6	8.0	45.7	116.0	3.9	22.6	56.8	8.1	41.0	97.0	71.8	69.0	71.2
5	1.9	0.1	15.4	94.2	0.0	8.9	46.3	0.0	16.4	81.2	64.9	61.7	64.6
6	0.8	0.0	0.9	61.6	0.0	1.1	42.1	0.0	0.9	53.8	62.4	60.0	61.7
7	1.0	0.7	9.5	101.3	0.1	6.4	68.6	0.6	8.7	98.4	67.3	63.5	65.4
8	1.6	0.0	3.2	44.4	0.0	2.0	28.1	0.0	3.2	42.5	62.1	59.0	61.2
9	1.3	1.0	25.4	89.7	0.2	16.5	59.5	0.9	24.9	81.9	68.8	65.9	67.9
10	1.3	0.0	4.9	52.1	0.0	3.0	34.7	0.0	4.6	50.0	62.8	59.7	61.8
11	1.8	0.0	0.8	14.0	0.0	0.4	8.7	0.0	0.8	12.1	57.6	54.6	56.7
12	1.2	0.1	9.7	91.9	0.0	5.2	58.6	0.0	9.3	90.9	66.0	62.6	64.7
13	1.9	0.1	8.8	46.8	0.0	5.9	31.2	0.0	12.8	50.2	63.9	61.5	64.2
14	1.2	0.0	3.5	38.6	0.0	0.3	38.1	0.0	0.2	47.0	61.8	58.6	60.2
15	2.8	0.8	24.7	58.8	0.0	1.5	25.6	0.0	4.5	39.4	61.6	59.1	61.1
16	2.4	0.0	0.9	53.5	0.4	15.9	38.2	0.9	25.4	57.1	69.2	66.7	68.7
17	5.3	0.0	0.0	0.2	0.0	0.5	33.9	0.0	1.0	52.7	61.8	59.1	61.0
18	5.9	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.2	45.9	43.1	45.0
19	8.7	0.0	0.0	13.0	0.0	0.0	0.1	0.0	0.0	0.3	45.5	43.0	44.7
20	8.4	0.0	0.0	14.3	0.0	0.0	7.9	0.0	0.0	12.8	56.4	53.5	55.5
21	4.5	0.0	0.1	11.3	0.0	0.1	10.2	0.0	0.0	14.1	55.0	53.5	54.8
22	6	0.0	0.0	20.8	0.0	0.0	4.6	0.0	0.1	10.1	54.6	51.5	53.8
23	6.3	0.0	0.0	7.8	0.0	0.0	10.2	0.0	0.0	18.4	55.9	53.0	54.7
24	8.1	0.0	0.0	0.2	0.0	0.0	3.5	0.0	0.0	6.3	54.0	51.3	52.9
25	4.2	0.0	0.1	29.9	0.0	0.0	0.2	0.0	0.0	0.1	50.5	46.8	48.9
26	6	0.0	0.0	12.7	0.0	0.0	21.0	0.0	0.0	22.7	59.7	57.9	58.3
27	5.3	0.0	0.0	3.2	0.0	0.1	7.8	0.0	0.0	5.8	54.8	50.7	50.9

Table I-24 Time Above (TA) dBA Thresholds in a 24-Hour Period for Average Day

Site[1]	Distance[2] (mi)	Minutes above Threshold									Modeled DNL (dB)[3]		
		2019			2021			2022			2019	2021	2022
		85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA			
28	7.7	0.0	0.0	0.2	0.0	0.0	1.7	0.0	0.0	1.5	51.6	47.4	47.9
29	7.3	0.0	0.2	15.6	0.0	0.0	0.0	0.0	0.0	0.2	48.6	44.5	45.4
30	1.5	0.0	3.5	38.6	0.0	0.1	10.5	0.0	0.1	10.4	59.0	55.7	57.3
Average TA Value[4]		0.4	5.3	38.7	0.2	3.1	23.8	0.2	0.4	34.9	59.0	56.0	57.6

Source: HMMH, 2023

Notes: dBA - A-weighted decibel; dB – decibel; DNL - Day-Night Average Sound Level.

1 Site numbers correlate with the Figure 7-16 map and the addresses listed in Table 7-8

2 Distance from Logan Airport calculated from the Airport Reference Point.

3 2019 modeled with AEDT version 3c, 2020 with version 3d, and 2022 with version 3e.

4 Arithmetic average includes all noise monitoring sites.

Table I-25 Time Above (TA) dBA Thresholds in a Nine Hour Night Period for Average Day[3]

Site[1]	Distance[2] (mi)	Minutes above Threshold									Modeled DNL (dB)[4]		
		2019			2021			2022			2019	2021	2022
		85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA			
1	3.7	0.0	0.0	4.1	0.0	0.0	1.1	0.0	0.0	0.7	56.4	52.2	52.4
2	2.9	0.0	0.5	6.1	0.1	0.1	1.6	0.0	0.1	1.2	59.7	55.5	56.2
3	2.5	0.0	0.1	10.5	0.0	0.0	4.4	0.0	0.2	9.9	61.8	58.0	60.5
4	1.6	1.2	5.7	15.4	2.2	2.2	6.1	1.2	5.7	13.2	71.8	69.0	71.2
5	1.9	0.0	1.8	11.8	0.7	0.7	4.4	0.0	2.0	11.0	64.9	61.7	64.6
6	0.8	0.0	0.2	10.8	0.2	0.2	5.5	0.0	0.1	6.7	62.4	60.0	61.7
7	1	0.2	1.6	20.9	0.7	0.7	9.1	0.1	1.1	13.1	67.3	63.5	65.4
8	1.6	0.0	0.5	10.4	0.2	0.2	5.0	0.0	0.4	5.9	62.1	59.0	61.2
9	1.3	0.2	6.1	18.9	3.0	3.0	8.5	0.1	3.5	11.3	68.8	65.9	67.9
10	1.3	0.0	0.6	10.9	0.3	0.3	5.3	0.0	0.6	6.8	62.8	59.7	61.8
11	1.8	0.0	0.1	2.2	0.0	0.0	0.7	0.0	0.1	1.5	57.6	54.6	56.7
12	1.2	0.1	2.6	19.5	1.0	1.0	10.2	0.0	1.1	11.3	66.0	62.6	64.7
13	1.9	0.1	1.7	7.5	1.1	1.1	4.5	0.0	1.5	6.0	63.9	61.5	64.2
14	1.2	0.0	0.1	11.7	0.0	0.0	4.1	0.0	0.0	5.8	61.8	58.6	60.2
15	2.8	0.0	0.9	6.0	0.5	0.5	3.6	0.0	0.5	4.8	61.6	59.1	61.1
16	2.4	0.2	6.1	13.6	3.1	3.1	6.7	0.1	3.7	8.3	69.2	66.7	68.7
17	5.3	0.0	0.2	13.4	0.1	0.1	6.7	0.0	0.1	7.7	61.8	59.1	61.0
18	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.9	43.1	45.0
19	8.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	45.5	43.0	44.7

Table I-25 Time Above (TA) dBA Thresholds in a Nine Hour Night Period for Average Day[3]

Site[1]	Distance[2] (mi)	Minutes above Threshold									Modeled DNL (dB)[4]		
		2019			2021			2022			2019	2021	2022
		85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA	85 dBA	75 dBA	65 dBA			
20	8.4	0.0	0.0	3.9	0.0	0.0	1.9	0.0	0.0	1.9	56.4	53.5	55.5
21	4.5	0.0	0.0	2.5	0.0	0.0	1.6	0.0	0.0	1.7	55.0	53.5	54.8
22	6	0.0	0.0	2.2	0.0	0.0	1.1	0.0	0.0	1.2	54.6	51.5	53.8
23	6.3	0.0	0.0	3.0	0.0	0.0	1.9	0.0	0.0	2.7	55.9	53.0	54.7
24	8.1	0.0	0.0	1.1	0.0	0.0	0.6	0.0	0.0	0.9	54.0	51.3	52.9
25	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.5	46.8	48.9
26	6	0.0	0.0	9.3	0.0	0.0	6.3	0.0	0.0	3.2	59.7	57.9	58.3
27	5.3	0.0	0.0	3.2	0.0	0.0	0.8	0.0	0.0	0.6	54.8	50.7	50.9
28	7.7	0.0	0.0	0.9	0.0	0.0	0.2	0.0	0.0	0.2	51.6	47.4	47.9
29	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.6	44.5	45.4
30	1.5	0.0	0.0	4.0	0.0	0.0	1.3	0.0	0.0	1.3	59.0	55.7	57.3
Average TA		0.1	1.0	7.5	0.4	0.4	3.4	0.1	0.7	4.6	59.0	56.0	57.6

Source: HMMH, 2023
Notes: dBA - A-weighted decibel; dB – decibel; DNL - Day-Night Average Sound Level.
1 Site numbers correlate with the Figure 7-16 map and the addresses listed in Table 7-8.
2 Distance from Logan Airport calculated from the Airport Reference Point.
3 Nine-hour nighttime period from 10:00 PM – 7:00 AM.
4 2019 modeled with AEDT version 3c, 2020 with version 3d, and 2022 with version 3e.
5 Arithmetic average includes all noise monitoring sites.

I.4 Status of Mitigation Programs

I.4.1 Residential Sound Insulation Program

As discussed in Chapter 7, *Noise*, Massport has been working to restart its residential sound insulation program (RSIP). In 2022, no new dwelling units received sound insulation from Massport. A total of 5,467 residential buildings and 11,515 dwelling units have been sound insulated since 1986 when the program was first implemented. **Table I-26** lists the yearly progress of this mitigation effort.

Following FAA's approval of model adjustments based on the effects of terrain (discussed in the *1999 ESPR*), Massport submitted, and the New England Region of FAA approved, a new sound insulation program. The revised contour, approved for a two-year period beginning in 1999, included dwelling units in East Boston, South Boston, and Winthrop that previously had not been eligible for insulation. Massport received notice of FAA funding for $5 million. Subsequently, Massport updated its program contour, first with the *2001 EDR* contour and more recently with the Logan Airside Improvements Project approved contour. These updates allowed Massport to continue the program with yearly additional funds through 2014.

The Logan Airside Improvements Project incorporated runway use changes due to the new Runway 14-32 which opened in late November 2006. The Logan Airside Improvements Project update expanded the focus of the sound insulation program into Chelsea to satisfy the mitigation commitments made in the Airside Improvements Program Record of Decision (ROD). Massport also contacted property owners that were still eligible within the RSIP boundaries that had previously declined to participate; those owners were offered a second chance to participate in the program.

As of 2015, the FAA requires airports to use the AEDT model to establish eligibility for sound insulation; therefore, Massport has been working with the FAA to develop a Noise Exposure Map (NEM) contour (including block rounding). The FAA accepted Massport's 2020 Noise Exposure Map in December, 2021, allowing Massport to move forward with the RSIP.

Table I-26 Residential Sound Insulation Program (RSIP) Status (1986-2022)

Construction Year	Residential Buildings[1]	Dwelling Units[2]
1986	4	8
1987	43	51
1988	102	159
1989	94	133
1990	121	200
1991	175	360
1992	197	354
1993	318	654
1994	310	542
1995	372	753
1996	323	577
1997	364	808
1998	328	806
1999	330	718
2000	195	601
2001	260	278
2002	205	354
2003	230	468
2004	320	791
2005	314	471
2006	286	827
2007	160	548
2008	94	388
2009	111	287
2010	56	83
2011	62	114

Table I-26 Residential Sound Insulation Program (RSIP) Status (1986-2022)

Construction Year	Residential Buildings[1]	Dwelling Units[2]
20123	0	0
2013	45	76
2014	48	106
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0
2021	0	0
2022	0	0
Total	**5,467**	**11,515**

Source: Massport, 2022

1 Includes multiple units.

2 Individual units.

3 Federal funding was delayed in 2012.

Table I-27 provides a list of all schools that have been treated under Massport's sound insulation program. To date, Massport has provided sound insulation to 36 schools at a cost of over $8 million.

Table I-27 Schools Treated Under Massport Sound Insulation Program

Boston: 27 total	**Winthrop: 3 total**
East Boston: 13 total	Winthrop Jr. High School
East Boston High	E. B. Newton
St. Mary's Star of the Sea	A. T. Cummings (Ctr.) School
St. Dominic Savio High	**Revere: 1 total**
St. Lazarus	Beachmont School
James Otis	**Chelsea: 5 total**
Samuel Adams	Shurtleff School
Curtis Guild	Williams School
Dante Alighieri	Chelsea High School
P.J. Kennedy	St. Rose Elementary
Donald McKay	St. Stanislaus
Hugh Roe O'Donnell	**Total Schools: 36**
E Boston Central Catholic	
Manassah Bradley	
South Boston: 6 total	
St. Augustine	
Cardinal Cushing	
Patrick Gavin	
St. Bridgid's	
Oliver Hazard Perry	
Condon School	
Roxbury and Dorchester: 8 total	
Samuel Mason	
Dearborn Middle	
Ralph Waldo Emerson	
Lewis Middle	
Nathan Hale Elem.	
Phillis Wheatley Elem.	
Davis Ellis Elem.	
Henry L. Higginson	

Source: Massport, 2015.

I.4.2 Noise Complaints

Table I-28 presents a detailed list by community of the total noise complaints made in 2019, 2021 and 2022, which can be filed either on Massport's Noise Complaint Line, through a form on Massport's website, or through the PublicVue flight track portal. The Noise Complaint Line provides individuals the ability to express their concerns about aviation noise (activities) or to ask questions regarding noise at

Logan Airport. Callers[22] ask a range of questions such as "Why is this runway being used?"; "What time do the planes stop flying?"; and "Was that aircraft off-course?"

