APPENDIX I

Noise

E

Aviation Noise

This technical appendix includes a summary of the information necessary to compute the average annual day (AAD) noise exposure associated with aircraft operations at Charlotte/Douglas International Airport (CLT) in 2016 (representing Existing Conditions).

For this aircraft noise analysis, the aircraft-related noise is described using noise contours prepared with the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT). According to the FAA, "AEDT is a software system that models aircraft performance in space and time to estimate fuel consumption, emissions, and noise from aviation-related sources. AEDT is a comprehensive tool that provides information to FAA stakeholders on each of these specific environmental impacts. AEDT facilities environmental review activities required under the National Environmental Policy Act (NEPA) by consolidating the modeling of these environmental impacts in a single tool."[1] AEDT 2d was the most current version of the AEDT at the time the noise contour development for this study were prepared.

E.1 Noise Modeling Approach

In order to understand results from a noise analysis, a foundation in the basics of sound and the specific metrics used to model it in aviation related environments is necessary. The following sections describe aircraft noise, the primary metric used to measure it, and the tools used to undergo a noise analysis.

E.1.1 General Characteristics of Aircraft Noise

Sound, when transmitted through the air and upon reaching our ears, may be perceived as desirable or unwanted. People normally refer to noise as unwanted sound. Because the response to sound is subjective, individuals have different perceptions, sensitivities, and reactions to noise. Loud sounds may bother some people, while others may be bothered by certain rhythms or frequencies of sound. Sounds that occur during sleeping hours are usually considered to be more objectionable than those that occur during waking hours and hours of activity (typically daytime).

Aircraft noise originates from both the engines and the airframe of an aircraft. Meteorological conditions affect the transmission of sound through the air. Wind speed and direction, and the temperature immediately above ground level, cause diffraction and displacement of sound waves. Humidity and temperature materially affect the transmission

1 Aviation Environmental Design Tool (AEDT), Federal Aviation Administration. https://aedt.faa.gov/

of air-to-ground sound through absorption associated with the instability and viscosity of the air.

E.1.2 Day-Night Average Sound Level (DNL) Noise Metric

Noise levels are measured using a variety of scientific metrics, but for NEPA actions at airports the use of DNL is the required metric to determine the significance threshold for noise and noise-compatible land use.[2] As a result of the 1979 *Aviation Safety and Noise Abatement Act* (ASNA), Congress required the FAA to select a single metric to standardize the evaluation of aircraft noise, and the FAA then formally adopted DNL as its primary metric for evaluating aircraft noise to ensure consistency across the country. To understand DNL, one must first understand decibels and the units in which DNL is expressed, A-weighted decibels.

Sound is a wave of alternating high and low pressure levels that travels through the air; any undesirable sound is considered noise. The decibel (dB) is a unit used to describe levels of sound. When working with values with units of dB, it is important to note that decibels are logarithmic, which means they cannot be summed together like other numbers. For example, if two sound sources each produce 100 dB, when they are operated together they will produce 103 dB, not 200 dB. Four 100 dB sources operating together double the sound energy again, resulting in a total SPL of 106 dB, and so on.

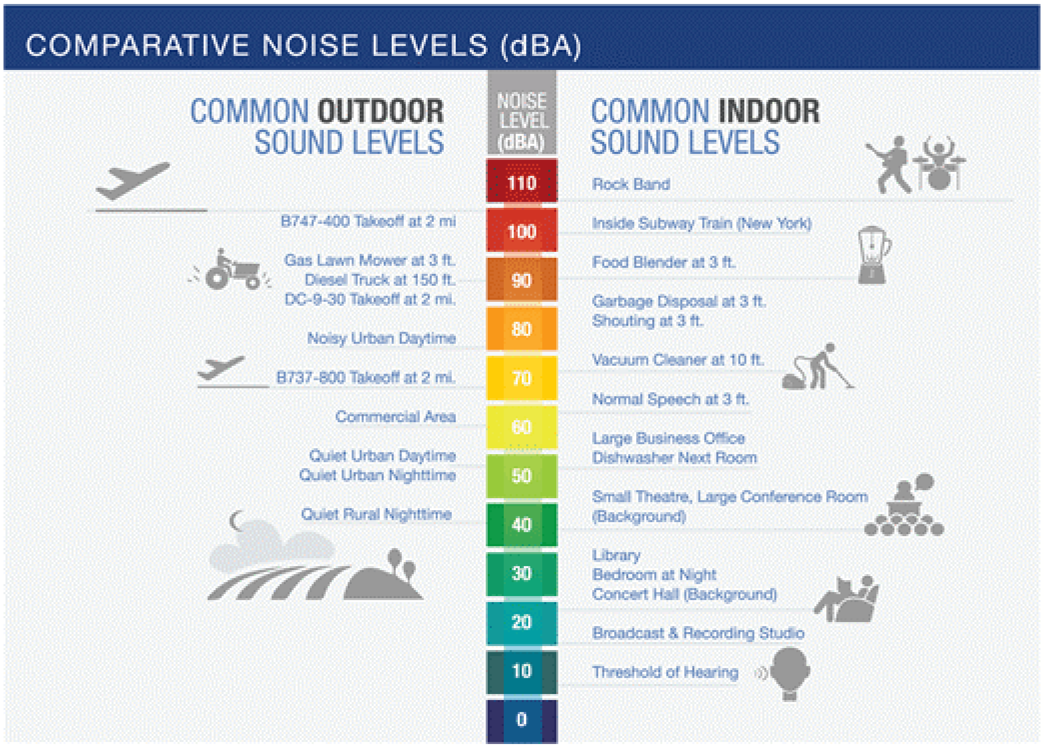
Frequency is a direct measurement of how rapidly a sound wave alternates between high and low pressures and is described in cycles per second, known as Hertz (Hz). The normal range of frequencies that a young adult can hear is 20 Hz to 20,000 Hz, while the frequency range for aircraft noise is typically 50 Hz to 5,000 Hz. Because the human ear is not sensitive to all frequencies, the magnitudes of individual aircraft noise events are typically determined through emphasis of frequencies where the human ear is most sensitive. These “frequency-weighted” magnitudes are expressed as A-weighted decibels (dBA). The DNL metric is measured in units of A-weight decibels (dBA).

When expressed in dBA, the sound has been filtered to reduce the effect of very low and very high frequency sounds, much as the human ear filters sound frequencies. Without this filtering, calculated and measured sound levels would include events that the human ear cannot hear (e.g., dog whistles and low frequency sounds, such as the groaning sounds emanating from large buildings with changes in temperature and wind). Some common sounds on the dBA scale are listed in **Figure E-1**. Generally, sounds with differences of 2 dBA or less are not perceived to be noticeably different by most listeners.

To simultaneously describe both the magnitude and duration of an individual aircraft noise event, the single-event noise metric known as Sound Exposure Level (SEL) can be used. SEL expresses what magnitude would result if the entire noise event were to occur over a duration of one second. SEL is computed from instantaneous dBA levels that occur across the duration of the noise event.

2 FAA Order 1050.1F, Page 4-8, https://www.faa.gov/documentLibrary/media/Order/FAA_Order_1050_1F.pdf

Figure E-1. Common Sounds on the A-Weighted Decibel Scale



Source: U.S. Federal Aviation Administration, Fundamentals of Noise and Sound, https://www.faa.gov/regulations_policies/policy_guidance/noise/basics/

To describe the average noise level of multiple events over a specific period of time, the cumulative noise metric known as Equivalent Continuous Sound Level (L_{eq}) can be used. To produce an L_{eq} value, all noise energy occurring during a specified period of time is averaged. L_{eq} can be measured for any time period, but typical L_{eq} time periods are 15 minutes, 1 hour, or 24 hours in length.

DNL is an Equivalent Continuous Sound Level representing a 24-hour period with a noise penalty added it during a nighttime period. DNL includes the cumulative effects of a number of sound events rather than a single event. It also accounts for increased sensitivity to noise during relaxation and sleeping hours due to the nighttime noise penalty. In the calculation of DNL, for each hour during the nighttime period (10:00 PM to 6:59:59 AM), the sound levels are increased by a 10 decibel-weighting penalty (equivalent to a 10-fold increase in aircraft operations) before the 24-hour value is computed. Since the FAA was adopted DNL as their standard noise metric, the Department of Housing and Urban Development, the Veterans Administration, the Department of Defense, the United States Coast Guard, and the Federal Transit Administration have also adopted DNL for measuring cumulative noise exposure.

E.1.3 Noise Modeling Methodology Overview

The methodology for analyzing noise from most transportation or community noise sources, including aircrafts, follows a generally accepted process that includes the application of a computer model to estimate noise levels and compare them to those for baseline conditions and future alternatives. The aircraft noise modeling analysis methodology outlined in the FAA Order 1050.1F (Environmental Impacts: Policies and Procedures) and the FAA's 1050.1F Desk Reference were followed, where applicable.

In practice, one can either use noise monitors to measure the actual noise around an airport, or the noise can be simulated or modeled using a computer program. Noise monitoring systems provide noise levels at specific points and for specific aircraft events and can be helpful when looking at trends at one particular location, but noise monitoring has several drawbacks. These include the number of monitors that would be required to provide appropriate coverage of the airport environment, the fact that noise monitors cannot isolate aircraft noise from other noise sources, and the fact that noise monitoring cannot be used for alternative operational scenarios such as potential future conditions. Analytical noise models overcome these limitations and provide mathematical predictions of aircraft noise levels within communities. Therefore, the FAA requires noise exposure based on modeled rather than measured data for its evaluations of changes in aircraft operating conditions or operating scenarios at an airport (FAA Order 1050.1F, Appendix A, Section 14, Paragraph 14.2b).

To ensure a consistent approach to aircraft noise analyses, the FAA developed the AEDT, which is a planning tool designed to compare the relative environmental impacts of aviation operational scenarios. AEDT allows for the calculation of DNL values at thousands of locations around an airport and is regularly updated for both aircraft noise characteristics and computational algorithms. AEDT is the FAA-approved tool for quantifying potential aircraft noise exposure from future planning efforts. The discussion below provides an overview of the AEDT, which is a planning tool designed to compare the relative effect of one set of theoretical conditions against those of another. Although differences between measured and modeled noise levels can be expected, the relative variances between the two are expected to remain consistent over a series of modeled scenarios, regardless of any potential inconsistencies between measured and modeled noise levels.

AEDT Model Overview

The AEDT is the FAA-approved, industry-accepted, state-of-the-art tool for determining the total effect of aircraft noise exposure in the vicinity of an airport. The AEDT has been the FAA's required model for estimating aircraft noise exposure in the vicinity of airports for NEPA studies since May of 2015. Regulatory requirements for AEDT use in relation to NEPA actions are given in FAA Order 1050.1F, *Policies and Procedures for Considering Environmental Impacts*; and expanded upon in the FAA's 1050.1F Desk Reference. The following sections describe the model and the inputs required for analyzing aircraft noise.

The AEDT uses runway and flight track information, aircraft operation levels distributed by time of day, aircraft fleet mix, and aircraft performance characteristics as inputs. The AEDT calculates noise exposure levels at a series of "noise grids," and produces noise exposure contours based on the grid results. The number of point within these "noise grids" is set by the user and should be considered on any AEDT run. As you add more points to your grid, the distance between the points gets smaller and smaller so the precision of the resulting noise contour is increased but increasing points results in longer run times. These noise exposure contours are also used for land use compatibility maps. The program includes a built-in Geographic Information System (GIS) platform, tools for comparing contours, and utilities that facilitate easy export to other GIS software suites. The model can also calculate predicted noise at specific sites such as hospitals, schools, or other noise-sensitive locations. For these discrete locations, the AEDT has the capability to report noise exposure levels at the specific location.

The most current version of the AEDT when this analysis was initiated was Version 2d. The FAA has made detailed information available related to the updates to AEDT 2d via release notes located on its website: http://aedt.faa.gov.

AEDT Input Data and Assumptions

In order for the AEDT to generate aircraft DNL contours, the following inputs to the model are required:

- A physical description of the airport layout, including location, length and orientation of all runways, and airport elevation;
- The AAD aircraft fleet mix;
- The number of daytime flight operations (7:00 AM to 9:59:59 PM);
- The number of nighttime flight operations (10:00 PM to 6:59:59 AM);
- Stage Length Information (a proxy for aircraft weight, typically input by specifying aircraft flight distance);
- Runway utilization rates; and
- Aircraft flight tracks, and flight track utilization rates.

Each of these input factors is discussed below, along with the AAD concept.

Aircraft Fleet Mix

Fleet mix defines the various types of aircraft using an airport and includes specific data needed for noise modeling, such as engine type, noise levels, departure stage length, and aircraft performance characteristics. The AEDT aircraft database contains actual noise and performance data for approximately 5,000 combinations of airframe and engine type. This database includes information for most, but not all, aircraft types that typically use commercial service airports.

Daytime and Nighttime Operations

For aircraft DNL calculations, AAD aircraft operations are used in the AEDT. The number of annual operations by each AEDT aircraft type is divided by 365 to arrive at the AAD level. This representation of airport activity does not reflect any particular day but gives an accurate picture of operations throughout the year. As noted in Section E.2.2, the DNL metric weights nighttime noise by an additional 10 dB in comparison with daytime noise. Therefore, daytime and nighttime AAD operations are entered separately into the AEDT.

Stage Length

Stage length (unrelated to "stage" classifications of aircraft for noise characteristics in 14 CFR Part 36) refers to the non-stop distance that an aircraft travels after departing from an airport. The stage length determines the gross takeoff weight assigned to each aircraft type in the AEDT. The aircraft weight serves as the basis for determining the appropriate departure climb altitude and thrust profiles used for noise modeling purposes. Aircraft noise characteristics vary depending on altitude and thrust. For example, a fully loaded aircraft departing on a long flight would probably weigh more than the same aircraft departing on a shorter flight due to a higher fuel load. The heavier aircraft climbs at a slower rate than the lighter aircraft. The heavier aircraft may also require use of higher takeoff thrust levels for a longer period of time. Thrust levels and distances from the ground are two important factors related to noise levels heard by residents. The more power applied to the engines, the louder the noise is from the source. The closer the aircraft is to the ground, the shorter the distance there is for attenuation. AEDT provides multiple stage lengths for larger aircraft departures. Most small aircraft only have one departure stage length profile included in the AEDT, while most commercial jet aircraft have several stage length profiles. Most arrivals, regardless of aircraft type, have one single approach stage length, because of similarities expected in the final approach profile (e.g., most aircraft follow a three-degree glide slope).

Runway Utilization Rates

In the AEDT, runways are defined by runway end in terms of latitude and longitude coordinates as well as elevation. A runway may include a displaced take-off or landing threshold. The portions of the runway outside of the thresholds are defined to be unavailable for that type of operation for safety or noise reasons (e.g., obstruction clearance). Displaced thresholds are identified in the AEDT, which uses the input to determine actual start-of-take-off or touchdown points along the runway.

Runway use for departures or arrivals is typically a function of prevailing wind and weather; lengths and widths of the runways; runway instrumentation; and effects of other airports or air traffic facilities in the area. Runway use may also be influenced by the direction of flight of an arriving or departing aircraft; the aircraft parking position; and/or periodic closures of runways and taxiways. The runway use information is determined through a review of aircraft operations data and is entered into the AEDT by the AEDT user.

Aircraft Flight Tracks and Flight Track Utilization Rates

Flight tracks depict the paths of aircraft over the ground for aircraft arrival, departure, closed-pattern (touch-and-go), and overflight operations as relevant to the airport of study. In order to calculate the noise exposure, it is necessary to identify the predominant arrival, departure and pattern flight tracks for each runway end, and the number of aircraft that used or will use each runway end and flight track. The use of individual flight tracks is dependent on a variety of factors such as standard procedures, the aircraft's origin or destination, aircraft performance, and weather conditions.

Flight tracks are defined to represent the typical paths of the large majority of aircraft located throughout the study area. When using AEDT, these flight tracks are specified to capture the complexity of the actual flight patterns by representing the center of a specific flow of traffic, known as a backbone, and dispersed tracks (known as sub-tracks) linked to the backbone track to account for the variation of individual aircraft flight paths within the traffic flow. Flight tracks are defined in AEDT before aircraft operations are entered. The number of operations is entered for each aircraft type, runway end, and flight track for an AAD condition.

E.2 2016 Existing Conditions Noise Analysis

The following sections describe the noise modeling inputs for the 2016 Existing Conditions scenario.

E.2.1 Aircraft Fleet Mix and Flight Operations

Annual operations by aircraft category for the 2017 Existing Conditions scenario are summarized in **Table E-1** and **Table E-2**. Table E-2 presents the number of AAD operations by operation type and AEDT aircraft type for the 2016 Existing Conditions scenario. The annual operation counts and the AEDT fleet mix are based on the 2016 AAD flight schedule prepared in the CLT EIS Forecast Technical Memorandum (April 2018). This flight schedule was the basis for developing all operational parameters for the Existing scenario except for the flight tracks, which will be discussed below.

The preparation of the forecast began with a 2016 AAD flight schedule, which was the basis for developing runway usage, stage lengths, and fleet mix. A weekday that fell close to the average for both daily seats and operations was selected to be the initial flight schedule data source. Using professional judgement, the AAD flight schedule was scrubbed to ensure that arrivals and departures could be matched. Load factors by market were applied to the matched flight schedule to calculate daily and peak hour passengers. These daily and peak hour passengers and operations were used to set the control totals, allowing the AAD flight schedule to be annualized. Cargo, air taxi, general aviation, and military were calculated similarly.

Table E-1 2016 Existing Conditions – Numbers of Operations by Aircraft Category

Aircraft Category	Numbers of Operations
Air Carrier	493,222
Cargo	4,344
General Aviation	36,797
Military	2,685
Annual Total	537,048
AAD Operations	1,471

Source: CLT EIS Forecast Technical Memorandum (April 2018); VHB/InterVISTAS/ESA, 2019.

Table E-2 Aircraft Fleet Mix – 2016 Existing Conditions

AEDT Airframe	AEDT Engine Type	AEDT Engine Modification Code	Arrivals	Departures
Airbus A300F4-600 Series	1PW048	NONE	1,094.77	1,060.29
Airbus A319-100 Series	3CM028	NONE	44,860.01	42,299.04
Airbus A320-200 Series	1IA003	NONE	17,508.93	16,057.06
Airbus A321-100 Series	3IA008	NONE	36,836.43	33,987.76
Airbus A330-200 Series	2RR023	NONE	730.00	711.05
Airbus A330-300 Series	4PW067	NONE	1,460.00	1,425.26
Boeing 717-200 Series	4BR004	NONE	1,825.00	1,825.00
Boeing 737-300 Series	1CM004	NONE	730.00	730.00
Boeing 737-700 with winglets	8CM066	SACTIP	1,825.00	1,810.98
Boeing 737-800 Series	4CM042	NONE	6,205.00	5,328.54
Boeing 737-900 Series	4CM043	NONE	365.00	693.77
Boeing 757-200 Series	5RR039	NONE	1,825.00	1,523.18
Boeing 767-200 Series Freighter	1GE012	NONE	365.00	365.00
Boeing DC-10-10 Series	1GE001	NONE	730.00	729.27
Boeing MD-88	4PW071	NONE	3,650.00	3,637.34
Bombardier Challenger 300	8HN001	NONE	1,825.00	1,714.09
Bombardier Challenger 600	5GE084	NONE	0.00	347.51
Bombardier CRJ-200	5GE084	NONE	31,366.39	29,494.50
Bombardier CRJ-700-LR	5GE083	NONE	15,680.70	15,281.95
Bombardier CRJ-900-ER	6GE092	NONE	57,670.00	53,272.47
Bombardier Learjet 31	1AS001	NONE	730.00	0.00
Bombardier Learjet 45	1AS001	NONE	1,095.00	704.24
Bombardier Learjet 60	7PW077	NONE	1,095.00	1,054.40
Cessna 172 Skyhawk	IO360	NONE	730.00	730.00
Cessna 525A CitationJet	BIZLIGHTJET_F	NONE	365.00	323.73
Cessna 560 Citation V	1PW037	NONE	365.00	330.74
Cessna 560 Citation XLS	BIZMEDIUMJET_F	NONE	1,095.00	1,348.75
Cessna 750 Citation X	6AL021	NONE	730.00	332.31
Cirrus SR22	TIO540	NONE	730.00	1,027.26
CX 680 SOVEREIGN	BIZLIGHTJET_F	NONE	730.00	0.00
Dassault Falcon 2000	7PW080	NONE	365.00	340.81
Dassault Falcon 900-EX	TFE731	NONE	365.00	339.45
DeHavilland DHC-8-300	PW123	NONE	13,866.76	12,622.40

Table E-2 Aircraft Fleet Mix – 2016 Existing Conditions (Continued)

AEDT Airframe	*AEDT Engine Type*	*AEDT Engine Modification Code*	*Arrivals*	*Departures*
Dornier 328 Jet	7PW078	NONE	365.00	365.00
EADS Socata TBM-700	PT6A60	NONE	365.00	365.00
Embraer 505	BIZLIGHTJET_F	NONE	364.98	338.48
Embraer EMB120 Brasilia	PW118	NONE	1,095.00	1,058.06
Embraer ERJ145	6AL008	NONE	730.00	702.14
Embraer ERJ170	6GE093	NONE	1,460.00	1,422.73
Embraer ERJ175	6GE094	NONE	13,505.00	13,224.69
Embraer ERJ190	8GE116	NONE	1,095.00	1,095.00
GULFSTREAM AEROSPACE Gulfstream G650	11BR011	NONE	365.00	365.00
Gulfstream G150	1AS002	NONE	365.00	319.38
Gulfstream G200	7PW077	NONE	0.00	336.12
Gulfstream G500	3BR001	NONE	364.98	699.03
Gulfstream IV-SP	6RR042	NONE	0.00	330.59
Lockheed C-130 Hercules	T56A7	NONE	1,460.00	1,225.37
Partenavia P.68 Victor	IO360	NONE	365.00	364.91
Piaggio P.180 Avanti	PT6A60	NONE	365.00	0.00
Pilatus PC-12	PT67B	NONE	730.00	332.25
Piper PA-32 Cherokee Six	TIO540	NONE	365.00	0.00
Piper PA46-TP Meridian	PT6A42	NONE	365.00	666.72
Raytheon Beech Bonanza 36	TIO540	NONE	0.00	344.42
Raytheon Beechjet 400	1PW035	NONE	1,094.98	692.88
Raytheon Hawker 800	BIZMEDIUMJET_F	NONE	1,095.00	1,040.66
Raytheon King Air 90	PT6A60	NONE	730.00	648.60
Raytheon Super King Air 200	PT6A61	NONE	1,824.96	1,393.56
Raytheon Super King Air 300	P660AG	NONE	0.00	314.36
Raytheon Super King Air 300	PT6A60	NONE	364.98	306.52
Total			**277,648.85**	**259,399.62**

Stage lengths and fleet mix for the AAD were computed from the flight schedule and annualized using the control totals. For runway use, 2016 Aerobahn Data was used as the baseline to establish runway usage by aircraft type. Data between September 6 and November 17 were excluded due to a runway closure at the airport. Some aircraft types, like the B767-200, did not have complete sets of runway data. To solve for this, estimates were made based on similar aircraft type and user categories. In addition, the number of missed approaches was adjusted for some aircraft types to remove FAA aircraft conducting missed-approach tests over several nights throughout the year. The resulting ratios of runway usage by aircraft type were applied to the aircraft mix in the AAD flight schedule.

E.2.2 Time of Day

To model aircraft noise exposure in terms of DNL, aircraft operations are grouped into two time periods over the day: daytime (7:00 AM to 9:59:59 PM) and nighttime (10:00 PM to 6:59:59 AM). The numbers of operations by time of day and operation type are shown in **Table E-3**. The day/night split of aircraft operations for the 2016 Existing Conditions scenario was from the CLT EIS Forecast Technical Memorandum.

Table E-3 Aircraft Operations by Time of Day – 2016 Existing Conditions

AEDT Aircraft Type	AEDT Engine Type	AEDT Engine Modification Code	Arrivals		Departures		Missed Approaches	
			Day	Night	Day	Night	Day	Night
Airbus A300F4-600 Series	1PW048	NONE	4.63%	10.45%	2.80%	5.17%	0.00%	12.73%
Airbus A319-100 Series	3CM028	NONE	3.87%	8.38%	8.95%	13.69%	8.48%	13.93%
Airbus A320-200 Series	1IA003	NONE	3.15%	7.25%	4.07%	7.30%	7.45%	8.75%
Airbus A321-100 Series	3IA008	NONE	3.59%	7.77%	9.36%	13.38%	7.87%%	13.79
Airbus A330-200 Series	2RR023	NONE	1.40%	0.00%	0.76%	0.00%	0.85%	0.00%
Airbus A330-300 Series	4PW067	NONE	1.04%	0.00%	1.42%	0.00%	1.45%	0.00%
Boeing 717-200 Series	4BR004	NONE	1.20%	3.02%	0.76%	1.60%	1,03%	0.00%
Boeing 737-300 Series	1CM004	NONE	0.64%	0.00%	0.41%	0.00%	0.79%	0.00%
Boeing 737-700 with winglets	8CM066	SACTIP	2.16%	4.75%	2.24%	5.02%	2.12%	4.77%
Boeing 737-800 Series	4CM042	NONE	2.55%	5.61%	3.26%	6.08%	4.30%	1.59%
Boeing 737-900 Series	4CM043	NONE	0.32%	0.00%	1.02%	1.52%	0.00%	0.00%
Boeing 757-200 Series	5RR039	NONE	1.24%	0.00%	2.24%	4.56%	1.64%	0.00%
Boeing 767-200 Series Freighter	1GE012	NONE	0.72%	0.00%	0.66%	0.00%	0.00%	0.00%
Boeing DC-10-10 Series	1GE001	NONE	0.88%	0.95%	0.36%	1.52%	0.00%	0.00%
Boeing MD-88	4PW071	NONE	0.76%	1.73%	1.12%	3.35%	0.18%	0.00%
Bombardier Challenger 300	8HN001	NONE	2.75%	0.00%	3.51%	0.00%	1.88%	0.00%
Bombardier Challenger 600	5GE084	NONE	0.00%	0.00%	1.32%	0.00%	0.00%	0.00%
Bombardier CRJ-200	5GE084	NONE	3.67%	7.94%	4.98%	7.15%	8.12%	15.65%
Bombardier CRJ-700-LR	5GE083	NONE	3.07%	7.08%	4.78%	7.15%	4.72%	8.89
Bombardier CRJ-900-ER	6GE092	NONE	3.63%	7.86%	5.29%	8.37%	8.60%	12.07
Bombardier Learjet 31	1AS001	NONE	0.80%	0.00%	0.00%	0.00%	0.00%	0.00%
Bombardier Learjet 45	1AS001	NONE	2.08%	0.00%	0.00%	0.00%	1.15%	0.00%
Bombardier Learjet 60	7PW077	NONE	1.24%	0.00%	0.61%	0.00%	0.00%	0.00%
Cessna 172 Skyhawk	IO360	NONE	2.36%	0.00%	0.76%	0.00%	1.09%	0.00%
Cessna 525A CitationJet	BIZLIGHTJET_F	NONE	2.95%	0.00%	0.15%	0.00%	0.67%	0.00%
Cessna 560 Citation V	1PW037	NONE	0.00%	0.00%	1.02%	0.00%	0.00%	0.00%
Cessna 560 Citation XLS	BIZMEDIUMJET_F	NONE	1.52%	3.45%	1.32%	0.00%	2.48%	0.00%
Cessna 750 Citation X	6AL021	NONE	1.72%	0.00%	1.37%	0.00%	0.00%	0.00%
Cirrus SR22	TIO540	NONE	2.48%	0.00%	0.76%	0.00%	0.30%	0.00%