The Noise Abatement Office (NAO) staff documents noise line complaints by obtaining information from the caller about the nature of the complaint, time of the occurrence, location of caller's residence, and the activity that was disturbed. The NAO uses the collected information to determine the probable activity responsible for the complaint and writes a letter report to the complainant. The letter includes the original complaint, a response that identifies the activity responsible for the call (arrivals, departures, run-up, etc.), meteorological information at the time of the call (a major factor in aviation activities), runways in use at the time of the call, and a notice that FAA will receive a copy of the report.

In 2022, Massport received 272,943 noise complaints from 80 communities, an increase from 269,867 noise complaints from 84 communities in 2021. The number of individual complainants increased from 1,204 callers in 2021 to 1,301 callers in 2022. The increase in complaints from 2021 to 2022 was about 1 percent, with an increase in the number of individual callers of roughly 8 percent.

Recent technological advances in both Massport's noise complaint phone system and online complaint tracking system, as well as the incorporation of third-party complaint applications, have made it easier for community members to file a complaint and to receive information about particular noise events. In late 2018, Massport added the option to submit complaints through the Airnoise button[23] which has dramatically increased complaints logged in the system. In 2019, the average number of complaints per individual caller (the ratio of calls to callers) was 100.8. This ratio increased to an average 232 complaints per caller for 2020 and was an average 224 complaints per caller in 2021. In 2022, there were, on average, 210 complaints per caller.

Figure I-17 shows the call and callers data graphically. Massport's website, http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/), provides for additional general questions and answers regarding the Noise Complaint Line.

22 For clarity, the people logging the complaints are referred to here as "callers" despite most complaints arriving electronically (as opposed to by telephone calls).

23 Airnoise is a subscription service that allows the user to file an online noise complaint by clicking a button. The system finds the aircraft closest to the complainer and then files a detailed noise complaint directly with Massport. https://www.airnoise.io/

Table I-28 Noise Complaint Line Summary

Town Name	2019		2021		2022		Change in number of calls, 2021 to 2022	Change in number of calls, 2019 to 2022
	Calls	Callers	Calls	Callers	Calls	Callers		
Abington	0	0	1	1	0	0	-1	0
Allston	0	0	77	2	6	2	-71	6
Arlington	7,021	77	10,017	30	11,276	58	1,259	4,255
Ayer	0	0	49	1	0	0	-49	0
Belmont	1,132	41	1,152	32	920	47	-232	-212
Beverly	13	6	38	5	36	5	-2	23
Billerica	2	2	2	1	0	0	-2	-2
Boston	162	27	70	28	430	29	360	268
Boxford	10	4	0	0	1	1	1	-9
Braintree	126	5	2	2	1,010	5	1,008	884
Brighton	0	0	0	0	1	1	1	1
Brookline	2	2	3	2	2	2	-1	0
Burlington	0	0	1	1	0	0	-1	0
Cambridge	1,958	142	629	50	1,214	68	585	-744
Canton	5	2	1	1	4	3	3	-1
Carlisle	0	0	1	1	0	0	-1	0
Charlestown	65	14	20	10	51	19	31	-14
Chelmsford	1,931	2	1,201	3	1,093	1	-108	-838
Chelsea	1,605	47	232	15	103	35	-129	-1,502
Cohasset	975	9	732	5	571	4	-161	-404
Danvers	2	2	3	2	39	2	36	37
Dedham	2	2	2	1	0	0	-2	-2
Dorchester	28	15	37	15	19	11	-18	-9
Dover	8	1	1	1	2	2	1	-6
Duxbury	287	2	8	1	23	1	15	-264
East Boston	3,803	70	139	49	191	56	52	-3,612
East Bridgewater	0	0	1	1	0	0	-1	0
Easton	0	0	0	0	12	1	12	12
Essex	4	2	0	0	1	1	1	-3
Everett	58	23	8	5	18	12	10	-40
Framingham	8	1	13	2	28	2	15	20
Gloucester	2	2	0	0	30	1	30	28
Grafton	7	2	0	0	1	1	1	-6
Hamilton	187	11	1	1	3	3	2	-184
Hingham	15	6	66	3	6	4	-60	-9
Holbrook	1	1	4	1	1	1	-3	0

Table I-28 Noise Complaint Line Summary

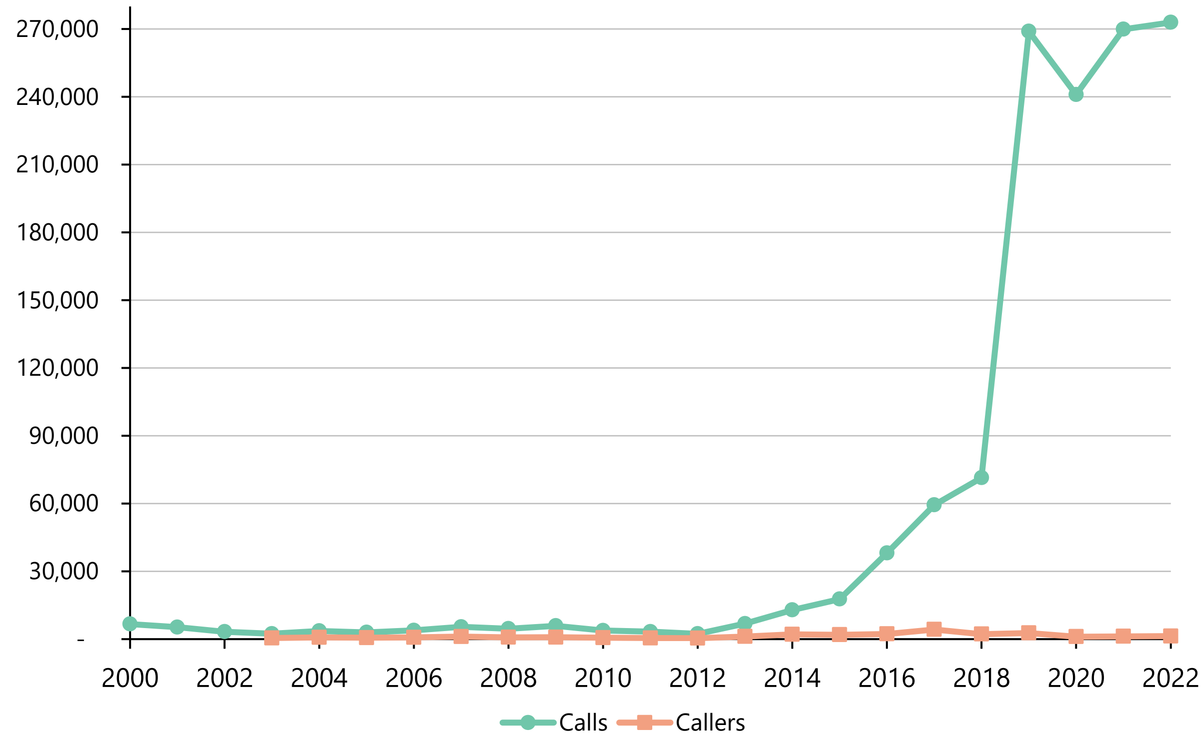
Town Name	2019		2021		2022		Change in number of calls, 2021 to 2022	Change in number of calls, 2019 to 2022
	Calls	Callers	Calls	Callers	Calls	Callers		
Holliston	0	0	1	1	0	0	-1	0
Hopkinton	0	0	0	0	1	1	1	1
Hull	1,047	97	796	31	650	33	-146	-397
Hyde Park	1,514	11	11	5	7	2	-4	-1,507
Ipswich	139	8	2	2	16	2	14	-123
Jamaica Plain	17,132	108	1,975	56	224	30	-1,751	-16,908
Lawrence	0	0	0	0	332	1	332	332
Littleton	0	0	0	0	1	1	1	1
Lynn	60	21	64	16	72	18	8	12
Malden	15,414	34	6,324	24	3,265	9	-3,059	-12,149
Marblehead	1,291	14	2,742	16	2,807	6	65	1,516
Marlborough	0	0	11	1	3	1	-8	3
Marshfield	5	4	5	3	20	6	15	15
Medford	98,021	712	102,182	210	73,912	211	-28,270	-24,109
Melbourne	0	0	2	1	0	0	-2	0
Melrose	1,967	4	1,488	3	1,008	2	-480	-959
Middleton	5	2	0	0	7	2	7	2
Millis	12	1	8	1	1	1	-7	-11
Milton	41,575	219	17,454	77	17,420	110	-34	-24,155
Nahant	73	20	219	36	134	26	-85	61
Needham	9	3	49	2	1	1	-48	-8
Newington	5	1	38	1	153	2	115	148
Newton	208	18	124	6	38	11	-86	-170
North Andover	0	0	72	1	0	0	-72	0
North Easton	0	0	0	0	19	1	19	19
Norton	2	2	3	1	3	2	0	1
Norwell	2	1	3	2	7	2	4	5
Peabody	29	10	24	4	11	8	-13	-18
Pepperell	0	0	1	1	0	0	-1	0
Princeton	0	0	1	1	0	0	-1	0
Quincy	7	6	12	5	21	8	9	14
Randolph	3	3	0	0	6	1	6	3
Reading	1	1	47	1	2	2	-45	1
Revere	291	95	12,389	29	10,200	27	-2,189	9,909
Roslindale	2,975	78	4,157	40	350	16	-3,807	-2,625
Roxbury	5,151	24	3,548	21	1,586	6	-1,962	-3,565

Table I-28 Noise Complaint Line Summary

Town Name	2019		2021		2022		Change in number of calls, 2021 to 2022	Change in number of calls, 2019 to 2022
	Calls	Callers	Calls	Callers	Calls	Callers		
Salem	82	16	176	8	326	12	150	244
Saugus	1	1	2	2	0	0	-2	-1
Scituate	946	5	0	0	4	3	4	-942
Somerville	28,070	229	26,565	108	40,372	155	13,807	12,302
South Boston	448	48	53	27	25	18	-28	-423
South End	5,309	27	359	14	3,347	7	2,988	-1,962
Stoneham	3	3	2	1	-23	0	-2	-3
Stoughton	65	1	23	1	0	0	-23	-65
Sudbury	21	2	5	2	0	0	-5	-21
Swampscott	8	6	24	15	16	7	-8	8
Tewksbury	0	0	1	1	0	0	-1	0
Topsfield	33	2	6	1	0	0	-6	-33
Upton	0	0	0	0	1	1	1	1
Wakefield	23	2	6	2	30	1	24	7
Waltham	3	3	1	1	2	2	1	-1
Watertown	3,709	28	2,710	18	3,661	28	951	-48
Wellesley	0	0	1	1	0	0	-1	0
Wenham	537	5	39	2	479	5	440	-58
West Roxbury	5,239	27	1,097	11	50	8	-1,047	-5,189
Westford	0	0	9	1	0	0	-9	0
Weston	0	0	1	1	1	1	0	1
Westwood	192	2	0	0	1	1	1	-191
Weymouth	152	7	183	4	696	6	513	544
Whitman	0	0	0	0	1	1	1	1
Winchester	9,143	15	15,329	19	8,466	9	-6,863	-677
Winthrop	8,121	201	54,166	85	84,748	103	30,582	76,627
Woburn	387	8	846	9	1,346	5	500	959
Total	268,929	2,669	269,867	1,204	272,943	1,301		

Source: Massport, HMMH 2023.
Note: Negative numbers are shown in parentheses ( ).

Figure I-17 Noise Complaint Line Calls and Callers by Year



Source: Massport and HMMH, 2023.

I.4.3 Noise and Operations Monitoring System

Massport installed its first automated monitoring system in 1973, which consisted of 12 fixed remote noise monitors (expanded to 18 in 1980), data acquisition and reporting software, a teletype-style printer, a public display panel consisting of lights on a map representing the locations of the noise monitors and analog displays indicating the real-time noise level at each noise monitor, and a separate system to monitor and record Automated Terminal Information Service (ATIS) transmissions and radio communications between the pilots and Air Traffic Control Tower staff with a time-search capability to research aircraft reported to cause community annoyance.

In 1989, Massport awarded a contract to Larson Davis Laboratories (LD) to install a fully integrated Noise and Operations Monitoring System (NOMS), which included 36 fixed remote noise monitors (30 installed to measure noise from aircraft operating at BOS and 6 for BED), 20 wind speed and direction sensors installed select noise monitoring sites (18 for BOS and two for BED), three humidity and temperature sensors installed at select noise monitoring sites (two for BOS and one for BED), two portable noise monitoring kits, hourly airport weather data, runway operating configuration data, flight track and aircraft identification data for aircraft operating at BOS, software running on servers at BOS and BED, and an independent public web portal providing 10-minute-delayed flight tracks.