Table E-3 Aircraft Operations by Time of Day – 2016 Existing Conditions (Continued)

AEDT Aircraft Type	AEDT Engine Type	AEDT Engine Modification Code	Arrivals		Departures		Missed Approaches	
			Day	Night	Day	Night	Day	Night
CX 680 SOVEREIGN	BIZLIGHTJET_F	NONE	1.16%	0.00%	0.81%	0.00%	0.30%	0.00%
Dassault Falcon 2000	7PW080	NONE	1.20%	0.00%	0.00%	0.00%	2.06%	0.00%
Dassault Falcon 900-EX	TFE731	NONE	0.00%	0.00%	0.81%	0.00%	0.00%	0.00%
DeHavilland DHC-8-300	PW123	NONE	4.63%	2.07%	1.07%	0.00%	10.96%	3.85%
Dornier 328 Jet	7PW078	NONE	0.80%	10.02%	3.15%	5.17%	0.00%	0.00%
EADS Socata TBM-700	PT6A60	NONE	0.24%	0.00%	0.25%	0.00%	0.00%	0.00%
Embraer 505	BIZLIGHTJET_F	NONE	2.36%	0.00%	0.36%	0.00%	0.00%	0.00%
Embraer EMB120 Brasilia	PW118	NONE	1.96%	0.00%	0.81%	0.00%	0.42%	0.00%
Embraer ERJ145	6AL008	NONE	1.64%	0.00%	1.98%	0.00%	0.55%	0.00%
Embraer ERJ170	6GE093	NONE	1.76%	0.00%	0.86%	0.00%	4.00%	0.00%
Embraer ERJ175	6GE094	NONE	2.59%	0.00%	2.95%	0.00%	1.82%	1.99%
Embraer ERJ190	8GE116	NONE	0.92%	6.04%	4.73%	7.07%	1.15%	0.00%
GULFSTREAM AEROSPACE Gulfstream G650	11BR011	NONE	1.24%	0.00%	1.63%	0.00%	0.00%	0.00%
Gulfstream G150	1AS002	NONE	2.63%	0.00%	0.76%	0.00%	2.06%	0.00%
Gulfstream G200	7PW077	NONE	0.00%	0.00%	0.81%	0.00%	0.00%	0.00%
Gulfstream G500	3BR001	NONE	3.07%	0.00%	1.53%	0.00%	0.00%	0.00%
Gulfstream IV-SP	6RR042	NONE	0.00%	0.00%	1.12%	0.00%	0.00%	0.00%
Lockheed C-130 Hercules	T56A7	NONE	2.99%	0.00%	1.07%	0.00%	3.27%	0.00%
Partenavia P.68 Victor	IO360	NONE	0.08%	0.00%	1.37%	0.00%	0.00%	0.00%
Pilatus PC-12	PT67B	NONE	0.64%	0.00%	0.00%	0.84%	0.91%	0.00%
Piper PA46-TP Meridian	PT6A42	NONE	1.84%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Beech Bonanza 36	TIO540	NONE	1.04%	0.00%	1.32%	0.00%	0.00%	0.00%
Raytheon Beechjet 400	1PW035	NONE	1.16%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Hawker 800	BIZMEDIUMJET_F	NONE	0.00%	0.00%	0.92%	0.00%	1.45%	0.00%
Raytheon King Air 90	PT6A60	NONE	2.00%	0.00%	0.36%	0.00%	0.55%	0.00%
Raytheon Super King Air 200	PT6A61	NONE	1.12%	0.00%	1.07%	0.00%	2.73%	1.99%
Raytheon Super King Air 300	P660AG	NONE	1.28%	2.68%	0.71%	1.06%	2.60%	0.00%
Raytheon Super King Air 300	PT6A60	NONE	2.40%	0.00%	0.76%	0.00%	0.00%	0.00%
All Aircraft			**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Source: CLT EIS Forecast Technical Memorandum (April 2018), VHB/InterVISTAS/ESA

E.2.3 Departure Stage Length

Departure stage lengths are used to further refine the noise exposure calculations. All departures at Charlotte Douglas International Airport fall within the following stage length categories:

Stage Length 1: 0 to 500 miles

Stage Length 2: 501 to 1,000 miles

Stage Length 3: 1,001 to 1,500 miles

Stage Length 4: 1,501 to 2,500 miles

Stage Length 5: 2,501 to 3,500 miles

Stage Length 6: 3,501 to 4,500 miles

Departure stage length information for 2016 is presented in **Table E-4** and is from the CLT EIS Forecast Technical Memorandum, which derived stage length values from the CLT forecast.

E.2.4 Runway Use

Runway use is a primary factor that determines both the size and shape of a noise exposure area and refers to the percentages of the AAD operations that arrive on or depart from each of the various runway ends based on average annual conditions. The average annual conditions account for varying weather patterns and FAA CLT Airport Traffic Control Tower (ATCT) procedures that ultimately dictate runway assignments.

Table E-5 shows the resulting runway use percentages for 2016 Existing Conditions by type of operation and time of day. Runway use distributions were calculated separately for each AEDT aircraft type.

E.2.5 Flight Track Location and Utilization

Flight tracks were developed using radar data provided by CLT for the following five representative weeks in 2017:

- January 8-14, 2017
- May 6-12, 2017
- August 6-12, 2017
- October 8-14, 2017
- November 5-11, 2017

This radar flight track data included detailed information that mirrored the data within the CLT EIS Forecast, which allowed for the two sets of data to be easily merged for the noise analysis.

Table E-4 Departure Stage Length Breakdown – 2016 Existing Conditions

AEDT Aircraft Type	AEDT Engine Type	AEDT Engine Modification Code	Departures by Stage Length (%)					
			Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Airbus A300F4-600 Series	1PW048	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Airbus A319-100 Series	3CM028	NONE	39.73%	13.39%	20.09%	26.79%	0.00%	0.00%
Airbus A320-200 Series	1IA003	NONE	71.43%	28.57%	0.00%	0.00%	0.00%	0.00%
Airbus A321-100 Series	3IA008	NONE	38.36%	13.70%	20.55%	27.40%	0.00%	0.00%
Airbus A330-200 Series	2RR023	NONE	35.25%	0.00%	0.00%	0.00%	0.00%	64.75%
Airbus A330-300 Series	4PW067	NONE	24.51%	0.00%	0.00%	0.00%	34.31%	41.18%
Boeing 717-200 Series	4BR004	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Boeing 737-300 Series	1CM004	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Boeing 737-700 with winglets	8CM066	SACTIP	68.12%	31.88%	0.00%	0.00%	0.00%	0.00%
Boeing 737-800 Series	4CM042	NONE	66.36%	33.64%	0.00%	0.00%	0.00%	0.00%
Boeing 737-900 Series	4CM043	NONE	9.09%	90.91%	0.00%	0.00%	0.00%	0.00%
Boeing 757-200 Series	5RR039	NONE	29.73%	0.00%	0.00%	0.00%	70.27%	0.00%
Boeing 767-200 Series Freighter	1GE012	NONE	25.71%	0.00%	0.00%	74.29%	0.00%	0.00%
Boeing DC-10-10 Series	1GE001	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Boeing MD-88	4PW071	NONE	53.19%	46.81%	0.00%	0.00%	0.00%	0.00%
Bombardier Challenger 300	8HN001	NONE	76.04%	23.96%	0.00%	0.00%	0.00%	0.00%
Bombardier Challenger 600	5GE084	NONE	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%
Bombardier CRJ-200	5GE084	NONE	73.48%	26.52%	0.00%	0.00%	0.00%	0.00%
Bombardier CRJ-700-LR	5GE083	NONE	67.92%	32.08%	0.00%	0.00%	0.00%	0.00%
Bombardier CRJ-900-ER	6GE092	NONE	70.92%	29.08%	0.00%	0.00%	0.00%	0.00%
Bombardier Learjet 31	1AS001	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bombardier Learjet 45	1AS001	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bombardier Learjet 60	7PW077	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cessna 172 Skyhawk	IO360	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cessna 525A CitationJet	BIZLIGHTJET_F	NONE	68.00%	32.00%	0.00%	0.00%	0.00%	0.00%
Cessna 560 Citation V	1PW037	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cessna 560 Citation XLS	BIZMEDIUMJET_F	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cessna 750 Citation X	6AL021	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cirrus SR22	TIO540	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CX 680 SOVEREIGN	BIZLIGHTJET_F	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dassault Falcon 2000	7PW080	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dassault Falcon 900-EX	TFE731	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DeHavilland DHC-8-300	PW123	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dornier 328 Jet	7PW078	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table E-4 Departure Stage Length Breakdown – 2016 Existing Conditions (Continued)

AEDT Aircraft Type	AEDT Engine Type	AEDT Engine Modification Code	Departures by Stage Length (%) Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
EADS Socata TBM-700	PT6A60	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Embraer 505	BIZLIGHTJET_F	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Embraer EMB120 Brasilia	PW118	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Embraer ERJ145	6AL008	NONE	59.52%	40.48%	0.00%	0.00%	0.00%	0.00%
Embraer ERJ170	6GE093	NONE	70.56%	29.44%	0.00%	0.00%	0.00%	0.00%
Embraer ERJ175	6GE094	NONE	43.84%	22.46%	33.70%	0.00%	0.00%	0.00%
Embraer ERJ190	8GE116	NONE	64.44%	35.56%	0.00%	0.00%	0.00%	0.00%
GULFSTREAM AEROSPACE Gulfstream G650	11BR011	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gulfstream G150	1AS002	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gulfstream G200	7PW077	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gulfstream G500	3BR001	NONE	66.67%	0.00%	0.00%	33.33%	0.00%	0.00%
Gulfstream IV-SP	6RR042	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Lockheed C-130 Hercules	T56A7	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Partenavia P.68 Victor	IO360	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Pilatus PC-12	PT67B	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Piper PA46-TP Meridian	PT6A42	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Beech Bonanza 36	TIO540	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Beechjet 400	1PW035	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Hawker 800	BIZMEDIUMJET_F	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon King Air 90	PT6A60	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Super King Air 200	PT6A61	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Super King Air 300	P660AG	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Raytheon Super King Air 300	PT6A60	NONE	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
All Aircraft			**66.52%**	**16.21%**	**6.12%**	**6.88%**	**2.80%**	**1.47%**

Source: CLT EIS Forecast Technical Memorandum (April 2018), VHB/InterVISTAS/ESA

Table E-5 Runway Use by Type of Operation and Time of Day – 2016 Existing Conditions

	Arrivals		Departures		Missed Approaches	
Runway	Day	Night	Day	Night	Day	Night
05	0.36%	4.23%	4.37%	7.98%	0.00%	0.00%
23	11.22%	9.93%	1.37%	8.21%	16.05%	6.50%
18C	16.09%	15.63%	20.50%	17.87%	13.63%	19.76%
36C	16.21%	13.47%	16.79%	16.35%	9.57%	20.69%
18L	14.73%	15.80%	25.74%	22.13%	16.78%	10.88%
36R	16.09%	16.15%	28.99%	25.32%	19.93%	18.97%
18R	13.93%	12.52%	1.22%	0.00%	14.35%	8.89%
36L	11.38%	12.26%	1.02%	2.13%	9.69%	14.32%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Source: CLT EIS Forecast Technical Memorandum (April 2018), VHB/InterVISTAS/Environmental Science Associates, 2019

Figure E-2 and **Figure E-3** depicts the 2016 Existing Conditions flight tracks, as modeled in the AEDT, for departures and arrivals. **Table E-6** provides flight tracks utilization percentages for the 2016 Existing Conditions scenario. Flight track utilization percentages were calculated for each AEDT aircraft type by time of day, type of operation, and runway.

E.2.6 2016 Existing Noise Contour

The 2016 Existing DNL 60, 65, 70, and 75 dBA contours are shown in **Figure E-4**. These contours reflect the DNL values in areas surrounding CLT on an average annual day in 2016. Noise contours tend to have nodes extending from each runway end, which are reflective of the low-altitude arrival and departure activity around those runway ends. The relative size of each node depends on the variables discussed above, such as the types of aircraft, frequency of use at that runway end, and times of use at that runway end. A detailed analysis of the land use within this contour can be found in the main document in **Section 11. Noise and Noise-Compatible Land Use**.

Table E-6 Flight Track Use – 2016 Existing Conditions

Runway/ Flight Track	Arrivals Day	Arrivals Night	Departures Day	Departures Night
05XAE1	9.69%	16.22%	0.00%	0.00%
05XANE1	34.71%	4.73%	0.00%	0.00%
05XANE2	0.32%	6.27%	0.00%	0.00%
05XANW1	53.66%	44.25%	0.00%	0.00%
05XASE1	1.62%	28.52%	0.00%	0.00%
05XDE1	0.00%	0.00%	5.10%	2.49%
05XDNE1	0.00%	0.00%	11.55%	9.44%
05XDNW1	0.00%	0.00%	14.10%	12.73%
05XDSE1	0.00%	0.00%	27.87%	26.42%
05XDSW1	0.00%	0.00%	41.38%	48.92%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
23XANE1	49.49%	51.10%	0.00%	0.00%
23XANE2	0.43%	0.09%	0.00%	0.00%
23XANW1	2.60%	4.14%	0.00%	0.00%
23XASE1	0.14%	0.09%	0.00%	0.00%
23XASE2	32.52%	27.44%	0.00%	0.00%
23XASE3	0.87%	0.27%	0.00%	0.00%
23XASW1	6.30%	7.61%	0.00%	0.00%
23XASW2	0.14%	0.15%	0.00%	0.00%
23XASW3	0.41%	0.02%	0.00%	0.00%
23XASW4	4.16%	4.63%	0.00%	0.00%
23XAW1	1.79%	3.23%	0.00%	0.00%
23XAW2	1.16%	1.23%	0.00%	0.00%
23XDE1	0.00%	0.00%	8.91%	20.14%
23XDN1	0.00%	0.00%	5.94%	14.39%
23XDNW1	0.00%	0.00%	22.66%	10.84%
23XDS1	0.00%	0.00%	15.10%	28.58%
23XDSE1	0.00%	0.00%	19.81%	18.44%
23XDSW1	0.00%	0.00%	27.58%	7.61%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
18CANE1	0.29%	0.31%	0.00%	0.00%
18CANE2	0.57%	0.42%	0.00%	0.00%
18CANE3	12.07%	6.10%	0.00%	0.00%
18CANE4	7.09%	3.97%	0.00%	0.00%
18CANW1	1.11%	1.06%	0.00%	0.00%
18CANW2	0.98%	1.23%	0.00%	0.00%
18CANW3	7.28%	7.67%	0.00%	0.00%
18CANW4	0.79%	0.78%	0.00%	0.00%
18CANW5	18.00%	16.23%	0.00%	0.00%
18CAS1	3.62%	3.36%	0.00%	0.00%
18CAS2	13.71%	13.64%	0.00%	0.00%
18CAS3	0.26%	0.29%	0.00%	0.00%
18CAS4	2.31%	1.89%	0.00%	0.00%
18CAS5	0.57%	0.72%	0.00%	0.00%

Runway/ Flight Track	Arrivals Day	Arrivals Night	Departures Day	Departures Night
18CASW1	1.44%	2.24%	0.00%	0.00%
18CAW1	3.95%	4.16%	0.00%	0.00%
18CAW2	3.07%	3.43%	0.00%	0.00%
18CAW3	22.88%	32.47%	0.00%	0.00%
18CDE1	0.00%	0.00%	0.99%	0.81%
18CDE2	0.00%	0.00%	0.20%	0.18%
18CDE3	0.00%	0.00%	1.65%	0.80%
18CDN1	0.00%	0.00%	1.07%	0.19%
18CDN2	0.00%	0.00%	18.53%	17.47%
18CDN3	0.00%	0.00%	0.12%	0.10%
18CDNW1	0.00%	0.00%	0.21%	0.22%
18CDNW2	0.00%	0.00%	19.27%	21.38%
18CDS1	0.00%	0.00%	4.39%	4.97%
18CDSW1	0.00%	0.00%	0.38%	0.29%
18CDW1	0.00%	0.00%	53.18%	53.59%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
18LAN1	1.90%	0.55%	0.00%	0.00%
18LANE1	0.46%	1.40%	0.00%	0.00%
18LANE2	0.53%	2.36%	0.00%	0.00%
18LANE3	20.52%	15.29%	0.00%	0.00%
18LANE4	19.52%	18.30%	0.00%	0.00%
18LANE5	2.73%	4.58%	0.00%	0.00%
18LANE6	2.81%	2.70%	0.00%	0.00%
18LANW1	1.66%	2.46%	0.00%	0.00%
18LANW2	3.10%	3.83%	0.00%	0.00%
18LANW3	0.55%	1.01%	0.00%	0.00%
18LAS1	3.34%	3.72%	0.00%	0.00%
18LAS2	2.03%	3.07%	0.00%	0.00%
18LAS3	2.24%	1.92%	0.00%	0.00%
18LAS4	13.87%	13.92%	0.00%	0.00%
18LAS5	14.17%	13.67%	0.00%	0.00%
18LASE1	0.54%	0.38%	0.00%	0.00%
18LASE2	0.49%	0.04%	0.00%	0.00%
18LASE3	0.04%	0.41%	0.00%	0.00%
18LASW1	0.45%	1.88%	0.00%	0.00%
18LASW2	0.24%	0.42%	0.00%	0.00%
18LAW1	7.95%	7.11%	0.00%	0.00%
18LAW2	0.35%	0.98%	0.00%	0.00%
18LAW3	0.50%	0.02%	0.00%	0.00%
18LDE1	0.00%	0.00%	2.33%	0.40%
18LDE2	0.00%	0.00%	36.81%	40.17%
18LDE3	0.00%	0.00%	5.89%	5.01%
18LDE4	0.00%	0.00%	1.97%	1.71%
18LDE5	0.00%	0.00%	0.86%	0.95%

Table E-6 Flight Track Use – 2016 Existing Conditions (Continued)

Runway/ Flight Track	Arrivals Day	Arrivals Night	Departures Day	Departures Night
18LDN 1	0.00%	0.00%	0.89%	0.02%
18LDN2	0.00%	0.00%	1.65%	1.88%
18LDN3	0.00%	0.00%	0.14%	0.00%
18LDN4	0.00%	0.00%	6.96%	9.09%
18LDN5	0.00%	0.00%	0.77%	0.85%
18LDNW1	0.00%	0.00%	3.50%	2.26%
18LDS1	0.00%	0.00%	30.13%	31.06%
18LDW1	0.00%	0.00%	1.63%	0.06%
18LDW2	0.00%	0.00%	3.60%	3.88%
18LDW3	0.00%	0.00%	2.87%	2.65%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
18RANE1	1.82%	1.55%	0.00%	0.00%
18RANE2	0.96%	0.87%	0.00%	0.00%
18RANE3	6.34%	6.42%	0.00%	0.00%
18RANW1	9.23%	9.04%	0.00%	0.00%
18RANW2	1.10%	1.26%	0.00%	0.00%
18RANW3	9.36%	10.21%	0.00%	0.00%
18RANW4	0.37%	0.40%	0.00%	0.00%
18RAS1	1.58%	1.24%	0.00%	0.00%
18RAS2	0.07%	0.06%	0.00%	0.00%
18RAS3	29.71%	31.83%	0.00%	0.00%
18RAS4	2.70%	2.17%	0.00%	0.00%
18RAW1	7.73%	6.72%	0.00%	0.00%
18RAW2	0.34%	0.25%	0.00%	0.00%
18RAW3	28.68%	27.98%	0.00%	0.00%
18RDS1	0.00%	0.00%	68.37%	0.00%
18RDW1	0.00%	0.00%	31.63%	0.00%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
36CAN1	12.06%	6.62%	0.00%	0.00%
36CAN10	0.26%	0.21%	0.00%	0.00%
36CAN2	0.17%	0.50%	0.00%	0.00%
36CAN3	0.66%	0.58%	0.00%	0.00%
36CAN4	1.41%	1.81%	0.00%	0.00%
36CAN5	0.06%	1.18%	0.00%	0.00%
36CAN6	0.83%	0.65%	0.00%	0.00%
36CAN7	2.43%	3.19%	0.00%	0.00%
36CAN8	22.26%	31.58%	0.00%	0.00%
36CAN9	13.20%	14.39%	0.00%	0.00%
36CASE1	3.99%	3.85%	0.00%	0.00%
36CASE2	8.88%	7.16%	0.00%	0.00%
36CASE3	0.47%	0.41%	0.00%	0.00%
36CASW1	9.27%	7.75%	0.00%	0.00%
36CASW2	13.16%	9.80%	0.00%	0.00%
36CASW3	6.18%	5.14%	0.00%	0.00%
36CASW4	1.11%	1.29%	0.00%	0.00%
36CASW5	3.59%	3.89%	0.00%	0.00%
36CDE1	0.00%	0.00%	0.06%	0.02%
36CDE2	0.00%	0.00%	3.07%	2.30%
36CDN1	0.00%	0.00%	21.43%	23.42%
36CDNE1	0.00%	0.00%	0.04%	0.04%
36CDNW1	0.00%	0.00%	17.78%	19.35%
36CDS1	0.00%	0.00%	0.02%	0.01%
36CDS2	0.00%	0.00%	9.85%	9.01%
36CDS3	0.00%	0.00%	0.11%	0.12%
36CDW1	0.00%	0.00%	0.82%	0.42%
36CDW2	0.00%	0.00%	46.76%	45.28%
36CDW3	0.00%	0.00%	0.06%	0.05%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
36LANE1	3.13%	3.24%	0.00%	0.00%
36LANE2	1.84%	1.54%	0.00%	0.00%
36LANE3	0.31%	0.37%	0.00%	0.00%
36LANE4	0.06%	0.04%	0.00%	0.00%
36LANW1	19.28%	22.77%	0.00%	0.00%
36LANW2	0.12%	0.27%	0.00%	0.00%
36LANW3	35.48%	33.94%	0.00%	0.00%
36LASE1	4.66%	3.21%	0.00%	0.00%
36LASE2	1.33%	0.92%	0.00%	0.00%
36LASE3	2.82%	1.91%	0.00%	0.00%
36LASW1	5.15%	5.48%	0.00%	0.00%
36LASW2	12.03%	13.48%	0.00%	0.00%
36LASW3	13.79%	12.83%	0.00%	0.00%
36LDN1	0.00%	0.00%	7.91%	15.89%
36LDW1	0.00%	0.00%	92.09%	84.11%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
36RAE1	0.28%	0.18%	0.00%	0.00%
36RANE1	4.64%	4.04%	0.00%	0.00%
36RANE2	22.79%	23.33%	0.00%	0.00%
36RANE3	29.44%	27.57%	0.00%	0.00%
36RANE4	0.51%	0.54%	0.00%	0.00%
36RANW1	3.32%	5.31%	0.00%	0.00%
36RANW2	1.77%	3.30%	0.00%	0.00%
36RANW3	0.75%	0.47%	0.00%	0.00%

Table E-6 Flight Track Use – 2016 Existing Conditions (Continued)

Runway/ Flight Track	Arrivals		Departures	
	Day	Night	Day	Night
36RANW4	1.68%	1.48%	0.00%	0.00%
36RANW5	0.24%	0.13%	0.00%	0.00%
36RANW6	5.82%	5.53%	0.00%	0.00%
36RAS1	0.70%	0.61%	0.00%	0.00%
36RASE1	14.92%	13.95%	0.00%	0.00%
36RASE2	8.26%	8.78%	0.00%	0.00%
36RASW1	3.20%	3.41%	0.00%	0.00%
36RASW2	1.45%	0.87%	0.00%	0.00%
36RAW1	0.16%	0.42%	0.00%	0.00%
36RAW2	0.06%	0.06%	0.00%	0.00%
36RDE1	0.00%	0.00%	3.72%	0.61%
36RDE2	0.00%	0.00%	41.93%	48.08%
36RDE3	0.00%	0.00%	19.25%	21.28%
36RDN1	0.00%	0.00%	1.98%	1.21%
36RDN2	0.00%	0.00%	2.50%	1.40%
36RDN3	0.00%	0.00%	0.13%	0.06%
36RDNE1	0.00%	0.00%	0.34%	0.17%
36RDNE2	0.00%	0.00%	0.68%	0.54%
36RDNE3	0.00%	0.00%	0.29%	0.08%
36RDNW1	0.00%	0.00%	2.61%	1.58%
36RDS1	0.00%	0.00%	1.50%	0.55%
36RDSE1	0.00%	0.00%	0.43%	0.32%
36RDSE2	0.00%	0.00%	14.25%	14.35%
36RDSW1	0.00%	0.00%	0.99%	0.08%
36RDSW2	0.00%	0.00%	1.36%	1.64%
36RDSW3	0.00%	0.00%	4.60%	5.43%
36RDW1	0.00%	0.00%	1.01%	0.12%
36RDW2	0.00%	0.00%	2.42%	2.50%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**