In 2004, Massport began to replace the NOMS with their current hosted system, which was completed in 2008. The system is being maintained and supported by the Harris Corporation (now Passur) and consists of the following principal components:

- Noise monitoring installations at 30 locations in the BOS environs and six locations in the BED environs. All 36 installations include a Brüel & Kjaer Model 3639 permanent noise monitor equipped with B&K Model 4952 microphones and other required permanent monitor elements (e.g., wind screen, cabling, batteries, power supplies, mounting pole elements, equipment enclosures, etc.). All 36 B&K permanent noise monitors capture 1/3 octave-band levels and audio recordings for the noise events. The system downloads these monitors via dial-up telephone connections, over analog telephone lines at 31 installations, and via cellular connections at the remaining installations.
- LD Model 2140 wind velocity (speed and direction) monitors at 20 of the monitoring sites (18 BOS and 2 BED).
- LD Model 2142 humidity and temperature sensors at three of the monitoring sites (two BOS and one BED).
- Two portable noise monitoring equipment sets, including a B&K Model 2250 analyzer equipped with B&K Model 4189 microphones and UA1404 preamplifiers.
- Hourly weather data (time, sky condition, wind direction, wind speed, and wind gust speed) collected by an automated weather observation station at BOS, imported from WSI Corporation each business day via a dial-up telephone connection, using an MS-DOS command line interface.
- Runway operating configuration data manually entered into the system from ATCT records.
- The Flight operations data is provided by Harris via a real-time connection to the NextGen data link. For BED the NextGen data link is augmented with information obtained from the Harris multi-lateration flight track sensors.
- A hosted web-based software application, Symphony EnvironmentalVue, provided by Harris for use at BOS and BED offices. During nighttime hours when the BOS and BED offices are not staffed, Plane Noise accepts and processes aircraft noise complaints.
- The Harris Symphony PublicVue web portal for the community to view near real-time flight operations, replay flight operations and submit aircraft noise complaints.

Massport evaluated the current system in early 2018 and went out to bid for an upgraded NOMS in late 2018. The prior vendor (L3Harris) was selected and in 2019, L3Harris began upgrading the system, including additional reports and the option for Virtual Noise Monitors (VNM). Massport has replaced the equipment for all permanent noise monitors. The monitor at Site 1 was removed in May 2017; Massport (in collaboration with the South End community) relocated Site 1 to the Union Park Street Playground in April 2023.

I.4.4 Airbus A320 Vortex Generators

Vortex Generator Device by Port on Wing

Massport encourages operators to use idle or reduced reserve thrust during landing, and to retrofit the Airbus A319/320/321 family of aircraft with vortex generators, which reduce tonal noise on approach. A vortex generator is a small device that disrupts wind over ports on the wing. Without the device, the wind can produce a "whistling" tone during the aircraft's approach into an airport. All Airbus A319/320/321 built after 2014 already come equipped with the Vortex Generator. United Airlines announced it was retrofitting its aircraft in 2017 as they went in for service. In a press release in October 2018, jetBlue Airways (the largest air carrier operator at Logan Airport) announced plans to retrofit its older Airbus fleet with Vortex Generators. The picture above shows an example of the device. American Airlines also completed the upgrade to their fleet. These changes reflect the partnership between Massport and the airlines to reduce aircraft noise to benefit surrounding communities. As airlines retrofit aircraft and transition to the newer models of the A320 family, the number of aircraft operating at Logan Airport without the vortex generators is expected to decrease.

I.4.5 FAA and Massport RNAV Pilot Project

Over the last several years, FAA implementation of Performance-Based Navigation (PBN) procedures – including RNAV – has resulted in a concentration of flights. On October 7, 2016, FAA signed a Memorandum of Understanding (MOU) with Massport[24] to frame the process for analyzing opportunities to reduce noise through changes or amendments to PBN. Massport worked with FAA and others to develop test projects designed to help address the concentration of noise from PBN. Massport proposed several ideas for a test program with FAA to better define the implications of flight concentration on the community. This program, supported by the FAA, studied possible strategies to address neighborhood concerns. This was a first-in-the-nation project between FAA and an airport operator that includes analyzing the feasibility of changes to some RNAV approaches and departures from Logan Airport. FAA and Massport committed to: (1) analyze the feasibility; (2) measure and model the benefits and impacts of changing some RNAV approaches; and (3) test and develop an implementation plan, which will include environmental analysis and community/public outreach.

24 Massport. October 7, 2016. Massport and FAA Work to Reduce Overflight Noise. https://www.massport.com/news-room/news/massport-and-faa-work-to-reduce-overflight-noise/.

The project was structured in two phases, or “blocks”. Block 1 recommendations were those that would not result in shifting noise from one area to another, and that would not have significant operational/technical implications. A report on Block 1 recommendations was completed in December 2017. Block 2 recommendations were those that could result in noise increases in some areas or face technical barriers that would require further review. The RNAV technical team, led by MIT, released the Block 2 report released in December 2021.

I.4.5.1 Block 1

Following the completion of Block 1, the Massport CAC voted to approve and recommend implementation of the four Block 1 procedures. On December 20, 2017, Massport sent a request for FAA review and implementation of the Block 1 recommendations. Massport provided a copy of the letter in the *2017 ESPR*. Two of the recommendations have not moved forward (restricting climb speed to 220 knots due to flyability issues and modifications to Runway 22 RNAV SIDs due to airspace conflicts). The other two recommendations have progressed; the development of an RNAV visual approach to Runway 33L and the modification of the Runway 15R RNAV SID which would shift departures further away from Hull. The Runway 33L RNAV approach is similar to the jetBlue Airways RNAV visual Special to Runway 33L already in place but would be a published procedure for all airlines to use. A copy of the Massport request to FAA from April 2017 was also published in the *2017 ESPR*. Since the Block 1 recommendations were sent, FAA and Massport have further refined the procedures and presented the FAA’s recommended options to the Massport CAC in January of 2020. On November 12, 2020, Massport submitted a request to the FAA for review and implementation of two procedures at Logan Airport. These include modifying the existing RNAV SID from Runway 15R to move tracks over water, and a new over-water Required Navigational Performance (RNP)[25] approach for users with the capability to utilize this more precise PBN procedure. A copy of the Block 1 letter is included as **Figure I-18**. The FAA completed development of these procedures and published the procedures in December 2021.

I.4.5.2 Block 2

The RNAV study team completed the evaluation of the Block 2 options in June 2021. Block 2 procedures were more complex due to potential operational/technical barriers or equity issues. Procedures considered as part of Block 2 were RNAV or RNP approaches to Runway 22L and Runway 4R, continuous descent RNAV profiles, heading-based departures from Runway 22L and Runway 22R, and dispersed headings from Runway 33L and 27. The Runway 33L, Runway 22L and Runway 22R departure concepts were presented to major airline representatives and FAA in May 2020.

At the request of the Massport CAC, FAA agreed to take an initial look at the feasibility of these options by August 2020. FAA assembled a panel of stakeholders consisting of representatives from the airline industry, the FAA Air Traffic Organization (Mission Support Services, Air Traffic Services, System

25 Required Navigational Performance (RNP) procedures provide a precise flight path both laterally and vertically for aircraft on approach.

Operations, and the National Air Traffic Controllers Association), the FAA Office of Environment and Energy, and FAA Flight Standards. FAA and industry stakeholders completed their initial review of the proposed procedures and determined that none of the procedures would be recommended for further evaluation.

The RNAV study team and FAA worked to revise several of the procedures for possible implementation and developed several additional procedures. Massport presented these during a public meeting in September 2021 and to the Massport CAC for review. Massport and MIT completed the RNAV study at the end of 2021 and the Massport CAC considered each measure during its December 2021 meeting. In January 2022, the Massport CAC put forth two of the procedures for further study and implementation by FAA. The Block 2 report can is available on the MIT website.[26] On January 19, 2022, Massport submitted a request to the FAA for review and implementation of two Block 2 procedures at Logan Airport. These include modifying the existing RNAV SID from Runways 22R and 22L to enable an earlier turn to the east and adding a new over-water RNAV approach for Runway 22L. A copy of the Block 2 letter is included as **Figure I-19**. Massport continues to coordinate with the Massport CAC, the FAA, and MIT on targeted, follow-on technical questions and reviews.

In 2022, Massport completed the study. The FAA's letter sunsetting the MOU is reproduced as **Figure I-20**.

26 MIT Libraries. Block 2 Procedure Recommendations for Boston Logan Airport Community Noise Reduction. September 8, 2021. https://dspace.mit.edu/handle/1721.1/131242.

Figure I-18 Massport Request to FAA for Block 1 Recommendations

massport

Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

November 12, 2020

Colleen D'Alessandro
Regional Administrator
Federal Aviation Administration New England Region
1200 District Avenue
Burlington, MA 01803-5299

Re: Request to implement procedures at Boston Logan related to FAA\MPA MOU

Dear Ms. D'Alessandro:

Consistent with the Memorandum of Understanding (MOU) executed in September 2016 between the Federal Aviation Administration (FAA) and the Massachusetts Port Authority (Massport) related to Precision Based Navigation (PBN), I am writing to request that the FAA review and implement the following procedures at Boston Logan International Airport (Boston Logan):

- 1-D2 R15R RNAV SID Modification Final FAA Redesign. This procedure modifies the existing RNAV SID from R15R to move tracks overwater, away from populated areas.
- RNAV R33L RNP Only Option. This is a new overwater RNP approach for users with the capability to utilize this more precise PBN procedure.

These procedures were developed as part of the MOU which outlines the actions that Massport and the FAA intend to undertake in seeking reductions to overflight noise impacts of aircraft operations at Logan Airport that result from the FAA's implementation of NexGen PBN procedures including RNAV. These two procedures were originally designed by Massachusetts Institute of Technology (MIT), revised with FAA input, and approved by the Massport Community Advisory Committee (MCAC) at their quarterly meeting on November 5, 2020.

It is our hope that the FAA will be able to undertake final review and publish these procedures as expeditiously as possible.

On behalf of Massport, I want to thank the FAA for its commitment to this very important and unique study, the MIT team for their innovative technical work, and the MCAC for their constructive engagement. Please feel free to contact me directly or Flavio Leo, Director of Aviation Planning and Strategy, with any further questions.

Sincerely,

Edward C. Freni
Director of Aviation
Massachusetts Port Authority

Cc: K. Knopp (FAA), D. Carlon (MCAC), J. Hansman (MIT), L. Wieland, F. Leo, A. Coppola

Figure I-19 Massport Request to FAA for Block 2 Recommendations

massport
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January 19, 2022

Colleen D'Alessandro
Regional Administrator
Federal Aviation Administration New England Region
1200 District Avenue
Burlington, MA 01803-5299

Re: Request to implement Block 2 procedures at Boston Logan related to FAA and Massport MOU related to Precision Based Navigation (PBN)

Dear Ms. D'Alessandro:

Consistent with the Memorandum of Understanding (MOU) executed in September 2016 between the Federal Aviation Administration (FAA) and the Massachusetts Port Authority (Massport) related to Precision Based Navigation (PBN), I am writing to request that the FAA review and implement the following procedures at Boston Logan International Airport (Boston Logan):

- MIT Recommended 2-D1 (MCAC Motion 2-D1) Runway 22L/R RNAV SID. This procedure modifies the existing RNAV SID from R22L/R with speed restriction to enable an earlier turn to the east, shifting tracks north away from the Town of Hull.

- MIT Recommended 2A-1 (MCAC Motion 2A-1) new overwater RNAV approach for Runway 22L. This new approach crosses the Nahant Causeway from the east to join a 4-mile final to R22L. Consistent with the MCAC motion, Massport also requests an initial operational 12-month test. During the test, Massport will work closely with MIT and the FAA to collect appropriate data including noise complaints, weather, runway use, and radar flight tracks. We will also work with MIT to assess the feasibility to conduct aviation related noise measurements and report findings to the MCAC for review and feedback.

These procedures were developed as part of the MOU which outlines the actions that Massport and the FAA intend to undertake in seeking reductions to overflight noise impacts of aircraft operations at Logan Airport that result from the FAA's implementation of NexGen PBN procedures including RNAV. These two procedures were originally designed by Massachusetts Institute of Technology (MIT), revised with FAA input, and approved by the Massport Community Advisory Committee (MCAC) at their quarterly meeting on December 9, 2021 (see attached MCAC transmittal letter to Massport).

Figure I-20 Massport Request to FAA for Block 2 Recommendations (*continued*)

On behalf of Massport, I want to thank the FAA for its commitment to this very important and unique study, the MIT team for their innovative technical work, and the MCAC for their constructive engagement. We look forward to collaborating with you and MIT during the review and implementation process for these two procedures.

Please feel free to contact me directly or Flavio Leo, Director of Aviation Planning and Strategy, with any further questions.

Sincerely,

Edward C. Freni
Director of Aviation
Massachusetts Port Authority

Cc: K. Knopp (FAA); R. Bongiovanni (MCAC); J. Hansman (MIT); L. Wieland, A. Coppola, T. Butler, F. Leo (Massport)

Attachment

Figure I-21 FAA Letter to Massport, Sunsetting the MOU

U.S. Department of Transportation
Federal Aviation Administration

Office of the Regional Administrator
New England Region

1200 District Avenue
Burlington, MA 01803

June 27, 2022

Mr. Edward C. Freni
Director of Aviation
Massachusetts Port Authority
One Harborside Drive, Suite 2005
East Boston, MA 02128

Dear Mr. Freni:

The Memorandum of Understanding (MOU) between the Federal Aviation Administration (FAA) and the Massachusetts Port Authority (Massport), which was executed in September 2016, established a framework for cooperation between the parties to explore changes or amendments to Performance Based Navigation (PBN) procedures used by aircraft operating at Boston Logan International Airport (BOS).

Exploration and development of procedures was separated into two sequential blocks, known as Block 1 and Block 2. Block 1 publication occurred in December 2021. Block 1 changes included the approach procedure to runway 33L (BOS RNAV (RNP) X RWY 33L) and Standard Instrument Departure (SID) transitions from runway 15R (BLZZR5, BRUWN6, CELTK6, HYLND6, LBSTA7, PATSS6 and REVSS5). These procedure changes reduced impacts from aircraft noise, while maintaining the safety and efficiency benefits of PBN procedures at BOS.