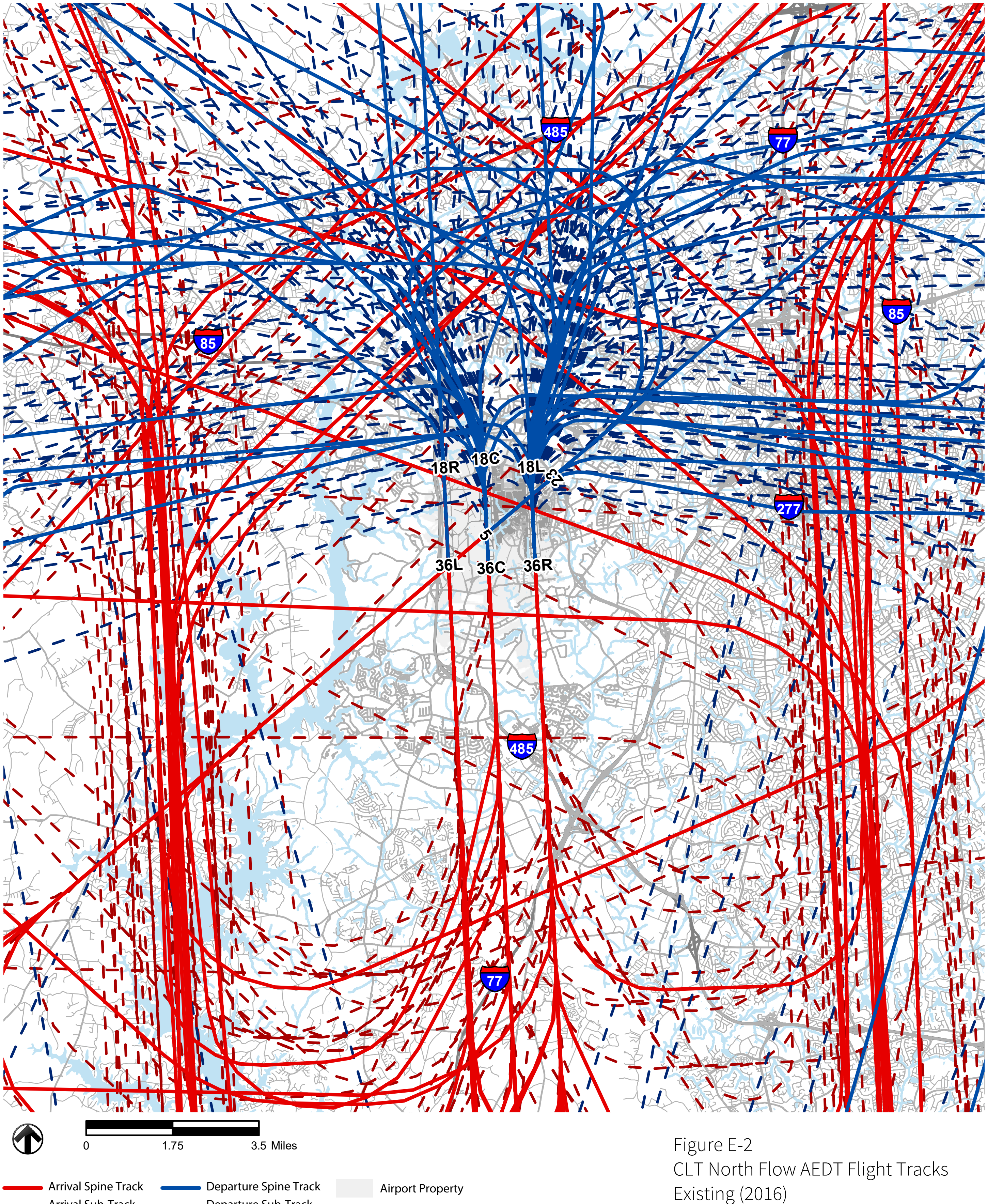


Figure E-2
CLT North Flow AEDT Flight Tracks
Existing (2016)

Charlotte Douglas International Airport
Improvement Program EIS

Source: AEDT 2d; Mecklenburg County GIS; North Carolina, 2017

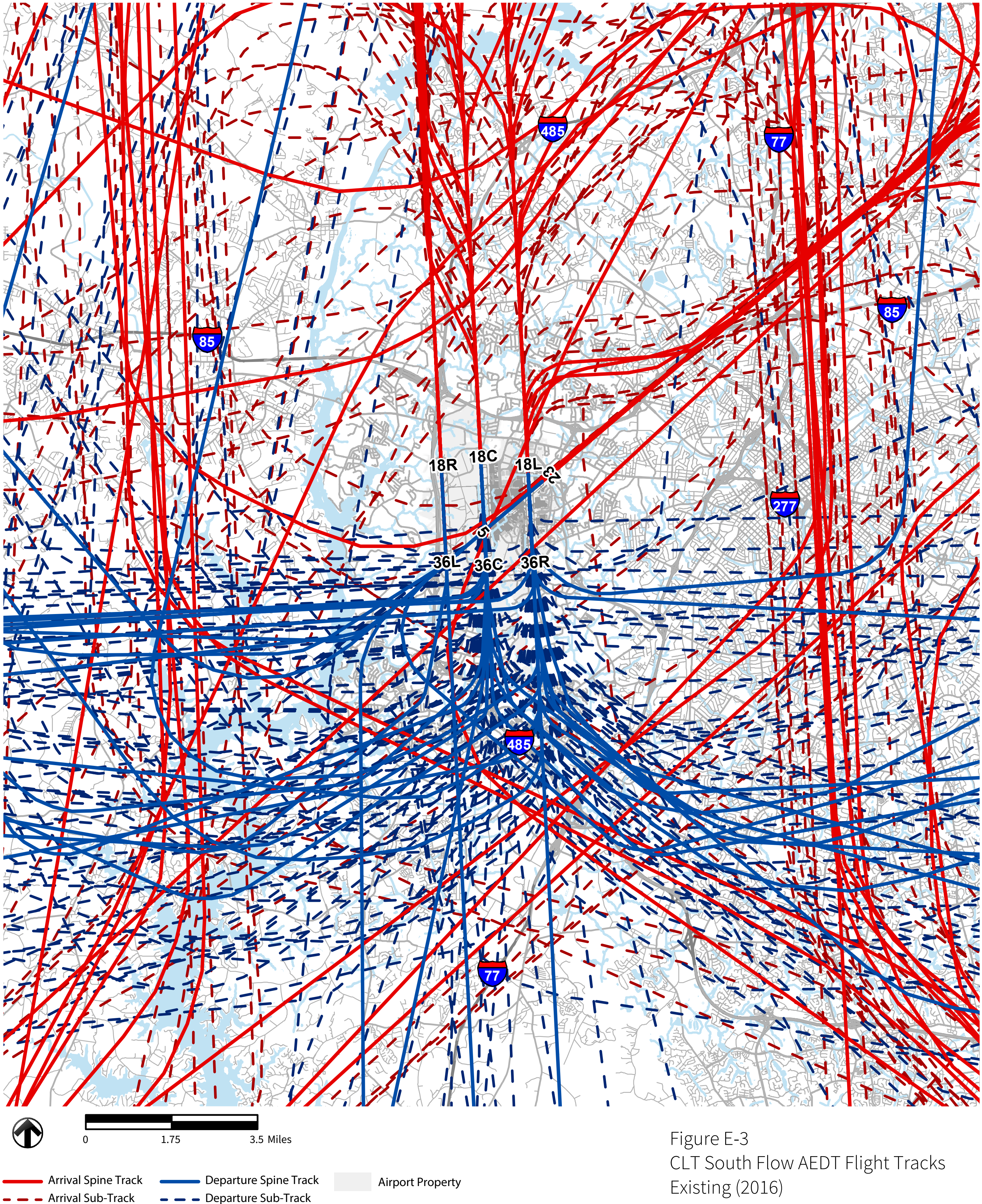


Figure E-3
CLT South Flow AEDT Flight Tracks
Existing (2016)

Charlotte Douglas International Airport
Improvement Program EIS

Source: AEDT 2d; Mecklenburg County GIS; North Carolina, 2017

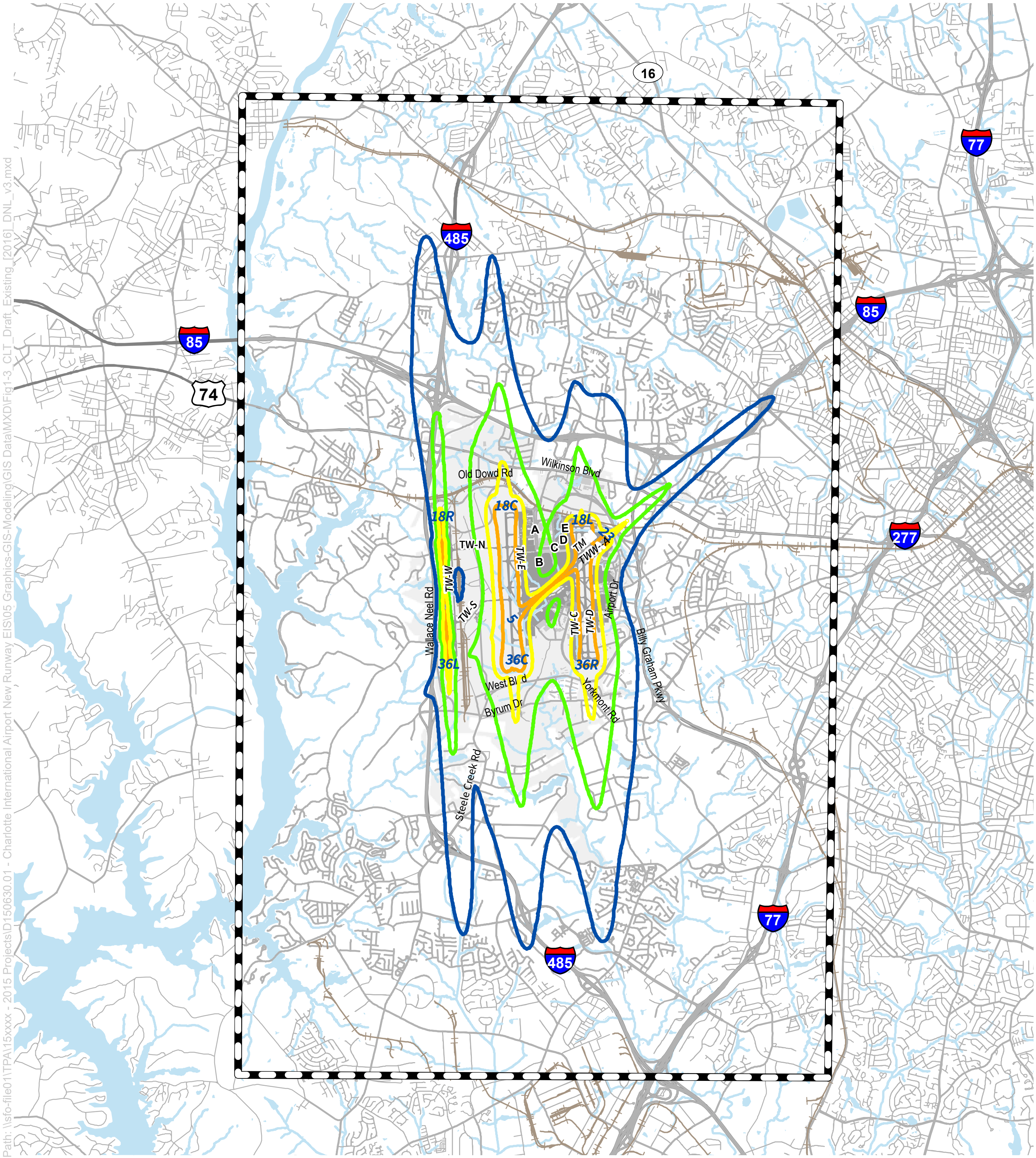


Figure E-4
CLT DNL Contours - Existing (2016)

Land Use Study Area
Airport Property

DNL Contours
60 dB
65 dB
70 dB
75 dB

Charlotte Douglas International Airport
Improvement Program EIS

Source: AEDT 2d; Mecklenburg County GIS; North Carolina, 2017

Proposed Capacity Enhancements at Charlotte Douglas International Airport

National Environmental Policy Act Environmental Assessment

Noise Methodology

August 2021

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Charlotte Douglas International Airport

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List of Acronyms

AEDT	Aviation Environmental Design Tool
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
CLT	Charlotte Douglas International Airport or Airport
dB	Decibel
dBA	A-weighted decibel scale
DNL	Day-Night Average Sound Level
EA	Environmental Assessment
FAA	Federal Aviation Administration
FICAN	Federal Interagency Committee on Aviation Noise
FICON	Federal Interagency Committee on Noise
IEC	International Electrotechnical Commission
IHD	Ischemic Heart Disease
Lmax	Maximum Sound Level
Leq	Equivalent Sound Level
NA	Number of Events Above Level
NEPA	National Environmental Policy Act of 1969, as amended
NLR	Noise Level Reduction
TA	Time Above Level
SEL	Sound Exposure Level
USEPA	U.S. Environmental Protection Agency
WHO	World Health Organization

1 Characteristics of Sound

Sound is created by a source that induces vibrations in the air. The vibration produces alternating bands of relatively dense and sparse particles of air, spreading outward from the source like ripples on a pond. Sound waves dissipate with increasing distance from the source. Sound waves can also be reflected, diffracted, refracted, or scattered. When the source stops vibrating, the sound waves disappear almost instantly and the sound ceases.

Sound conveys information to listeners. It can be instructional, alarming, pleasant, relaxing, or annoying. Identical sounds can be characterized by different people or even by the same person at different times, as desirable or unwanted. Unwanted sound is commonly referred to as “noise.”

Sound can be defined in terms of three components:

1) Level (amplitude)
2) Pitch (frequency)
3) Duration (time pattern)

1.1 Sound Level

The level or amplitude of sound is measured by the difference between atmospheric pressure (without the sound) and the total pressure (with the sound). Amplitude of sound is like the relative height of the ripples caused by the stone thrown into the water. Although physicists typically measure pressure using the linear Pascal scale, sound is measured using the logarithmic decibel (dB) scale. This is because the range of sound pressures detectable by the human ear can vary from 1 to 100 trillion units. A logarithmic scale allows us to discuss and analyze noise using more manageable numbers. The range of audible sound ranges from approximately 1 to 140 dB, although everyday sounds rarely rise above about 120 dB. The human ear is extremely sensitive to sound pressure fluctuations. A sound of 140 dB, which is sharply painful to humans, contains 100 trillion (10^{14}) times more sound pressure than the least audible sound. **Exhibit 1-1** shows a comparison of common sources of indoor and outdoor sounds measured on the dB scale.

By definition, a 10 dB increase in sound is equal to a tenfold (10^1) increase in the mean square sound pressure of the reference sound. A 20 dB increase is a 100 fold (10^2) increase in the mean square sound pressure of the reference sound. A 30 dB increase is a 1,000-fold (10^3) increase in mean square sound pressure.

A logarithmic scale requires different mathematics than used with linear scales. The sound pressures of two separate sounds, expressed in dB, are not arithmetically additive. For example, if a sound of 80 dB is added to another sound of 74 dB, the total is a 1 dB increase in the louder sound (81 dB), not the arithmetic sum of 154 dB (See **Exhibit 1-2**). If two equally loud noise events occur simultaneously, the sound pressure level from the combined events is 3 dB higher than the level produced by either event alone.

EXHIBIT 1-1, COMPARISON OF SOUND

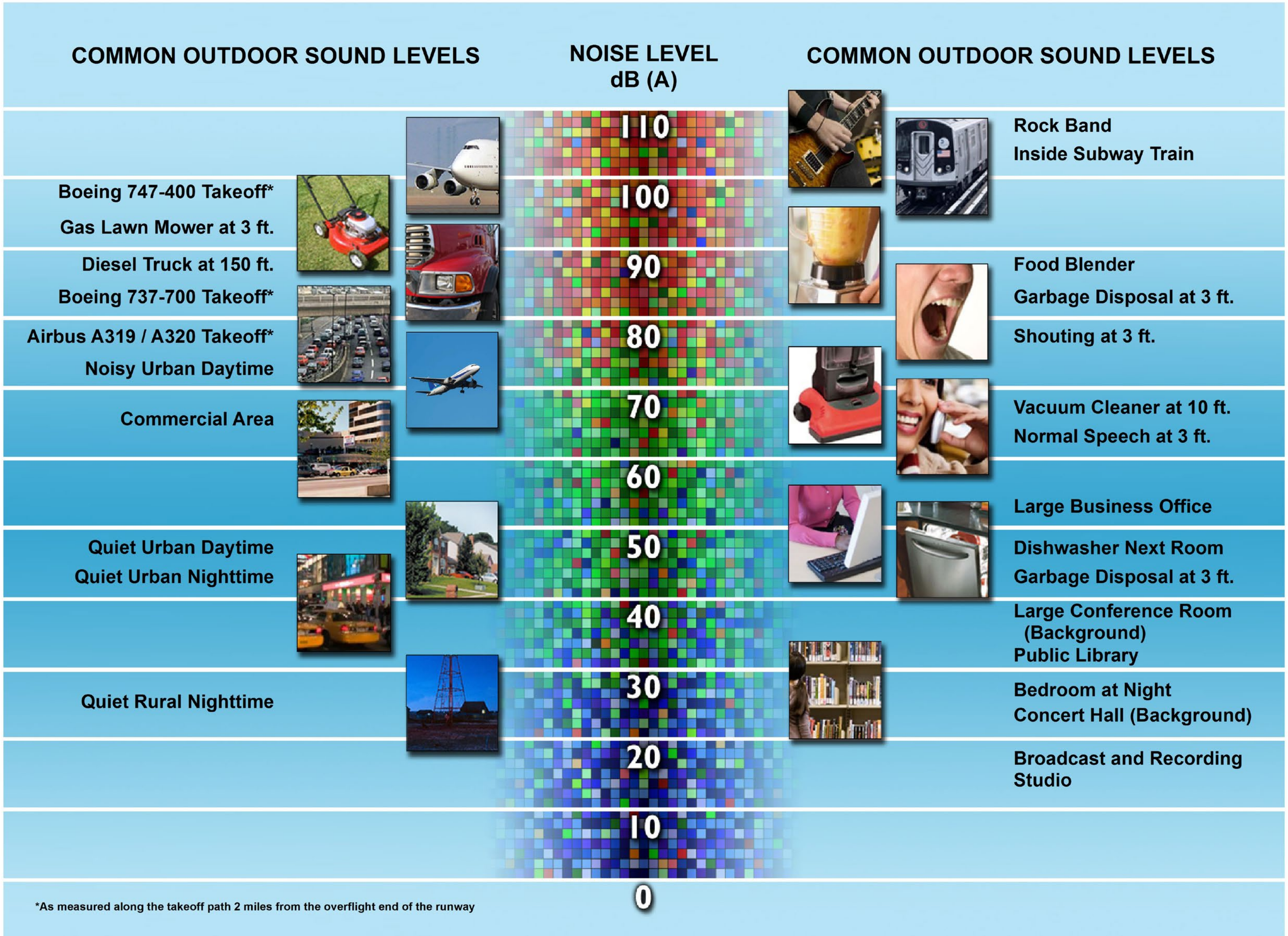
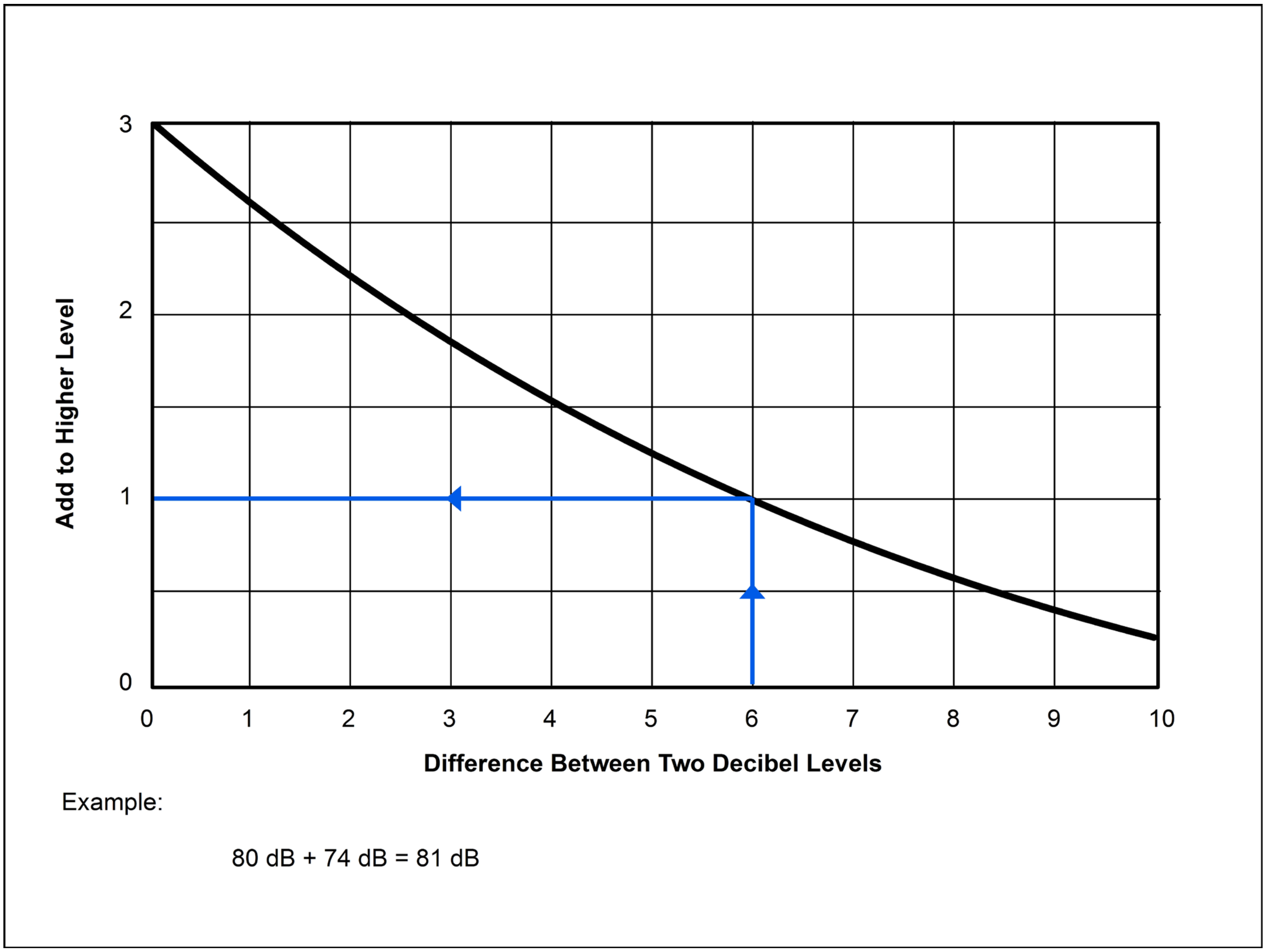


EXHIBIT 1-2, EXAMPLE ADDITION OF TWO DECIBEL LEVELS

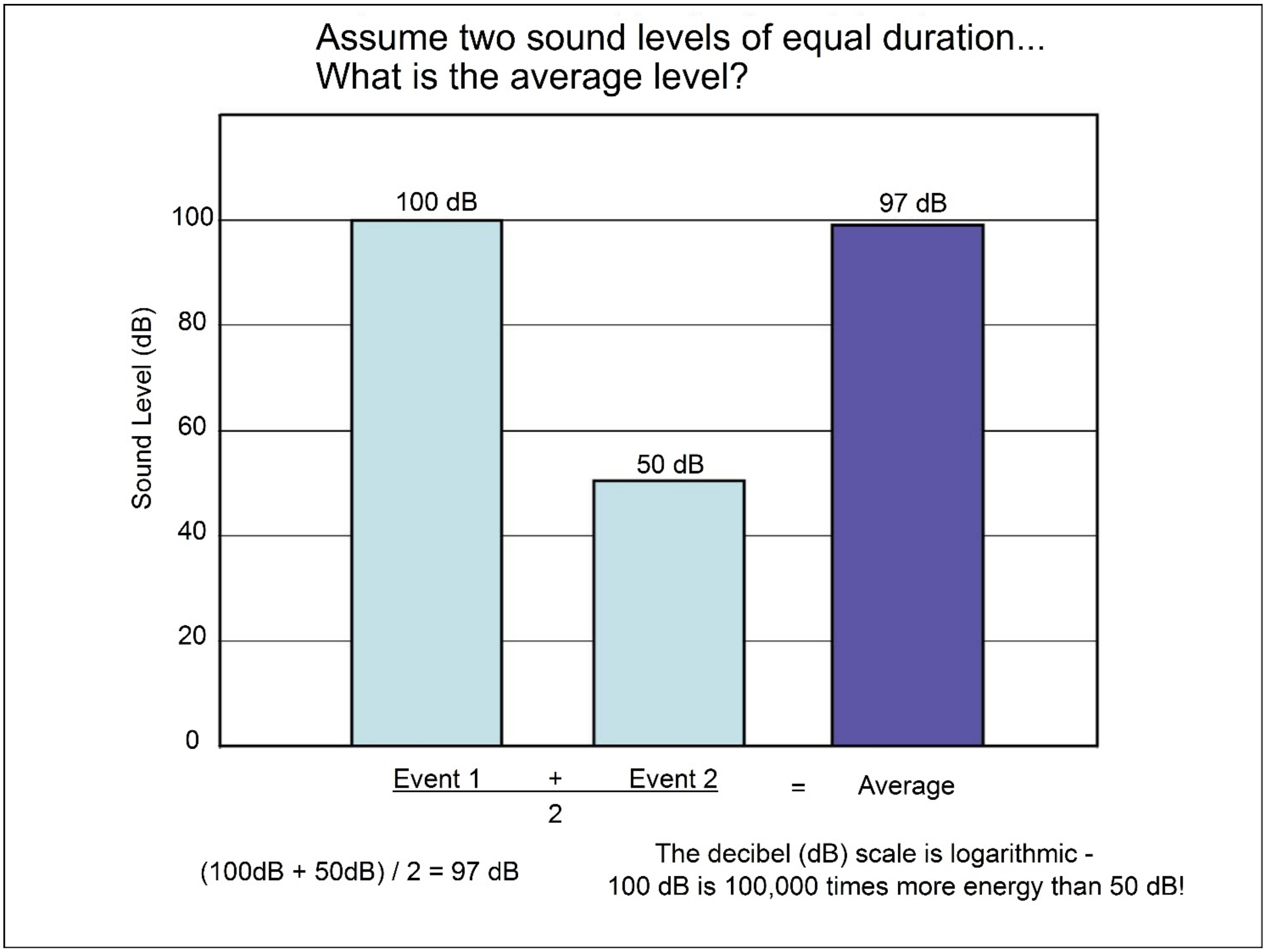


Source: Information on Levels of Environmental Noise. USEPA. March 1974.

Logarithmic averaging also yields results that are quite different from simple arithmetic averaging. Consider the example shown in **Exhibit 1-3**. Two sound levels of equal duration are averaged. One has a maximum sound level (Lmax) of 100 dB, the other 50 dB. Using conventional arithmetic, the average would be 75 dB. The true result, using logarithmic math, is 97 dB. This is because 100 dB has far more energy than 50 dB (100,000 times as much!) and is overwhelmingly dominant in computing the average of the two sounds.

Human perceptions of changes in sound pressure are less sensitive than a sound level meter. People typically perceive a tenfold increase in sound pressure, a 10 dB increase, as a doubling of loudness. Conversely, a 10 dB decrease in sound pressure is normally perceived as half as loud. In community settings, most people perceive a 3 dB increase in sound pressure (a doubling of the sound pressure or energy) as just noticeable. (In laboratory settings, people with good hearing are able to detect changes in sounds of as little as 1 dB.)

EXHIBIT 1-3, EXAMPLE OF SOUND LEVEL AVERAGING



Source: Landrum & Brown, 2020

1.2 Sound Frequency

The pitch (or frequency) of sound can vary greatly from a low-pitched rumble to a shrill whistle. If we consider the analogy of ripples in a pond, high frequency sounds are vibrations with tightly spaced ripples, while low rumbles are vibrations with widely spaced ripples. The rate at which a source vibrates determines the frequency. The rate of vibration is measured in units called “Hertz” – the number of cycles, or waves, per second. One’s ability to hear a sound depends greatly on the frequency composition. Humans hear sounds best at frequencies between 1,000 and 6,000 Hertz. Sound at frequencies above 10,000 Hertz (high-pitched hissing) and below 100 Hertz (low rumble) are much more difficult to hear.