Concerning Block 2, the Massachusetts Institute of Technology (MIT) report included four recommendations, two of which the Massachusetts Community Advisory Committee (MCAC)recommended for implementation—specifically, the Runway 22L/R RNAV SID and Runway 22L overwater RNAV Approach. Of the other two recommendations, one was rejected (Runway 33L departure) by the MCAC and one remains for further review by MCAC.

As part of our agency-wide focus on horizontal integration and community engagement, FAA facilitated and conducted internal and external outreach throughout the duration of the MOU. This outreach resulted in a strong partnership between the FAA, Massport, and the community. The MOU collaboration model amongst FAA, Massport, and the community was the first of its kind and was successful in developing workable solutions to community concerns. We also recognize the technical contributions of MIT and Harris Miller Miller & Hanson (HMMH) Inc. FAA continues to participate in community meetings with the leadership and members of the MCAC.

The FAA believes a positive working relationship has been developed between the parties and the community, and will continue through the consideration of the Block 2 procedures. In light of this progress, the FAA believes the purpose of the MOU has been met, and therefore pursuant to section 11 of the MOU, this letter conveys notice of termination of the MOU.

Figure I-20 FAA Letter to Massport, Sunsetting the MOU (continued)

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The sun-setting of this MOU is a major accomplishment and is possible because of the partnership and positive collaboration and coordination between the parties and the community. The FAA looks forward to continued collaboration with Massport.

We are proud to move forward from this successful accomplishment and look forward to additional meaningful collaboration towards providing the safest most efficient aerospace system in the world.

Sincerely,

COLLEEN M D'ALESSANDRO Digitally signed by COLLEEN M D'ALESSANDRO Date: 2022.06.27 12:15:42 -04'00'

Colleen M. D'Alessandro
Regional Administrator, New England Region

CC:
Lisa Wieland, Massport Chief Operating Officer
Flavio Leo, Massport Director Aviation Planning and Strategy
Gail Lattrell, FAA, Director New England Region Airports Division
Robert K. Jones, FAA, General Manager Boston District
Ryan Almasy, FAA, Director Eastern Service Center
Christopher Dorbian, FAA, Office of Environment and Energy
John Doyle, FAA, Attorney, Office of Chief Counsel

I.5 Flight Track Monitoring Report

As part of its ongoing commitment to mitigate noise at Logan Airport, Massport has undertaken evaluating the flight tracks of turbojet aircraft engaged in the implementation of established FAA noise abatement procedures. However, as is true for any airport operator, Massport has no authority to control where individual aircraft fly. That remains the responsibility of FAA, while the individual pilots are responsible for safely executing FAA's instructions. The flight procedures, which are used by the Air Traffic Control (ATC) staff at Boston Tower to achieve desired noise abatement tracks, are contained in FAA's Tower Order (BOS TWR 7040.1).

Since 2002, Massport has prepared annual reports for flight track monitoring. Prior to 2002, Massport had issued semi-annual reports, an outgrowth of the Flight Track Monitoring Program study. That study was contained in the *Generic Environmental Impact Report* filed with Massachusetts Environmental Policy Act (MEPA) in July 1996 and was the subject of two Community Working Group workshops in September and October 1996. The information for 2020 and 2021 are repeated in this report for reference. The period covered by this *2022 ESPR* is January 1, 2022 through December 31, 2022.

The purpose of the ongoing monitoring program is to identify any systematic changes in flight tracks that may occur and to reduce flight track dispersion, where appropriate.

I.5.1 FAA Air Traffic Control (ATC) Procedures

FAA Tower Order BOS TWR 7040.1 entitled "Noise Abatement" describes the series of noise abatement policies, rules, regulations, and the procedures to be followed by FAA air traffic controllers in meeting their designated responsibilities to be "a good neighbor, while meeting our operational objectives/ responsibilities to the National Airspace System." Section 7.a.3 of the Order, subtitled "Turbojet Departure Noise Abatement Procedures," states that all turbojet departures shall be issued the Standard Instrument Departure (SID) procedure appropriate for the departure runway. Logan Airport has ten published SIDs; nine area navigation (RNAV) SIDs and one conventional SID.

The conventional SID is for aircraft that are not equipped to fly RNAV procedures. The conventional SID uses terms such as "BOS 2 DME" to indicate where aircraft should turn. Here, BOS refers to an aid to navigation known as the BOSTON VORTAC, a radio beacon physically located on Logan Airport near the eastern shoreline between the ends of Runways 27 and 33L (see **Figure I-21**). DME refers to "Distance Measuring Equipment," a co-located aid to navigation that provides pilots with a cockpit display of the number of nautical miles that the aircraft is from the designated radio beacon. Thus, BOS 2 DME means an aircraft should be two nautical miles away from the BOS. Pilots are then "vectored" or assigned to fly a magnetic heading given by and at the discretion of FAA air traffic controller to maintain the safe separation of aircraft. All altitudes in feet listed below (unless otherwise noted) are in mean sea level (MSL) and indicate the aircraft altitude used both by the pilot in the cockpit and the air traffic controller on the ground.

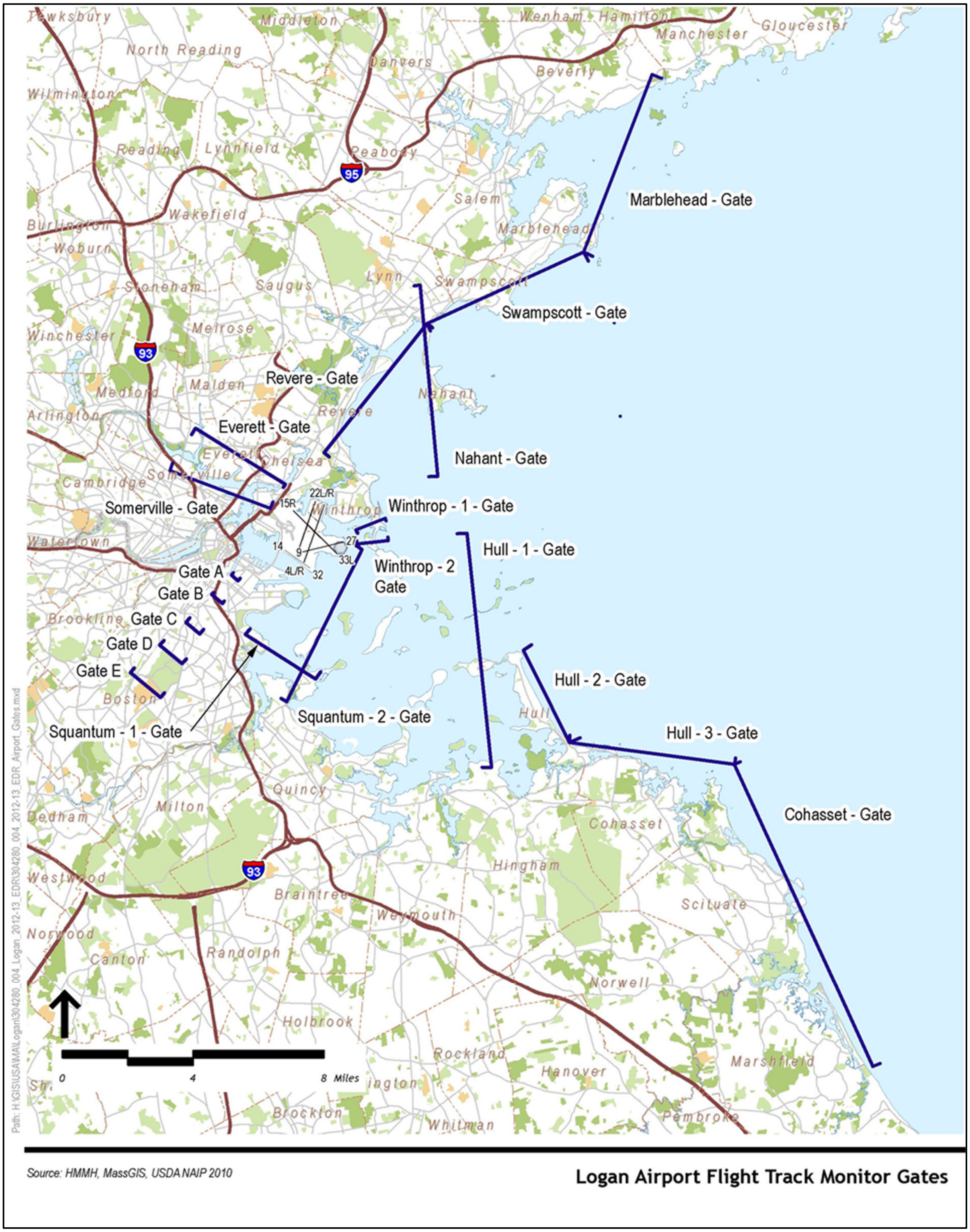
During 2010, several of the conventional-only (or radar vector) and RNAV procedures from the *Boston Logan Airport Noise Study Categorical Exclusion* (CATEX)[27] were implemented. There are eight RNAV procedures for departures from Logan Airport. These eight procedures are used by aircraft departing Runways 4R, 9, 15R, 22L, 22R, 27, and 33L (Runways 27 and 33L were added in 2014). These procedures primarily affected departures flying over the North and South shores and were designed to increase the amount of jet traffic crossing back over land above 6,000 feet to minimize noise impacts to communities. A ninth RNAV procedure, which is used by Runway 27, has been modified several times.

Figure I-21 presents the gates used in the analysis for the Flight Track Monitoring Report. These gates are virtual vertical planes, which are used in the analysis to capture the aircraft flight paths. The gates are defined using a geographic coordinate for each end of the gate along with a floor and a ceiling altitude. The analysis captures the direction of the flights (in or out of the gate). The edges of each gate in **Figure I-21** point in the direction that the aircraft is coming from. The gate analysis information is used to evaluate the performance of the flight procedures off each runway end.

The RNAV procedures are still captured by the original flight track monitoring gates. Traffic crossing over the North Shore passes through the Revere, Swampscott and Marblehead Gates and traffic passing over the South Shore passes through the Hull 2, Hull 3, and Cohasset Gates. Turbojets departing Runway 27 on the RNAV pass through the Runway 27 gates and the Runway 33L RNAV flight tracks pass between (rather than through) the Somerville and Everett gates. The following pages present the jet aircraft gate crossing data by departure runway.

27 Federal Aviation Administration (FAA) *Boston Logan Airport Noise Study Categorical Exclusion Record of Decision* (CATEX ROD), Issued October 16, 2007.

Figure I-21 Logan Airport Flight Track Monitor Gates



I.5.2 Statistical Analyses of Flight Tracks - Runway 4R

Jet aircraft departures from Runway 4R remain on runway heading until 4 DME and then turn right, crossing the Nahant causeway. They gain altitude over the water, and then, as needed, turn to cross the shoreline and proceed to their destinations. The Nahant Gate (shown in **Figure I-21**) monitors aircraft after the first turn at 4 DME. The Swampscott and Marblehead Gates monitor northbound shoreline crossings, while the Hull 2, Hull 3, and Cohasset Gates monitor southbound shoreline crossings.

Table I-29 through **Table I-31** show that Runway 4R departures for 2022 were concentrated, with more than 99 percent "over the Causeway," and the remainder split between the north and south ends of the gate.

Table I-29 Runway 4R Nahant Gate Summary for 2020

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North End of Gate	9	0.2%
Over Causeway	4,505	99.5%
South End of Gate	12	0.3%
Total	4,526	100.0%

Source: Massport, HMMH 2022

Table I-30 Runway 4R Nahant Gate Summary for 2021

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North End of Gate	16	0.3%
Over Causeway	4,566	99.3%
South End of Gate	16	0.3%
Total	4,598	100.0%

Source: Massport, HMMH 2022

Table I-31 Runway 4R Nahant Gate Summary for 2022

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North End of Gate	21	0.3%
Over Causeway	6,081	99.4%
South End of Gate	13	0.2%
Total	6,115	100.0%

Source: Massport, HMMH 2023

Table I-32 through **Table I-34** show how many of the shoreline crossings from Runway 4R were above 6,000 feet. For 2020, 97.8 percent of the flights were above 6,000 feet compared to almost 96.5 percent in 2021 and 95.5 percent in 2022. The Swampscott gate had the lowest percent of flights above 6,000 feet due to its proximity to the Nahant gate; aircraft crossing the Swampscott gate make an immediate left turn after crossing the Nahant causeway. Generally, less than 20 percent of Swampscott gate crossings are above 6,000 feet; in 2020, it was 38 percent. Crossings of the other four shoreline gates achieved altitudes over 6,000 feet over 98 percent of the time in 2022.

Table I-32 Runway 4R Shoreline Crossings Above 6,000 Feet for 2020

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	52	20	38.5%
Marblehead Gate	1,438	1,410	98.1%
Hull 2 Gate	260	259	99.6%
Hull 3 Gate	1,029	1,025	99.6%
Cohasset Gate	135	135	100.0%
Total	2,914	2,849	97.8%

Source: Massport, HMMH 2022

Table I-33 Runway 4R Shoreline Crossings Above 6,000 Feet for 2021

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	102	15	14.7%
Marblehead Gate	1,800	1,780	98.9%
Hull 2 Gate	247	247	100.0%
Hull 3 Gate	745	744	99.9%
Cohasset Gate	189	188	99.5%
Total	3,083	2,974	96.5%

Source: Massport, HMMH 2022

Table I-34 Runway 4R Shoreline Crossings Above 6,000 Feet for 2022

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	155	20	12.9%
Marblehead Gate	2,333	2,291	98.2%
Hull 2 Gate	333	333	100.0%
Hull 3 Gate	814	814	100.0%
Cohasset Gate	307	307	100.0%
Total	3,942	3,765	95.5%

Source: Massport, HMMH 2023

I.5.3 Statistical Analyses of Flight Tracks - Runway 9

Jets departing from Runway 9 maintain runway heading and gain altitude before turning back to cross the shoreline and proceed to their destinations. The Winthrop 1 and Winthrop 2 gates (shown in **Figure I-21**) monitor early turns for departures off Runway 9. The Revere, Swampscott, or Marblehead gates monitor northbound shoreline crossings, while the Hull 2, Hull 3, or Cohasset gates monitor southbound shoreline crossings.

Table I-35 through **Table I-37** show how many tracks turned prior to the BOS 2 DME. Northbound turns before BOS 2 DME pass through the Winthrop 1 Gate. Southbound traffic would pass through the Winthrop 2 Gate. In 2020 and 2021, 13 and 14 tracks crossed these gates respectively and in 2022, 25 tracks crossed these gates. The compliance rate for avoiding the early turns was 99.9 percent in 2020, 2021 and 2022.

Table I-35 Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2020

	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	8	<0.1%
Winthrop 2 Gate	5	<0.1%
Neither gate	16,543	99.9%
Total	16,556	100.0%

Source: Massport, HMMH 2022

Table I-36 Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2021

	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	8	<0.1%
Winthrop 2 Gate	6	<0.1%
Neither gate	27,038	99.9%
Total	27,052	100.0%

Source: Massport, HMMH 2022

Table I-37 Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2022

	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	13	<0.1%
Winthrop 2 Gate	12	<0.1%
Neither gate	45,310	99.9%
Total	45,335	100.0%

Source: Massport, HMMH 2023

Table I-38 through **Table I-39** indicate that over 99 percent of Runway 9 departures were above 6,000 feet when crossing the shoreline in 2020, 2021 and 2022. In 2022, approximately 69 percent of aircraft departing Runway 9 that cross back over the shoreline did so over the South Shore, as opposed to about 31 percent over the North Shore. Those percentages are close to what was observed in 2021 and recent previous years. In 2020, the split was approximately 59 percent over the south shore and 41 percent over the north shore, with significantly lower traffic levels.

Table I-38 Runway 9 Shoreline Crossings Above 6,000 Feet for 2020

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	11	9	81.8%
Swampscott Gate	307	307	100.0%
Marblehead Gate	4,296	4,291	99.9%
Hull 2 Gate	102	101	99.0%
Hull 3 Gate	1,642	1,615	98.4%
Cohasset Gate	4,778	4,773	99.9%
Total	11,136	11,096	99.6%

Source: Massport, HMMH 2021

Table I-39 Runway 9 Shoreline Crossings Above 6,000 Feet for 2021

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	40	31	77.5%
Swampscott Gate	412	376	91.3%
Marblehead Gate	5,862	5,836	99.6%
Hull 2 Gate	1,510	1,500	99.3%
Hull 3 Gate	2,427	2,370	97.7%
Cohasset Gate	8,798	8,786	99.9%
Total	19,049	18,899	99.2%

Source: Massport, HMMH 2020

Table I-40 Runway 9 Shoreline Crossings Above 6,000 Feet for 2022

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	24	11	45.8%
Swampscott Gate	773	715	92.5%
Marblehead Gate	9,451	9,413	99.6%
Hull 2 Gate	2,921	2,918	99.9%
Hull 3 Gate	5,220	5,121	98.1%
Cohasset Gate	14,971	14,959	99.9%
Total	33,360	33,137	99.3%

Source: Massport, HMMH 2023

I.5.4 Statistical Analyses of Flight Tracks - Runway 15R

After takeoff, Runway 15R departures turn left approximately 30 degrees to avoid Hull, head out over Boston Harbor, and return over the shore through the Swampscott and Marblehead Gates (shown in **Figure I-21**) to the north, or through the Hull 2, Hull 3, and Cohasset Gates to the south. Massport uses the Hull 1 Gate to monitor departures from Runways 22R and 22L as well as from Runway 15R as they make their initial turn over Boston Harbor. The initial turn and success rate in avoidance of Hull overflights is shown in **Table I-41** through **Table I-43**. The percent of tracks from Runway 15R crossing north of the Hull peninsula as they passed through the Hull 1 Gate remained above 99 percent for 2020 through 2022.

Table I-41 Runways 15R Hull 1 Gate Summary for 2020

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull	5,830	99.8%
Over Hull	13	0.2%
Total	5,843	100.0%

Source: Massport, HMMH 2022

Table I-42 Runways 15R Hull 1 Gate Summary for 2021

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull	6,378	99.7%
Over Hull	22	0.3%
Total	6,400	100.0%

Source: Massport, HMMH 2022

Table I-43 Runways 15R Hull 1 Gate Summary for 2022

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull	7,782	99.7%
Over Hull	22	0.3%
Total	7,804	100.0%

Source: Massport, HMMH 2023

Table I-44 through **Table I-46** indicate that over 99 percent of Runway 15R departures were above 6,000 feet when crossing the shoreline in 2022. The proportion of flights over 6,000 feet is usually lowest at the Hull 3 gate, due to that gate's proximity to the runway end. Very few departures from Runway 15R cross back over the Hull 2 gate, which is even closer to the runway end and requires a tight turn with rapid climb to achieve.

Table I-44 Runway 15R Shoreline Crossings Above 6,000 Feet for 2020

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	190	189	99.5%
Marblehead Gate	1,290	1,289	99.9%
Hull 2 Gate	13	13	100.0%
Hull 3 Gate	308	297	96.4%
Cohasset Gate	2,062	2,061	100.0%
Total	3,863	3,849	99.6%

Source: Massport, HMMH 2022

Table I-45 Runway 15R Shoreline Crossings Above 6,000 Feet for 2021

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	133	132	99.2%
Marblehead Gate	1,401	1,401	100.0%
Hull 2 Gate	16	16	100.0%
Hull 3 Gate	322	299	92.9%
Cohasset Gate	2,175	2,174	100.0%
Total	4,047	4,022	99.4%

Source: Massport, HMMH 2022

Table I-46 Runway 15R Shoreline Crossings Above 6,000 Feet for 2022

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	213	211	99.1%
Marblehead Gate	1,737	1,734	99.8%
Hull 2 Gate	15	14	93.3%
Hull 3 Gate	230	207	90.0%
Cohasset Gate	2,224	2,219	99.8%
Total	4,419	4,385	99.2%

Source: Massport, HMMH 2023

I.5.5 Statistical Analyses of Flight Tracks - Runways 22R and 22L

Jet aircraft departures from Runways 22R and 22L make an immediate left turn. They gain altitude over the water, and then, as needed, turn to cross the shoreline and proceed to their destinations. The Squantum 2 and Hull 1 Gates (shown in **Figure I-21**) are used to monitor the turn to 140 degrees over Boston Harbor and then passage north of Hull. The shoreline gates are used to monitor shoreline crossings, as described for Runways 4R, 9, and 15R.

Table I-47 through **Table I-52** show the dispersion of the jet departures from Runways 22R and 22L as they pass through the Squantum 2 Gate. The first segment of the 27,000-foot-wide gate is the northernmost segment and is primarily over Boston Harbor. The subsequent segments extend southward toward Quincy. The percentage of tracks passing through the first two segments of this gate, representing compliance with the noise abatement procedures, is consistently about 93 percent.

Table I-47 Runways 22R and 22L Squantum 2 Gate[1] Summary for 2020

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	790	2.6%
12,000 - 14,000 ft	26,983	90.0%
14,000 - 21,000 ft	2,173	7.2%
21,000 - 27,000 ft	28	0.1%
Total	29,974	100.0%

Source: Massport, HMMH 2021

1 The 27000-foot-wide Squantum 2 Gate is divided into four segments, identified in this table by distance from the northernmost point.

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Table I-48 Runways 22R and 22L Squantum 2 Gate[1] Summary for 2021

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	1,336	3.8%
12,000 - 14,000 ft	32,040	90.5%
14,000 - 21,000 ft	1,997	5.6%
21,000 - 27,000 ft	23	0.1%
Total	35,396	100.0%

Source: Massport, HMMH 2021

1 The 27,000-foot-wide Squantum 2 Gate is divided into four segments, identified in this table by distance from the northernmost point.

Table I-49 Runways 22R and 22L Squantum 2 Gate[1] Summary for 2022

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	3,854	6.6%
12,000 - 14,000 ft	52,589	89.5%
14,000 - 21,000 ft	2,296	3.9%
21,000 - 27,000 ft	31	0.1%
Total	58,770	100.0%

Source: Massport, HMMH 2023

1 The 27,000-foot-wide Squantum 2 Gate is divided into four segments, identified in this table by distance from the northernmost point.

Departures from Runways 22R and 22L Massport are also monitored by Hull 1 Gate as they make their initial turn over Boston Harbor. Tables I-27a, I-27b and I-27c show that the percent of tracks crossing north of the Hull peninsula as they passed through the Hull 1 Gate is consistently about 99

Table I-50 Runways 22R, and 22L Hull 1 Gate Summary for 2020

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull Peninsula	29,627	99.1%
Over Hull	280	0.9%
Total	29,907	100.0%

Source: Massport, HMMH 2022

Table I-51 Runways 22R, and 22L Hull 1 Gate Summary for 2021

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull Peninsula	34,914	98.8%
Over Hull	409	1.2%
Total	35,323	100.0%

Source: Massport, HMMH 2022

Table I-52 Runways 22R, and 22L Hull 1 Gate Summary for 2022

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull Peninsula	58,188	99.1%
Over Hull	507	0.9%
Total	58,695	100.0%

Source: Massport, HMMH 2023

Table I-53 through **Table I-55** indicate the percent of Runway 22R and 22L departures that were above 6,000 feet when crossing the shoreline. Combined compliance for all the gates was 99.7 percent or better for all three years shown. The Hull 2 gate, closest to the Airport on the south shore, had the fewest crossings and also the lowest compliance rate.

Table I-53 Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2020

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	105	105	100.0%
Swampscott Gate	1,004	994	99.0%
Marblehead Gate	6,855	6,846	99.9%
Hull 2 Gate	24	23	95.8%
Hull 3 Gate	306	306	100.0%
Cohasset Gate	10,695	10,695	100.0%
Total	18,989	18,969	99.9%

Source: Massport, HMMH 2021

Table I-54 Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2021

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	98	97	99.0%
Swampscott Gate	890	884	99.3%
Marblehead Gate	8,073	8,069	100.0%
Hull 2 Gate	25	20	80.0%
Hull 3 Gate	1,823	1,774	97.3%
Cohasset Gate	13,272	13,266	100.0%
Total	24,181	24,110	99.7%

Source: Massport, HMMH 2021

Table I-55 Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2022

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	91	90	98.9%
Swampscott Gate	1,429	1,425	99.7%
Marblehead Gate	13,290	13,285	100.0%
Hull 2 Gate	34	31	91.2%
Hull 3 Gate	3,705	3,623	97.8%
Cohasset Gate	21,732	21,720	99.9%
Total	40,281	40,174	99.7%

Source: Massport, HMMH 2023

I.5.6 Statistical Analyses of Flight Tracks - Runway 27

On September 15, 1996, FAA implemented a new departure procedure for Runway 27 called the "WYLYY RNAV" procedure. In accordance with the provisions of the ROD issued for the Runway 27 Environmental Impact Statement, Massport has been providing on-going radar flight track data and analysis to FAA with respect to the procedure.

In 2012, for the first time since 1997 when flight track monitoring began, each gate (Gates A through E) averaged over 68 percent for every month in which the Airport had all runways open and for the annual average. The percent of flight tracks through all gates (a number tracked but not required per the 1996 ROD) rounded up to 68 percent for the last two months of 2011 and continued for all of 2012. FAA had discussed these data internally and concluded that acceptable flight track dispersion had been achieved and that no subsequent action by FAA is required per the 1996 ROD requirements.[28]

Massport continues to provide information on the Runway 27 departure corridor in the subsequent annual reports. **Table I-56** presents the conformance results for the Runway 27 corridor for 2020 and **Table I-57** and **Table I-58** for 2021 and 2022 respectively. Gate A is closest to the airport, with each subsequently labeled gate further from the runway. The gates increase in width as the distance is increased along the flight path, together forming a noise abatement corridor. A consistent percentage of traffic through each gate means that flights are not entering the corridor late or exiting the corridor too early. The average percentage of tracks through the entire corridor fell considerably from over 80 percent in 2020 and 2021 to 60.2 percent in 2022. The average percent through each gate followed a similar trend and went from 94.3 percent in 2020 and 90.5 percent in 2021 to 82.0 percent in 2022.