When attempting to measure sound in a way that approximates what our ears hear, we must give more weight to sounds at the frequencies we hear well and less weight to sounds at frequencies we do not hear well. Acousticians have developed several weighting scales for measuring sound. The A-weighted scale was developed to correlate with the judgments people make about the loudness of sounds. The A-weighted decibel scale (dBA) is used in studies where audible sound is the focus of inquiry. **Exhibit 1-4** shows the A, B, and C sound weighting scale. The U.S. Environmental Protection Agency (USEPA) has recommended the use of the A-weighted decibel scale in studies of environmental noise.[1] Its use is required by the Federal Aviation Administration (FAA) in airport noise studies.[2] For the purposes of this analysis, dBA was used as the noise metric and dB and dBA are used interchangeably.

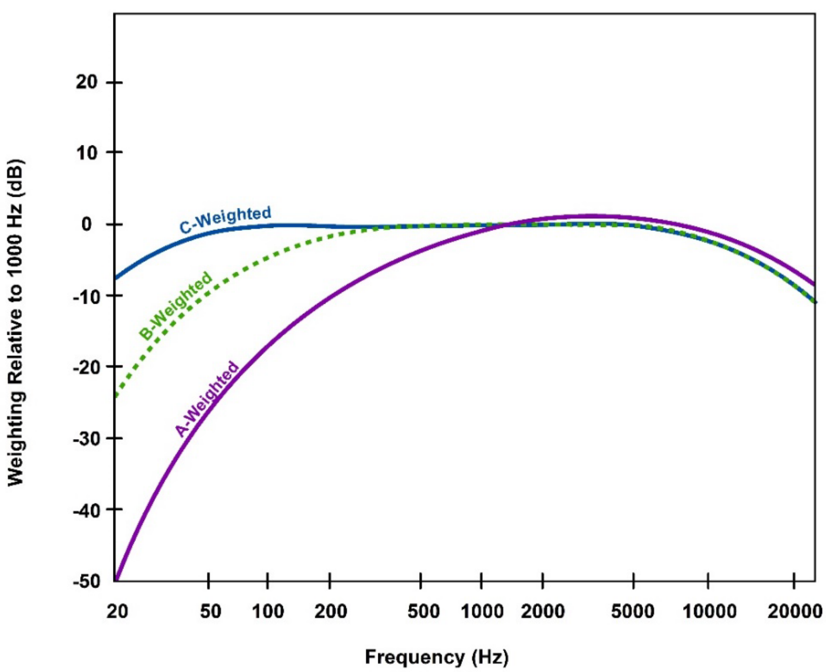
1.3 Duration of Sounds

The duration of sounds – their patterns of loudness and pitch over time – can vary greatly. Sounds can be classified as *continuous* like a waterfall, *impulsive* like a firecracker, or *intermittent* like aircraft overflights. Intermittent sounds are produced for relatively short periods, with the instantaneous sound level during the event roughly appearing as a bell-shaped curve. An aircraft event is characterized by the period during which it rises above the background sound level, reaches its peak, and then recedes below the background level.

1.4 Perceived Noise Level

Perceived noisiness is another method of rating sound that was originally developed for the assessment of aircraft noise. Perceived noisiness is the subjective measure of the degree to which noise is unwanted or causes annoyance to an individual. To determine perceived noise level, individuals are asked to judge in a laboratory setting when two sounds are equally noisy or disturbing if heard regularly in their own environment. These surveys are inherently subjective and thus subject to greater variability. For example, two separate events of equal noise energy may be perceived differently if one sound is more annoying to the listener than the other.

EXHIBIT 1-4, SOUND FREQUENCY WEIGHTING CURVES



Source: Federal Highway Administration

1 Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety. U.S. Environmental Protection Agency, Office of Noise Abatement and Control. 1974, P. A-10.

2 "Airport Noise Compatibility Planning." 14 CFR Part 150, Sec. A150.3.

1.5 Propagation of Noise

Outdoor sound levels decrease as a function of distance from the source, and as a result of wave divergence, atmospheric absorption, and ground attenuation. If sound is radiated from a source in an homogeneous and undisturbed manner, the sound travels as spherical waves. As the sound wave travels away from the source, the sound energy is distributed over a greater area, dispersing the sound energy of the wave. Spherical spreading of the sound wave reduces the noise level at a rate of 6 dB per doubling of the distance.

Atmospheric absorption also influences the levels that are received by the observer. The greater the distance traveled, the greater the influence of the atmosphere and the resultant fluctuations. Atmospheric absorption becomes important at distances of greater than 1,000 feet. The degree of absorption is a function of the frequency of the sound as well as the humidity and temperature of the air.

The rate of atmospheric absorption varies with sound frequency. The higher frequencies are more readily absorbed than the lower frequencies. Over large distances, the lower frequencies become the dominant sound as the higher frequencies are attenuated.

Turbulence and gradients of wind, temperature, and humidity also play a significant role in determining the degree of attenuation. Certain conditions, such as inversions, can also result in higher noise levels than would result from spherical spreading as a result of channeling or focusing the sound waves.

The effect of ground attenuation on noise propagation is a function of the height of the source and/or receiver and the characteristics of the terrain. The closer the source of noise is to the ground, the greater the ground absorption. Terrain consisting of soft surfaces such as vegetation provide for more ground absorption than hard surfaces. Ground attenuation is important for the study of noise from airfield operations (such as, thrust reversals) and in the design of noise berms or engine run-up facilities.

2 Factors Influencing Human Response to Sound

Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. These factors include not only physical (acoustic) characteristics of the sound but also secondary (non-acoustic) factors, such as sociological and external factors.

Sound rating scales are developed to account for the factors that affect human response to sound. Nearly all of these factors are relevant in describing how sounds are perceived in the community. Many of the non-acoustic parameters play a prominent role in affecting individual response to noise. Background sound (ambient noise) is also important in describing sound in rural settings. Some non-acoustic factors that may influence an individual's response to aircraft noise include:

- Predictability of when the sound/noise will occur;
- How the noise affects certain activities;
- Fear of an aircraft crashing;
- Belief that aircraft noise could be prevented or reduced by aircraft designers, pilots, or authorities related to airlines or airports; and
- Sensitivity to noise in general.

Thus, it is important to recognize that non-acoustic factors such as those described above, as well as acoustic factors, contribute to human response to noise.

3 Standard Noise Descriptors

Given the multiple dimensions of sound, a variety of descriptors, or metrics, have been developed for describing sound and noise. Some of the most commonly used metrics are discussed in this section. They include:

1) Maximum Level (**Lmax**)
2) Time Above Level (**TA**)
3) Sound Exposure Level (**SEL**)
4) Equivalent Sound Level (**Leq**)
5) Day-Night Average Sound Level (**DNL**)

3.1 Maximum Level (Lmax)

Lmax is simply the highest sound level recorded during an event or over a given period of time. It provides a simple and understandable way to describe a sound event and compare it with other events. In addition to describing the peak sound level, Lmax can be reported on an appropriate weighted decibel scale (A-weighted, for example) so that it can disclose information about the frequency range of the sound event in addition to the loudness.

Lmax, however, fails to provide any information about the duration of the sound event. This can be a critical shortcoming when comparing different sounds. Even if they have identical Lmax values, sounds of greater duration contain more sound energy than sounds of shorter duration. Research has demonstrated that for many kinds of sound effects, the total sound energy, not just the peak sound level, is a critical consideration.

3.2 Time Above Level (TA)

The “time above,” or TA, metric indicates the amount of time that sound at a particular location exceeds a given sound level threshold. TA is often expressed in terms of the total time per day that the threshold is exceeded. The TA metric explicitly provides information about the duration of sound events, although it conveys no information about the peak levels during the period of observation.

3.3 Number of Events Above Level (NA)

Similar to TA, the Number of Events Above (NA) metric indicates the total number of aircraft events at particular location that exceed a given sound level threshold in dB. The NA metric explicitly provides information about the number of sound events, although it conveys no information about the duration of the event(s).

3.4 Sound Exposure Level (SEL)

The sound exposure level, or SEL metric, provides a way of describing the total sound energy of a single event. In computing the SEL value, all sound energy occurring during the event, within 10 dB of the peak level (Lmax), is mathematically integrated over one second. (Very little information is lost by discarding the sound below the 10 dB cut-off, since the highest sound levels completely dominate the integration calculation.) Consequently, the SEL is always greater than the Lmax for events with a duration greater than one second. SELs for aircraft overflights typically range from five to 10 dB higher than the Lmax for the event.

Exhibit 3-1 shows graphs of instantaneous sound levels for three different events: an aircraft flyover, steady roadway noise, and a firecracker.

The Lmax and the duration of each event differ greatly. The pop of the firecracker is quite loud, 102 dB but lasts less than a second. The aircraft flyover has a considerably lower Lmax at 90 dB, but the event lasts for over a minute. The Lmax from the roadway noise is even quieter at only 72 dB, but it lasts for 15 minutes. By considering the loudness and the duration of these very different events simultaneously, the SEL metric reveals that the total sound energy of all three is identical. This can be a critical finding for studies where total noise dosage is the focus of study. As it happens, research has shown conclusively that noise dosage is crucial in understanding the effects of noise on animals and humans.

3.5 Equivalent Sound Level (Leq)

The equivalent sound level (Leq) metric may be used to define cumulative noise dosage, or noise exposure, over a period of time. In computing Leq, the total noise energy over a given period of time, during which numerous events may have occurred, is logarithmically averaged over the time period. The Leq represents the steady sound level that is equivalent to the varying sound levels actually occurring during the period of observation. For example, an 8-hour Leq of 67 dB indicates that the amount of sound energy in all the peaks and valleys that occurred in the 8-hour period is equivalent to the energy in a continuous sound level of 67 dB. Leq is typically computed for measurement periods of 1 hour, 8 hours, or 24 hours, although any time period can be specified.

Exhibit 3-2 shows the relationship of Leq to Lmax and SEL. In this example, a single aircraft event lasting 18 seconds is represented. The instantaneous noise levels for the event range from 64 to an Lmax of 101 dBA. The area under the curve represents the sound energy accumulated during the entire event. The compression of this energy into a single second results in an SEL of 105 dBA. The Leq average of the sound energy for each second during the event would be 93 dB. If this event were the only event to occur during an hour, the aircraft sound energy for the other 3,582 seconds would be considered to be zero. When converted to an hourly Leq, the level would be nearly 70 dB of Leq. This again indicates the dominance of loud events in noise summation and averaging computations.

Leq is a critical noise metric for many kinds of analysis where total noise dosage, or noise exposure, is under investigation. As already noted, noise dosage is important in understanding the effects of noise on both animals and people. Indeed, research has led to the formulation of the “equal energy rule.” This rule states that it is the total acoustical energy to which people are exposed that explains the effects the noise will have on them. That is, a very loud noise with a short duration will have the same effect as a lesser noise with a longer duration if they have the same total sound energy.

3.6 Day-Night Average Sound Level (DNL)

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

As with Leq, DNL values are strongly influenced by the loud events. For example, 30 seconds of sound of 100 dB, followed by 23 hours, 59 minutes, and 30 seconds of silence would compute to a DNL value of 65 dB. If the 30 seconds occurred at night, it would yield a DNL of 75 dB.

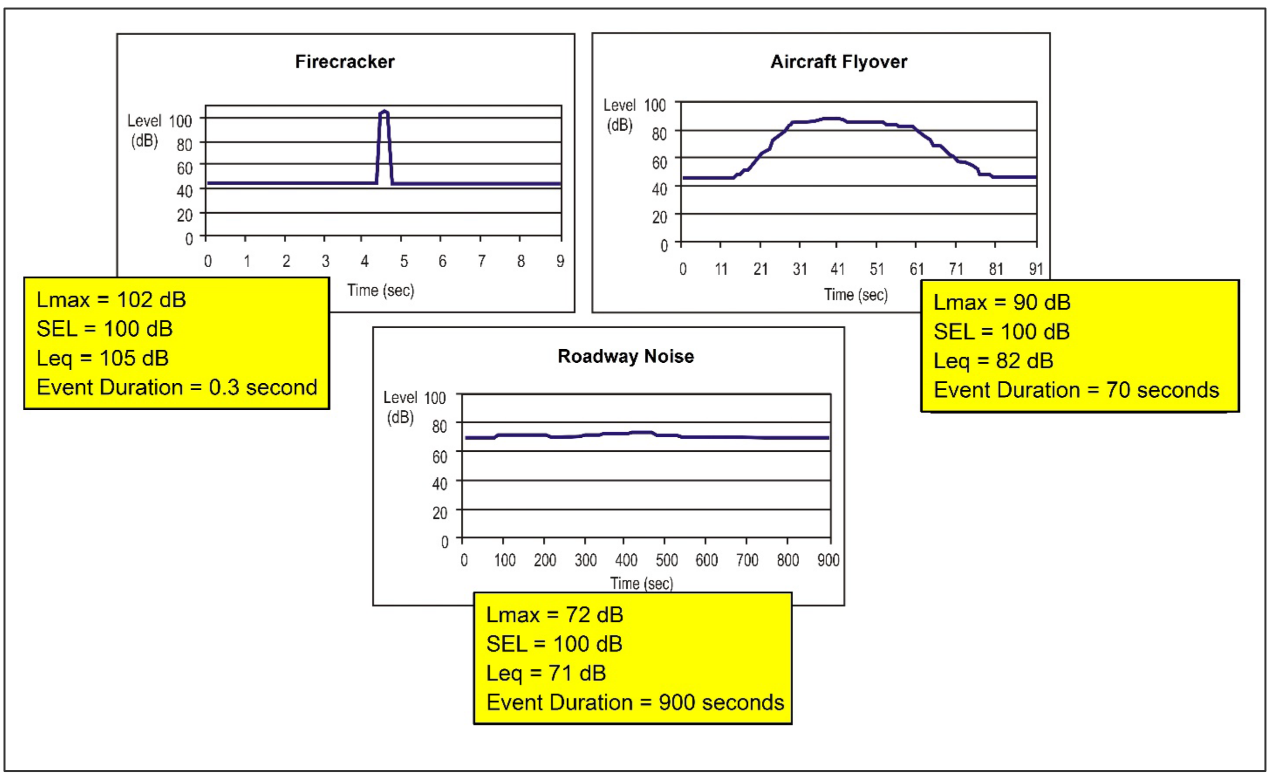
This example can be roughly equated to an airport noise environment. Recall that an SEL is the mathematical compression of a noise event into one second. Thus, 30 SELs of 100 dB during a 24-hour period would equal DNL 65 dB, or DNL 75 dB if they occurred at night.