Table I-56 Runway 27 Corridor Percent of Tracks Through Each Gate for 2020

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A	Gate B	Gate C	Gate D	Gate E	Average Percent Through Each Gate
				1,400[1]	2,200[1]	2,900[1]	4,700[1]	6,300[1]	
January	2,561	2,289	89.4%	2,330	2,506	2,540	2,556	2,539	97.4%
February	2,104	1,729	82.2%	1,796	1,873	1,895	1,892	1,871	88.7%
March	2,054	1,843	89.7%	1,892	1,998	2,026	2,029	2,015	97.0%
April	657	574	87.4%	594	627	639	646	643	95.9%
May	249	221	88.8%	225	237	239	243	242	95.3%
June	-	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-	-
August	574	474	82.6%	484	501	512	515	512	87.9%
September	294	220	74.8%	227	234	235	239	238	79.8%
October	603	540	89.6%	552	586	591	593	594	96.7%
November	993	919	92.5%	944	964	976	984	978	97.6%
December	914	802	87.7%	830	856	871	877	870	94.2%
Total	11,003	9,611	87.3%	9,874	10,382	10,524	10,574	10,502	94.3%

Source: Massport, HMMH 2022

Note: Runway 9-27 was closed from late May until mid-August in 2020 for a runway safety improvement project

28 Logan Airport Runway 27 Advisory Committee Meeting - January 23, 2012 meeting minutes.

Table I-57 Runway 27 Corridor Percent of Tracks Through Each Gate for 2021

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A	Gate B	Gate C	Gate D	Gate E	Average Percent Through Each Gate
				1,400[1]	2,200[1]	2,900[1]	4,700[1]	6,300[1]	
January	499	456	91.4%	469	477	491	495	490	97.1%
February	821	752	91.6%	772	793	811	813	807	97.3%
March	1,244	1,116	89.7%	1,163	1,190	1,216	1,224	1,216	96.6%
April	1,292	1,080	83.6%	1,099	1,148	1,161	1,168	1,166	88.9%
May	1,169	991	84.8%	1,024	1,056	1,076	1,080	1,071	90.8%
June	734	660	89.9%	678	710	725	730	720	97.1%
July	1,142	906	79.3%	949	997	1,009	1,003	980	86.5%
August	838	571	68.1%	590	598	603	605	594	71.4%
September	1,361	1,096	80.5%	1,118	1,165	1,175	1,179	1,166	85.3%
October	1,777	1,577	88.7%	1,621	1,716	1,749	1,752	1,729	96.4%
November	2,589	2,235	86.3%	2,271	2,398	2,426	2,432	2,415	92.3%
December	1,988	1,304	65.6%	1,324	1,490	1,896	1,981	1,972	87.2%
Total	15,454	12,744	82.5%	13,078	13,738	14,338	14,462	14,326	90.5%

Source: Massport, HMMH 2022

Table I-58 Runway 27 Corridor Percent of Tracks Through Each Gate for 2022

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A	Gate B	Gate C	Gate D	Gate E	Average Percent Through Each Gate
				1,400[1]	2,200[1]	2,900[1]	4,700[1]	6,300[1]	
January	2,797	1,656	59.2%	1,685	1,929	2,467	2,587	2,577	80.4%
February	1,316	726	55.2%	731	851	1,078	1,139	1,137	75.0%
March	1,939	1,220	62.9%	1,231	1,421	1,827	1,926	1,921	85.9%
April	1,568	887	56.6%	899	1,078	1,418	1,481	1,471	81.0%
May	879	565	64.3%	578	651	827	867	857	86.0%
June	630	384	61.0%	394	438	560	580	576	80.9%
July	362	252	69.6%	258	276	344	354	351	87.5%
August	4	4	100.0%	4	4	4	4	4	100.0%
September	288	195	67.7%	199	221	278	287	283	88.1%

Table I-58 Runway 27 Corridor Percent of Tracks Through Each Gate for 2022

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A	Gate B	Gate C	Gate D	Gate E	Average Percent Through Each Gate
				1,400[1]	2,200[1]	2,900[1]	4,700[1]	6,300[1]	
October	132	77	58.3%	79	97	119	127	128	83.3%
November	302	186	61.6%	189	224	289	300	298	86.1%
December	-	-	-	-	-	-	-	-	-
Total	10,217	6,152	60.2%	6,247	7,190	9,211	9,652	9,603	82.0%

Source:Massport, HMMH 2023

I.5.7 Statistical Analyses of Flight Tracks - Runway 33L

Jets departing from Runway 33L fly in a corridor along the north side of the Mystic River until 5 DME or reaching an altitude of 3,000 feet and then turn on course to their destinations. The Somerville and Everett Gates (shown in **Figure I-21**) extend from BOS 2 DME to BOS 5 DME and are used to monitor the departure procedure for Runway 33L. Early turns to the left would pass through the Somerville Gate below 3,000 feet. Early turns to the right would pass through the Everett Gate below 3,000 feet.

Table I-59 through **Table I-61** indicate that the percentage of tracks below 3,000 feet turning before BOS 5 DME increased from 1.3 percent in 2020 to 2.5 percent in 2021, then decreased to 2.0 percent in 2022. The portion of flights complying with the prescribed departure procedure in 2020 was 98.7, in 2021 was 97.5 percent, and in 2022 was 98.0 percent.

Table I-59 Runway 33L Gates — Passages Below 3,000 Feet for 2020

	Number of Tracks Through Gate	Number Above 3,000 ft	Number Below 3,000 ft	Percentage Through Gate When Below 3,000 ft
Everett Gate	91	29	62	0.3%
Somerville Gate	240	59	181	1.0%
Neither gate	18,139			
Total	18,470	88	243	1.3%

Source: Massport, HMMH 2021

Table I-60 Runway 33L Gates — Passages Below 3,000 Feet for 2021

	Number of Tracks Through Gate	Number Above 3,000 ft	Number Below 3,000 ft	Percentage Through Gate When Below 3,000 ft
Everett Gate	108	18	90	0.4%
Somerville Gate	580	85	495	2.1%
Neither gate	22,863			
Total	23,551	103	585	2.5%

Source: Massport, HMMH 2021

Table I-61 Runway 33L Gates — Passages Below 3,000 Feet for 2022

	Number of Tracks Through Gate	Number Above 3,000 ft	Number Below 3,000 ft	Percentage Through Gate When Below 3,000 ft
Everett Gate	149	50	99	0.3%
Somerville Gate	819	158	661	1.7%
Neither gate	38,055			
Total	39,023	208	760	1.9%

Source: Massport, HMMH 2023

I.6 2022 DNL Levels for Census Block Group Locations

Table I-62 reports the DNL value for each Census Block Group down to DNL 50 dB, computed with AEDT for 2022. A Census Block Group represents the outer limits of a group of US Census Blocks. The Average Block DNL provided below is the arithmetic average of the DNL calculated for the centroid of each US Census Block in that group. The DNL at centroid represents the DNL calculated at the geographic center of the Block Group.

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250203041	Boston	1283	827	50.2	50.2
250250203042	Boston	623	329	49.7	49.6
250250203051	Boston	1378	1135	49.5	49.6
250250301001	Boston	1197	785	51.3	51.2

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250301002	Boston	918	596	50.8	50.8
250250302001	Boston	825	522	50.9	50.9
250250302002	Boston	990	621	50.6	50.6
250250303011	Boston	1103	723	53.2	53.2
250250303012	Boston	282	178	52.7	52.6
250250303021	Boston	1844	1249	51.0	50.6
250250304001	Boston	599	388	51.8	51.8
250250304002	Boston	1025	658	51.3	51.4
250250304003	Boston	978	650	51.2	51.2
250250304004	Boston	1558	940	51.9	51.8
250250305001	Boston	823	458	52.5	52.2
250250305002	Boston	1067	698	52.0	51.9
250250305003	Boston	825	516	51.8	51.8
250250401001	Boston	1052	561	50.9	50.8
250250401002	Boston	1308	694	50.3	50.4
250250402001	Boston	636	297	53.1	53.1
250250402002	Boston	958	407	51.8	51.8
250250403001	Boston	774	371	52.1	52.0
250250403002	Boston	1486	666	51.1	50.9
250250403003	Boston	739	367	51.2	51.2
250250403004	Boston	699	338	51.6	51.7
250250403005	Boston	827	373	50.6	50.6
250250404011	Boston	1957	825	50.0	49.9
250250404012	Boston	965	485	49.8	49.6
250250406001	Boston	1760	1095	50.9	51.2
250250408011	Boston	1190	533	52.4	52.5
250250408012	Boston	765	266	54.8	55.2
250250408013	Boston	2081	1323	52.8	53.4
250250501011	Boston	1643	563	62.7	62.8
250250501012	Boston	1389	628	59.9	59.7
250250501013	Boston	1885	687	61.6	61.8
250250502001	Boston	2140	785	60.1	60.2

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250502002	Boston	1238	556	59.1	59.2
250250502003	Boston	788	286	63.6	63.6
250250502004	Boston	1031	367	63.8	63.7
250250503001	Boston	1475	805	56.7	56.1
250250503002	Boston	777	317	55.6	55.5
250250503003	Boston	1006	807	55.1	55.1
250250504001	Boston	603	235	56.3	56.3
250250504002	Boston	1769	876	56.8	56.9
250250505001	Boston	2174	972	58.9	59.0
250250506001	Boston	1162	487	58.2	58.2
250250506002	Boston	912	392	57.1	57.5
250250507001	Boston	1766	663	59.3	59.5
250250507002	Boston	1341	496	61.5	61.4
250250507003	Boston	1413	521	62.9	62.6
250250509011	Boston	1421	452	66.7	67.5
250250509012	Boston	1860	717	65.2	65.4
250250509013	Boston	961	335	65.3	66.5
250250510001	Boston	2134	900	63.8	63.6
250250510002	Boston	1055	483	58.5	57.4
250250510003	Boston	1128	461	63.1	62.7
250250511011	Boston	1803	670	58.8	58.0
250250511012	Boston	1831	746	56.6	56.5
250250511013	Boston	1727	636	62.3	62.9
250250511014	Boston	1099	392	60.3	57.4
250250512001	Boston	833	499	57.2	58.5
250250512002	Boston	1703	737	59.1	58.8
250250512003	Boston	918	509	57.8	57.9
250250601011	Boston	1171	551	60.3	60.3
250250601012	Boston	667	373	59.3	59.2
250250601013	Boston	1067	518	59.6	59.6
250250601014	Boston	768	438	58.8	58.5

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250602001	Boston	996	466	56.7	56.8
250250602002	Boston	1332	653	55.8	55.6
250250603011	Boston	1491	815	54.6	54.5
250250603012	Boston	810	368	54.2	54.2
250250603013	Boston	1308	646	54.8	54.6
250250604001	Boston	1139	589	53.2	53.3
250250604002	Boston	1152	596	53.3	53.5
250250604003	Boston	1014	513	53.0	53.0
250250604004	Boston	1224	693	52.5	52.4
250250604005	Boston	666	317	53.3	53.2
250250605011	Boston	886	475	55.8	55.8
250250605012	Boston	936	523	54.7	54.7
250250605013	Boston	1162	623	54.6	54.6
250250605014	Boston	840	371	57.7	57.4
250250605015	Boston	909	458	54.6	54.6
250250606011	Boston	2006	1165	55.5	55.6
250250606021	Boston	331	246	58.0	57.7
250250606031	Boston	1502	1185	59.5	60.0
250250606041	Boston	1814	1515	57.5	60.8
250250606042	Boston	989	1002	56.5	56.4
250250607001	Boston	997	333	55.4	55.4
250250607002	Boston	692	271	55.0	55.0
250250608001	Boston	733	360	53.9	53.9
250250608002	Boston	960	486	53.9	53.9
250250608003	Boston	1243	639	54.8	54.8
250250608004	Boston	1923	1051	54.2	54.3
250250610001	Boston	1170	566	53.0	53.0
250250610002	Boston	535	227	52.7	52.6
250250610003	Boston	711	308	52.5	52.5
250250611011	Boston	682	302	51.9	51.9
250250611012	Boston	2028	964	51.2	51.1

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250612011	Boston	2013	1038	53.1	53.8
250250612031	Boston	2686	1444	55.5	55.4
250250612041	Boston	937	673	56.4	56.0
250250701021	Boston	897	542	50.3	50.2
250250701022	Boston	2202	934	50.3	50.3
250250701023	Boston	588	173	50.4	50.5
250250701031	Boston	751	379	53.3	53.2
250250701041	Boston	890	600	53.6	54.1
250250701042	Boston	610	312	52.5	52.4
250250701043	Boston	1362	804	51.0	51.0
250250702011	Boston	932	372	51.1	51.1
250250702012	Boston	3058	717	50.4	50.5
250250702021	Boston	4325	2437	51.7	51.7
250250702022	Boston	1135	456	52.1	52.2
250250703012	Boston	1165	662	50.1	50.1
250250703021	Boston	806	453	50.1	50.0
250250704021	Boston	2049	1462	52.9	52.8
250250704022	Boston	1512	716	51.3	51.3
250250705011	Boston	1149	660	51.1	51.1
250250705012	Boston	1074	601	51.6	51.7
250250705021	Boston	1067	585	50.6	50.6
250250705022	Boston	2326	1259	50.4	50.4
250250706001	Boston	1161	647	49.8	49.6
250250709011	Boston	1165	568	49.6	49.5
250250709021	Boston	1211	670	50.0	49.8
250250709022	Boston	1089	583	50.2	49.9
250250711011	Boston	1540	728	51.5	52.0
250250711012	Boston	916	557	51.3	51.4
250250711013	Boston	996	639	51.6	51.5
250250711014	Boston	659	348	52.4	52.3
250250712011	Boston	1013	546	52.3	52.3

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250712012	Boston	1231	506	53.1	53.3
250250712013	Boston	192	388	52.7	52.7
250250712014	Boston	1078	459	51.6	51.7
250250801001	Boston	2125	547	52.6	52.9
250250801002	Boston	775	314	52.0	52.0
250250803001	Boston	686	290	51.9	51.8
250250803002	Boston	1550	581	51.3	51.4
250250804011	Boston	1910	680	50.8	50.9
250250815002	Boston	1364	579	49.6	49.6
250250817001	Boston	623	218	51.0	51.1
250250817002	Boston	995	475	51.1	51.1
250250817003	Boston	882	299	50.2	50.2
250250817004	Boston	950	375	50.2	50.3
250250817005	Boston	691	314	50.3	50.2
250250818001	Boston	1313	596	51.5	51.5
250250818002	Boston	1006	471	51.7	51.7
250250818003	Boston	1248	419	51.3	51.3
250250819001	Boston	1090	451	50.7	50.8
250250819002	Boston	644	278	50.3	50.5
250250819003	Boston	816	287	50.3	50.3
250250819004	Boston	1121	455	50.2	50.2
250250820001	Boston	1498	620	50.7	50.8
250250820002	Boston	747	308	50.7	50.7
250250820003	Boston	950	424	50.9	50.9
250250821001	Boston	1323	521	50.3	50.4
250250821002	Boston	1543	595	50.0	50.1
250250821003	Boston	2358	1034	50.5	50.5
250250901001	Boston	1610	674	49.5	49.4
250250902003	Boston	984	319	49.7	49.6
250250903001	Boston	1033	339	49.6	49.6
250250903002	Boston	1681	566	49.7	49.8

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250250903003	Boston	1081	391	50.4	50.4
250250904001	Boston	921	322	51.0	51.1
250250904002	Boston	1462	521	50.9	50.8
250250904003	Boston	898	274	51.4	51.5
250250904004	Boston	820	311	51.7	51.7
250250906001	Boston	1099	370	52.0	52.0
250250906002	Boston	1351	470	52.2	52.2
250250907001	Boston	1171	517	49.9	50.0
250250907002	Boston	1260	654	50.9	50.8
250250907003	Boston	1178	562	49.9	50.0
250250907004	Boston	1064	677	52.0	52.2
250250909011	Boston	1403	624	50.9	50.3
250250909012	Boston	2197	1104	52.5	53.9
250250910013	Boston	748	363	49.9	51.0
250250912001	Boston	1057	455	49.5	49.7
250250912003	Boston	720	298	49.5	49.5
250250913001	Boston	1456	532	50.5	50.5
250250913002	Boston	1170	403	51.3	51.4
250250914001	Boston	1748	675	49.7	49.8
250250914002	Boston	1138	377	50.5	50.4
250250921011	Boston	1158	480	51.0	51.0
250250921013	Boston	914	349	51.2	51.8
250251006011	Boston	1027	495	52.2	52.1
250251006012	Boston	945	382	50.5	50.3
250251006031	Boston	1483	651	56.1	56.4
250251006032	Boston	689	300	57.7	58.7
250251007001	Boston	1078	516	54.5	54.4
250251007002	Boston	1008	543	56.9	57.5
250251007003	Boston	724	296	56.0	56.3
250251007004	Boston	839	388	52.9	53.0
250251007005	Boston	683	304	52.2	52.2

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250251008002	Boston	983	407	50.2	50.0
250251008003	Boston	924	423	50.3	50.3
250251008004	Boston	1033	624	50.4	52.4
250259812022	Boston	6	1	60.9	64.0
250259816001	Boston	2	1	67.3	70.0
250235001011	Boston/Hull	1501	859	54.2	51.6
250259815021	Boston/Revere	7	4	54.9	54.1
250259813001	Boston/Winthrop	79	35	64.8	78.4
250173548002	Cambridge	1241	609	50.2	50.3
250251601021	Chelsea	798	339	58.1	58.1
250251601022	Chelsea	1613	420	58.8	59.0
250251601023	Chelsea	864	302	60.3	60.2
250251601024	Chelsea	548	159	59.6	59.7
250251601031	Chelsea	1599	430	62.2	62.2
250251601032	Chelsea	1081	285	64.1	64.2
250251601033	Chelsea	994	383	60.7	60.8
250251601034	Chelsea	972	249	63.6	64.0
250251602001	Chelsea	1393	386	61.3	61.4
250251602002	Chelsea	1063	372	62.8	62.9
250251602003	Chelsea	852	260	64.1	64.2
250251602004	Chelsea	846	325	63.3	63.5
250251603001	Chelsea	728	375	62.9	60.9
250251603002	Chelsea	2025	1093	60.6	60.1
250251604001	Chelsea	1209	418	62.4	62.7
250251604002	Chelsea	931	306	60.1	59.8
250251604003	Chelsea	890	507	56.4	56.4
250251604004	Chelsea	848	375	59.8	59.4
250251605011	Chelsea	2159	670	55.1	55.0
250251605012	Chelsea	1338	403	55.5	55.7
250251605013	Chelsea	1009	308	57.0	57.0
250251605014	Chelsea	721	395	55.9	55.8

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250251605015	Chelsea	878	322	54.6	54.7
250251605021	Chelsea	1820	602	55.1	55.0
250251605023	Chelsea	1616	499	53.7	52.8
250251605024	Chelsea	1263	523	52.6	52.6
250251605025	Chelsea	905	305	55.6	56.2
250251606011	Chelsea	296	21	53.0	53.1
250251606012	Chelsea	1101	590	51.8	51.5
250251606013	Chelsea	1784	593	52.6	52.0
250251606014	Chelsea	1150	397	52.7	52.9
250251606021	Chelsea	1415	492	52.5	52.2
250251606022	Chelsea	968	349	50.3	50.0
250251606024	Chelsea	877	291	50.3	50.1
250251606025	Chelsea	1108	430	51.1	50.9
250251706012	Chelsea/Revere	1719	641	50.7	50.9
250173424012	Everett	1398	537	57.1	57.1
250235001012	Hull	775	463	51.3	50.4
250235001013	Hull	1341	738	50.0	49.9
250235001042	Hull	929	499	49.7	47.5
250250406002	Hull	1923	924	51.0	51.1
250092051001	Lynn	1434	538	51.7	52.5
250092051002	Lynn	1275	424	52.4	52.6
250092051003	Lynn	1074	364	54.3	54.5
250092051004	Lynn	1653	576	54.1	54.5
250092051005	Lynn	692	261	54.9	55.2
250092052001	Lynn	869	424	52.8	52.8
250092052002	Lynn	805	285	55.3	55.2
250092052003	Lynn	1607	577	55.1	55.2
250092052004	Lynn	1603	496	56.0	56.1
250092052005	Lynn	1041	390	52.6	55.0
250092055001	Lynn	2391	762	52.5	51.2
250092055002	Lynn	3109	1034	56.7	56.6

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250092058001	Lynn	1124	364	52.1	52.3
250092058002	Lynn	1220	342	52.3	52.6
250092058003	Lynn	1381	508	50.8	50.5
250092059001	Lynn	1952	581	52.2	52.3
250092059002	Lynn	1398	453	51.2	51.3
250092060001	Lynn	1630	478	56.3	56.5
250092060002	Lynn	2074	685	54.9	55.2
250092061001	Lynn	1998	795	56.4	56.9
250092061002	Lynn	2201	684	57.2	57.4
250092062001	Lynn	1352	361	54.8	54.9
250092062002	Lynn	2507	811	56.5	56.9
250092062003	Lynn	2020	578	55.5	55.0
250092063001	Lynn	1220	388	51.7	51.6
250092063002	Lynn	1137	376	53.6	53.9
250092063003	Lynn	1018	325	50.7	50.2
250092063004	Lynn	839	258	52.4	52.8
250092064004	Lynn	1578	499	50.6	50.4
250092068001	Lynn	1982	719	51.3	51.2
250092068002	Lynn	2443	1062	53.3	53.2
250092069001	Lynn	1006	672	50.9	50.8
250092069003	Lynn	1809	967	50.6	50.6
250092070001	Lynn	966	614	55.2	54.3
250092070002	Lynn	1323	440	57.8	57.9
250092071001	Lynn	1581	455	55.9	56.1
250092071002	Lynn	1176	326	57.1	57.3
250092071003	Lynn	1050	338	54.5	54.6
250092072001	Lynn	1443	409	57.3	59.1
250092072002	Lynn	1560	713	57.9	58.0
250173412004	Malden	1737	736	51.7	51.8
250173396005	Medford	897	373	52.6	52.6
250173397001	Medford	654	296	54.0	54.4

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250173400003	Medford	704	304	52.7	52.7
250092106001	Peabody	1809	744	50.1	51.1
250092106002	Peabody	2615	1033	50.2	50.2
250092107002	Peabody	1062	509	49.7	49.7
250092107003	Peabody	1271	545	50.2	50.5
250092107004	Peabody	787	286	50.0	50.0
250251701013	Revere	856	317	49.5	49.7
250251704001	Revere	1398	500	50.1	48.7
250251704002	Revere	1266	544	49.9	50.1
250251705021	Revere	1122	473	59.4	59.9
250251705022	Revere	1424	937	56.3	58.4
250251705023	Revere	861	369	60.8	60.9
250251705031	Revere	1698	840	55.4	56.8
250251705041	Revere	2105	1515	56.4	56.8
250251705042	Revere	1052	323	53.3	52.7
250251706014	Revere	1172	386	50.3	50.2
250251707011	Revere	1181	575	56.0	54.7
250251707012	Revere	1521	629	60.8	62.3
250251707021	Revere	1242	383	53.6	53.2
250251707022	Revere	1867	600	55.0	54.9
250251707023	Revere	2015	625	52.0	52.0
250251707024	Revere	1282	415	53.1	53.3
250251707025	Revere	1589	640	55.7	55.4
250251708001	Revere	1974	807	64.8	63.9
250251708002	Revere	1572	582	64.4	65.8
250251708003	Revere	1184	464	62.4	64.4
250251708004	Revere	1043	455	63.3	61.1
250092047011	Salem	1014	402	51.8	53.6
250173391011	Winthrop	1286	696	52.1	52.2
250173391012	Winthrop	872	323	50.9	51.0
250173391013	Winthrop	1109	806	52.2	52.0

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250173391022	Winthrop	1314	600	51.6	51.6
250173391023	Winthrop	1435	452	50.0	50.3
250173394001	Winthrop	1098	541	50.3	50.0
250173394002	Winthrop	666	266	50.9	50.8
250173394003	Winthrop	772	382	50.5	50.6
250173394004	Winthrop	943	418	50.2	50.1
250173395001	Winthrop	2982	600	51.9	52.0
250173395002	Winthrop	1214	555	52.6	52.6
250173395003	Winthrop	677	297	51.4	51.2
250173395004	Winthrop	789	309	51.5	51.6
250173396001	Winthrop	844	388	52.9	52.8
250173396002	Winthrop	892	377	53.2	53.2
250173396003	Winthrop	1000	450	52.9	53.0
250173396004	Winthrop	843	370	52.9	53.1
250173396006	Winthrop	978	435	52.2	52.3
250173397002	Winthrop	1622	686	53.6	53.8
250173397003	Winthrop	753	354	53.8	53.8
250173397004	Winthrop	887	375	53.1	53.1
250173398021	Winthrop	1490	703	55.6	55.7
250173398022	Winthrop	680	253	53.6	53.7
250173398023	Winthrop	761	275	54.4	54.4
250173398024	Winthrop	2554	1420	54.8	55.5
250173398031	Winthrop	1043	620	56.6	56.9
250173398032	Winthrop	2340	1431	56.3	56.3
250173398041	Winthrop	695	265	56.1	56.2
250173398042	Winthrop	535	240	55.7	55.8
250173398043	Winthrop	1030	429	55.2	54.9
250173399001	Winthrop	1577	671	53.8	53.9
250173399002	Winthrop	943	382	53.7	53.7
250173399003	Winthrop	1073	459	52.6	52.6
250173399004	Winthrop	812	347	53.1	53.2

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250173399005	Winthrop	922	382	52.9	52.9
250173400001	Winthrop	1108	461	52.1	52.1
250173400002	Winthrop	778	379	52.1	52.2
250173401002	Winthrop	1589	510	49.6	49.3
250173401003	Winthrop	1535	639	51.6	51.7
250173401005	Winthrop	857	327	50.7	50.8
250173412001	Winthrop	2216	903	49.8	49.8
250173412002	Winthrop	1022	472	53.2	53.4
250173412003	Winthrop	937	369	53.0	53.1
250173412005	Winthrop	1076	392	51.0	50.9
250173414003	Winthrop	2032	723	49.6	49.7
250173414004	Winthrop	1827	634	50.3	50.2
250173414005	Winthrop	781	392	52.1	52.0
250173421011	Winthrop	1706	599	49.6	49.8
250173421012	Winthrop	1227	402	50.2	50.3
250173421014	Winthrop	1052	377	49.9	49.8
250173422011	Winthrop	1682	602	50.0	49.8
250173422012	Winthrop	1351	488	50.8	50.8
250173423011	Winthrop	1460	513	51.8	51.5
250173423012	Winthrop	1782	625	52.5	52.5
250173423021	Winthrop	2003	710	53.2	53.3
250173423022	Winthrop	805	287	54.9	54.8
250173423023	Winthrop	1740	620	53.1	53.1
250173424011	Winthrop	2148	897	56.1	56.1
250173424013	Winthrop	1058	407	53.5	53.3
250173424021	Winthrop	1387	674	57.9	58.0
250173424022	Winthrop	1413	630	56.9	56.0
250173424023	Winthrop	842	402	57.2	57.3
250173424024	Winthrop	22	9	58.8	58.5
250173425011	Winthrop	2291	843	53.3	53.3
250173425012	Winthrop	2449	991	55.9	55.7

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250173425021	Winthrop	1607	575	51.4	51.5
250173425022	Winthrop	1473	513	49.9	50.0
250173426001	Winthrop	1368	428	52.4	52.3
250173426002	Winthrop	1076	363	54.2	54.4
250173426003	Winthrop	2525	960	53.2	53.3
250173501051	Winthrop	1181	530	54.1	54.3
250173501061	Winthrop	1660	1006	53.7	53.8
250173501071	Winthrop	1355	553	51.0	51.2
250173501081	Winthrop	2655	1049	53.0	52.9
250173501082	Winthrop	1519	725	51.6	51.7
250173501091	Winthrop	2176	882	52.0	51.7
250173502011	Winthrop	602	243	49.5	49.5
250173502012	Winthrop	1328	532	49.5	49.7
250173502013	Winthrop	769	319	50.3	50.3
250173502021	Winthrop	1361	586	50.7	50.8
250173502022	Winthrop	1379	601	49.7	49.7
250173502023	Winthrop	1120	564	50.8	50.8
250173503001	Winthrop	900	429	51.1	50.7
250173503002	Winthrop	1118	528	50.6	50.7
250173503003	Winthrop	966	407	51.7	51.6
250173504001	Winthrop	1054	397	52.5	52.6
250173504002	Winthrop	1380	601	51.8	51.8
250173504003	Winthrop	1077	468	51.2	51.2
250173504004	Winthrop	1491	732	51.6	51.6
250173504005	Winthrop	899	392	52.2	52.2
250173505001	Winthrop	874	391	51.9	51.9
250173505002	Winthrop	869	395	51.7	51.8
250173506001	Winthrop	1779	9	52.2	52.2
250173506002	Winthrop	984	391	51.7	51.7
250173506003	Winthrop	743	241	51.4	51.4
250173506004	Winthrop	1282	507	52.0	52.0

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250173507011	Winthrop	1109	466	51.2	51.2
250173507012	Winthrop	1048	476	50.8	51.0
250173507013	Winthrop	843	468	51.0	51.1
250173507022	Winthrop	1298	678	50.6	50.6
250173507023	Winthrop	866	421	50.2	49.8
250173508001	Winthrop	1045	507	51.4	51.4
250173508002	Winthrop	1031	461	51.5	51.5
250173509001	Winthrop	875	408	50.8	50.9
250173509002	Winthrop	1312	581	50.2	50.3
250173509003	Winthrop	1344	718	51.0	51.1
250173510021	Winthrop	878	445	49.8	49.9
250173510022	Winthrop	1174	511	50.2	50.2
250173514031	Winthrop	674	286	50.4	50.4
250173514032	Winthrop	928	391	49.9	49.8
250173514033	Winthrop	597	317	50.0	49.9
250173514034	Winthrop	1121	434	49.9	49.8
250173514035	Winthrop	623	280	49.7	49.7
250173546011	Winthrop	5	0	49.9	50.0
250173546021	Winthrop	1742	827	49.6	49.7
250173547001	Winthrop	1428	647	49.7	49.8
250173548001	Winthrop	1082	522	50.9	50.9
250173549012	Winthrop	964	567	50.2	50.2
250173549013	Winthrop	1477	854	49.6	49.7
250173549021	Winthrop	1311	567	50.7	50.8
250173549022	Winthrop	1318	623	50.5	50.5
250173549023	Winthrop	2070	808	50.3	50.3
250173549024	Winthrop	917	445	50.4	50.4
250173550001	Winthrop	883	423	50.5	50.6
250173550002	Winthrop	1309	677	51.0	51.0
250173550003	Winthrop	937	445	50.9	51.1
250173561002	Winthrop	1482	691	50.0	50.1

Table I-62 2022 DNL Values at U.S. Census 2020 Block Groups

Census Block Group ID	Name	Population	Housing units	2022 Average Block DNL	2022 DNL at centroid
250173567011	Winthrop	1444	636	50.0	50.0
250214161011	Winthrop	1269	439	53.2	54.0
250214161013	Winthrop	275	99	52.3	52.1
250214164002	Winthrop	201	66	53.9	54.1
250214164003	Winthrop	751	272	51.9	54.4
250214164005	Winthrop	205	79	54.1	55.3
250214164006	Winthrop	473	136	53.1	56.0
250214172013	Winthrop	540	164	49.6	50.4
250214172014	Winthrop	750	406	52.0	53.2
250214173001	Winthrop	2704	1726	52.4	53.9
250214175023	Winthrop	231	104	50.2	49.8
250251801011	Winthrop	1426	628	53.3	53.4
250251801012	Winthrop	1292	738	51.7	51.1
250251801013	Winthrop	766	476	54.5	54.7
250251801014	Winthrop	2320	1004	55.0	55.1
250251802001	Winthrop	1429	526	58.8	59.1
250251802002	Winthrop	749	311	56.8	56.7
250251802003	Winthrop	695	347	58.4	58.3
250251802004	Winthrop	1453	666	60.7	61.2
250251803011	Winthrop	661	266	60.0	59.9
250251803012	Winthrop	838	369	61.0	60.8
250251803013	Winthrop	812	303	63.1	62.9
250251803014	Winthrop	858	343	61.5	61.5
250251804001	Winthrop	1016	486	57.9	56.0
250251804002	Winthrop	912	358	58.6	58.2
250251805001	Winthrop	1277	616	55.5	56.6
250251805002	Winthrop	628	266	64.8	64.3
250251805003	Winthrop	1244	663	59.8	58.5
250251805004	Winthrop	940	455	66.3	67.3

Source: HMMH, 2023.

I.7 Airline Fleet Improvements

Commercial air carrier and cargo operators are deploying the newest engine technology at Logan Airport. **Table I-63** reports the percent of an airline's fleet that is Stage 3, Stage 4 equivalent, or Stage 5 equivalent for 2019, 2020, and 2021. All the major U.S. airlines at Logan Airport are using a fleet composed of 100 percent originally manufactured Stage 3, Stage 4, or Stage 5 aircraft. The majority of air carriers at Logan Airport in 2020 and 2021 are using Stage 4 or Stage 5 equivalent aircraft. As reported in **Table 7-3**, the new FAA Stage 5 requirements were met by about 34 percent of Logan Airport jet operations for 2022.

Massport previously made terminal and airfield improvements to accommodate FAA Airplane Design Group VI aircraft, which are the largest aircraft in terms of wingspan and tail height. Use of those larger aircraft, such as the 747-800 and the A380, increased from 2017 to 2019 but dropped in 2020 and 2021 due to the pandemic. Some use of the A380 (348 operations) and a few 747-800 flights (12 operations) occurred at Logan Airport in 2022; for comparison, there were over 1,100 operations by those aircraft (combined) in 2019.

Use of new engine technology aircraft has also been increasing as seen in the A320neo family with the addition of Frontier Airline flights in 2019 and with jetBlue Airways A321neo and A220 operations. Additionally, Delta Air Lines introduced Airbus A220 flights and use of Boeing 787 models. Due to the COVID-19 pandemic, several airlines accelerated the retirement of older and louder aircraft models such as the Airbus A330-200/300, A340, and Boeing 747, 757, 767, McDonnell Douglas MD-88, Embraer 190, and the smaller Bombardier CRJ200 regional jet. Examination of the 2022 radar data reveals a collective 9- to 10-fold increase in the A320neo/A321neo aircraft and in A220 aircraft as compared to the 2019 fleet operations. Simultaneously, there was an approximate 32 percent reduction of operations by the above-named older aircraft from 2019 to 2022.

Table I-63 Percentage of Airline Operations in Stage 3, 4 or 5 Aircraft

Airlines with more than 100 flights in 2022	2019[1]	2021[1]	2022[1]	2019[2]			2021[2]			2022[2]		
				Stage 3	Stage 4	Stage 5	Stage 3	Stage 4	Stage 5	Stage 3	Stage 4	Stage 5
jetblue Airways	114,091	61,898	91,803	0%	98%	2%	0%	39%	61%	0%	44%	56%
Delta Air Lines	42,218	28,826	46,893	2%	86%	12%	0%	92%	8%	0%	72%	28%
Republic Airlines	21,832	29,990	46,247	0%	100%	0%	0%	100%	0%	0%	100%	0%
American Airlines	50,333	28,474	41,255	1%	87%	12%	0%	93%	7%	0%	58%	42%
United Airlines	27,318	14,393	22,123	0%	61%	39%	0%	76%	24%	0%	83%	17%
Southwest Airlines	19,907	8,916	10,535	0%	99%	1%	0%	95%	5%	0%	91%	9%
Spirit Airlines	9,838	5,689	6,717	0%	16%	84%	0%	3%	97%	0%	26%	74%
Federal Express	3,775	4,892	4,722	4%	96%	0%	1%	99%	0%	0%	100%	0%
Endeavor Air	10,520	2,973	4,621	0%	100%	0%	0%	100%	0%	0%	100%	0%
Alaska Airlines	5,920	2,882	4,404	0%	92%	8%	0%	83%	17%	0%	98%	1%
Jazz Air Inc.	2,922	2,274	4,166	0%	52%	48%	1%	99%	1%	0%	100%	0%
Piedmont Airlines	3,087	1,439	2,955	0%	0%	100%	0%	0%	100%	0%	2%	98%
United Parcel Service	2,096	2,183	2,114	0%	97%	3%	0%	100%	0%	0%	99%	1%
Envoy Airlines	396	528	2,039	0%	1%	99%	100%	0%	0%	0%	100%	0%
Aer Lingus	1,860	655	1,910	0%	93%	7%	0%	45%	55%	0%	68%	32%
British Airways	2,650	991	1,703	0%	23%	77%	0%	10%	90%	0%	90%	10%
Frontier Airlines, Inc.	1,211	1,036	1,489	6%	30%	64%	0%	35%	65%	0%	33%	67%
Icelandair	1,044	1,122	1,450	0%	85%	15%	0%	49%	51%	0%	49%	51%
Lufthansa	1,703	867	1,446	0%	14%	86%	0%	1%	99%	0%	28%	72%
Allegiant Air	0	1,063	1,154	N/A	N/A	N/A	0%	100%	0%	0%	100%	0%
TAP - Air Portugal	644	526	965	0%	28%	72%	0%	0%	100%	0%	98%	2%
Air France	856	616	961	0%	7%	93%	0%	2%	98%	0%	3%	97%
Swiss Air	978	328	804	0%	0%	100%	0%	3%	97%	0%	0%	100%

Table I-63 Percentage of Airline Operations in Stage 3, 4 or 5 Aircraft

Airlines with more than 100 flights in 2022	2019[1]	2021[1]	2022[1]	2019[2]			2021[2]			2022[2]		
				Stage 3	Stage 4	Stage 5	Stage 3	Stage 4	Stage 5	Stage 3	Stage 4	Stage 5
SkyWest Airlines	4,880	250	782	100%	0%	0%	0%	99%	1%	0%	100%	0%
Turkish Airlines	674	500	742	0%	0%	100%	0%	0%	100%	0%	0%	100%
Japan Airlines	728	644	730	0%	0%	100%	0%	0%	100%	0%	0%	100%
Qatar Airways	730	528	728	0%	100%	0%	0%	0%	100%	0%	2%	98%
Emirates Airlines	719	456	702	0%	57%	43%	0%	100%	0%	0%	99%	1%
Iberia Air Lines Of Spain	859	158	696	0%	59%	41%	0%	72%	28%	0%	99%	1%
Virgin Atlantic	1,361	391	670	0%	0%	100%	0%	0%	100%	0%	0%	100%
SATA International Airlines	809	409	648	0%	1%	99%	0%	0%	100%	0%	0%	100%
Air Canada	1,908	0	625	0%	100%	0%	N/A	N/A	N/A	0%	5%	95%
Italia Trasporto Aereo S.p.A.	0	0	484	N/A	N/A	N/A	N/A	N/A	N/A	0%	100%	0%
Fly Play Corp	0	0	453	N/A	N/A	N/A	N/A	N/A	N/A	0%	0%	100%
Hawaiian Airlines	426	380	422	0%	0%	100%	0%	0%	100%	0%	0%	100%
MN Airlines, LLC	288	358	416	0%	100%	0%	0%	100%	0%	0%	100%	0%
Scandinavian Airlines	369	0	389	0%	88%	12%	N/A	N/A	N/A	0%	0%	100%
Korean Air Lines Co., Ltd.	367	314	366	0%	0%	100%	0%	11%	89%	0%	51%	49%
KLM Royal Dutch Airlines	263	304	364	0%	98%	2%	0%	99%	1%	0%	98%	2%
Kalitta Air (Cargo)	0	316	349	N/A	N/A	N/A	100%	0%	0%	100%	0%	0%
Compañía Panameña de Aviación	962	283	228	0%	100%	0%	0%	100%	0%	0%	100%	0%
El Al Israel Airlines Ltd.	296	0	164	0%	97%	3%	N/A	N/A	N/A	0%	99%	1%

Table I-63 Percentage of Airline Operations in Stage 3, 4 or 5 Aircraft

Airlines with more than 100 flights in 2022	2019[1]	2021[1]	2022[1]	2019[2]			2021[2]			2022[2]		
				Stage 3	Stage 4	Stage 5	Stage 3	Stage 4	Stage 5	Stage 3	Stage 4	Stage 5
ABX Air, Inc.	0	0	147	N/A	N/A	N/A	N/A	N/A	N/A	95%	5%	0%
WestJet Airlines Ltd.	0	0	144	N/A	N/A	N/A	N/A	N/A	N/A	0%	100%	0%
Condor Flugdienst GmbH	0	0	104	N/A	N/A	N/A	N/A	N/A	N/A	0%	52%	48%

Source: Massport and HMMH, 2023.

N/A Not available.

1 Operations for some carriers differ with those in Chapter 3, *Activity Levels and Forecasting*, and Chapter 8, *Air Quality and Greenhouse Gas Emissions,* because the table only includes jet aircraft, not turboprops, and it includes both scheduled and unscheduled air carriers.

2 Original Stage 3 means originally manufactured as a certificated Stage 3 aircraft under FAR Part 36. Stage 4 equivalent or Stage 5 equivalent means the aircraft meets Stage 4 or Stage 5 requirements, even if it is not certificated as such