This situation could actually occur in places around a real airport. If the area experienced 30 overflights during the day, each of which produced an SEL of 100 dB, it would be exposed to DNL 65 dB. Recalling the relationship of SEL to the peak noise level (Lmax) of an aircraft overflight, the Lmax recorded for each of those overflights (the peak level a person would actually hear) would typically range from 90 to 95 dB.

3.7 Federal Requirements to Use DNL in Environmental Noise Studies

The DNL metric is the standard noise metric for use in FAA studies and decision-making purposes. The FAA uses the DNL metric for purposes of determining an individual's cumulative noise exposure, for land use compatibility under 14 CFR part 150, and for assessing the significance of predicted noise impacts under NEPA. The FAA uses the DNL metric for purposes of determining an individual's cumulative noise exposure, for land use compatibility under 14 CFR part 150, and for assessing the significance of predicted noise impacts under NEPA. Ongoing research activities sponsored by the FAA and the broader research community are working to develop a greater understanding of other noise-related impact criteria. This research may expand the use of supplemental metrics, including new metrics designed to measure speech interference (N75), Percent Awakening, Learning (Leq(8)), and rattling from low frequency noise Lmax(c).[3]

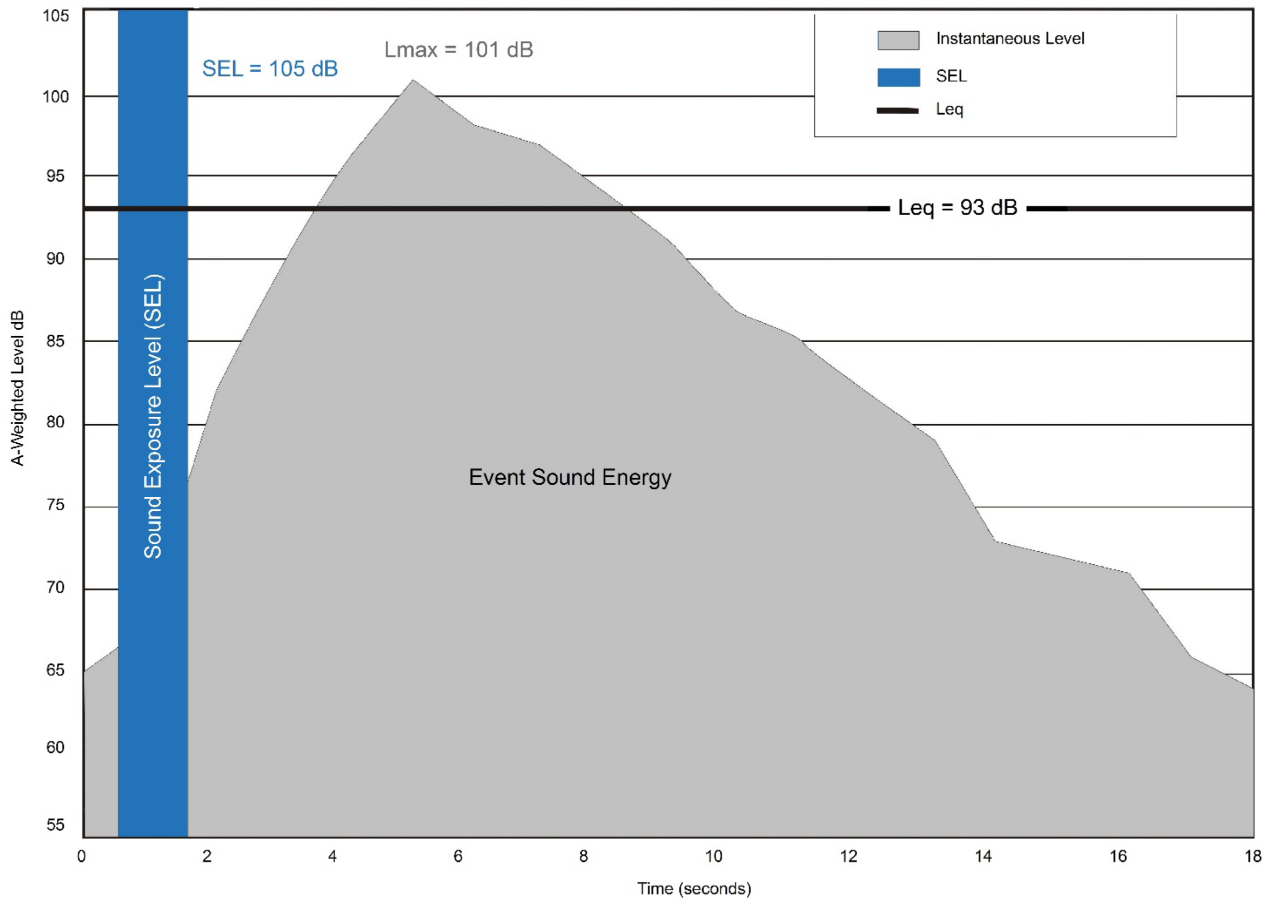
EXHIBIT 3-1, MEASUREMENT OF DIFFERENT TYPES OF SOUND



Source: Landrum & Brown, 2020

EXHIBIT 3-2, RELATIONSHIP AMONG SOUND METRICS

3 Report to Congress, FAA Reauthorization Act of 2018 (Pub. L. 115-254), Section 188 and Sec 173. Federal Aviation Administration, 2020.



Source: Landrum & Brown, 2020

4 Health Effects of Noise

A considerable amount of research has been conducted to identify, measure, and quantify the potential effects of aviation noise on health. The various methods by which noise can be measured (e.g. single dose, long-term average, number of events above a certain level, etc.), and difficulties in separating other lifestyle factors from the analysis, increases the complexity of determining the health effects of noise, and has caused considerable variability in the results of past studies. The health effects of noise are often divided into the following topics: cardiovascular effects, hearing loss, sleep disturbance, and speech/communication interference.

4.1 Cardiovascular Effects

Several studies have suggested that increased hypertension or other cardiovascular effects, such as increased blood pressure, and change in pulse rate, may be associated with long-term exposure to high levels of environmental noise. When conducting cross-sectional studies of environmental noise exposure, it is difficult to control for other important variables. Subsequent reviews of past research have pointed out that such studies "…are notoriously difficult to interpret. They often report conflicting results, generally do not identify a cause and effect relationship, and often do not report a dose-response relationship between the cause and effect."[4] In 2018, the World Health Organization (WHO) published its Environmental Noise Guidelines report (WHO report) with reference to recent research related to aircraft noise and human response.[5] The WHO report references two ecological studies that provide information on the relationship between aircraft noise and incidence of ischemic heart disease (IHD); however, this "…evidence was rated low quality." Additionally, the WHO report reference one cohort study and several cross-sectional studies of the relationship between aircraft noise and hypertension. The WHO report noted "…inconsistency across studies" and the "…evidence was rated low quality." Similar studies of the relationship between aircraft noise and cases of stroke were reviewed. The WHO report noted that this "…evidence was rated very low quality." Therefore, it is difficult to draw any conclusions about the relationship between aircraft noise exposure and cardiovascular effects.

4.2 Hearing Loss

The potential for noise-induced hearing loss is commonly associated with occupational noise exposure from working in a noisy work environment or recreational noise such as listening to loud music. Recent studies have concluded that "because environmental noise does not approximate occupational noise levels or recreational noise exposures…it does not have an effect on hearing threshold levels." Furthermore, "aviation noise does not pose a risk factor for child or adolescent hearing loss, but perhaps other noise sources (personal music devices, concerts, motorcycles, or night clubs) are a main risk factor."[6] This conclusion is supported by the 2018 WHO Environmental Noise Guidelines which notes that "(n)o studies were found, and therefore no evidence was available on the association between aircraft noise and hearing impairment and tinnitus."[7] Because aviation noise levels near airports do not approach levels of occupational or recreational noise exposures associated with hearing loss, hearing impairment is likely not caused by aircraft noise for populations living near an airport.

4.3 Sleep Disturbance

Sleep disturbance is a common complaint from people who live in the vicinity of an airport. A large amount of research has been published on the topic of sleep disturbance caused by environmental noise. This research has produced variable results due to differing definitions of sleep disturbance, different ways for measuring sleep disturbance (behavioral awakenings or sleep interruption), and different settings in which to measure it (laboratory setting or field setting).

In 1992, the Federal Interagency Committee on Noise (FICON) recommended an interim dose-response curve to predict the percent of the exposed population expected to be awakened (percent awakening) as a function of the exposure to single event noise levels expressed in terms of the Sound Exposure Level (SEL). This interim curve was based on statistical adjustment of previous analysis and included data from both laboratory and field studies. In 1997, Federal Interagency Committee on Aviation Noise (FICAN) recommended a revised sleep disturbance relationship based on data and analysis from three field studies.

Exhibit 4-1 shows the results of the 1992 and 1997 analyses. The top graph shows a comparison of the 1992 FICON and 1997 FICAN curves. The 1997 FICAN curve represents the upper limit of the

4 Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.
5 World Health Organization, Regional Office for Europe, Environmental Noise Guidelines for the European Region, 2018.
6 Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.
7 World Health Organization, Regional Office for Europe, Environmental Noise Guidelines for the European Region, 2018.

observed field data and should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened", or the "maximum percent awakened" for a given residential population.

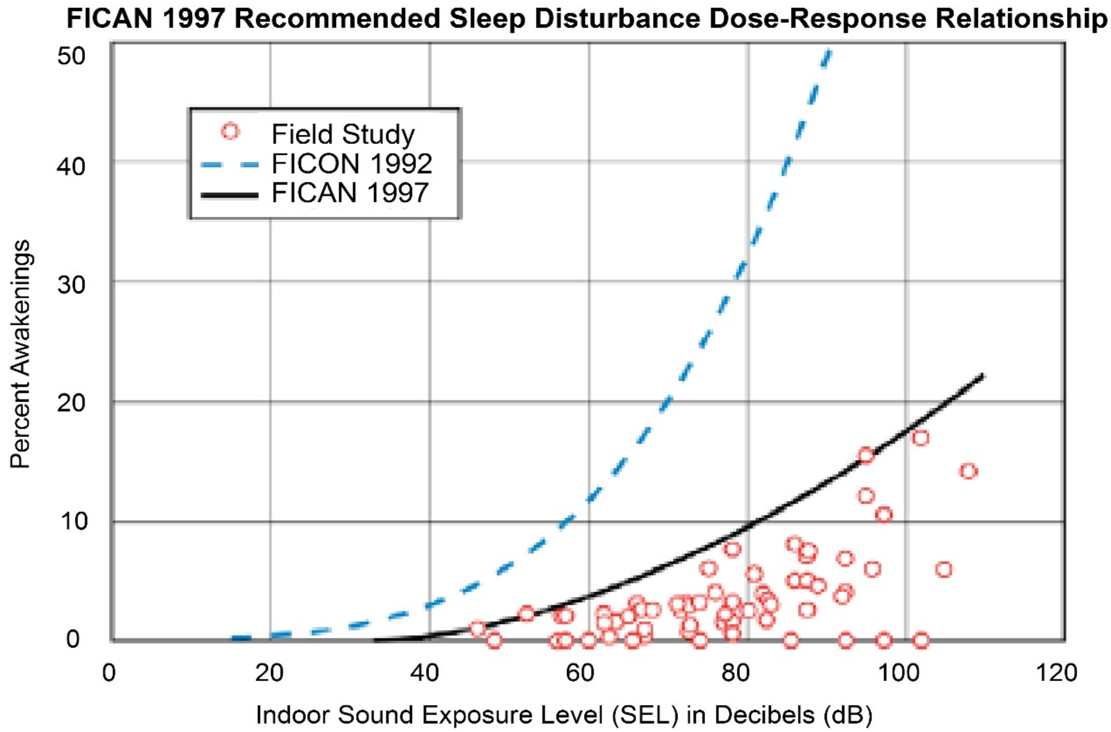
In 2008, FICAN recommended the use of a revised method to predict sleep disturbance in terms of percent awakenings based on data published by the American National Standards Institute (ANSI).[8] In contrast to the earlier FICAN recommendation, the 2008 ANSI standard indicates that the probability of awakening is lower for a single noise event in cases where the population is exposed to the given noise source for a long period of time (more than one year) compared to the probability of awakening for sound that is new to an area. In Exhibit 4-1, the lower graph shows these two relationships, with Equation 1 (blue dotted line) representing percent awakenings from long-term noise and Equation B1 (pink dashed line) representing percent awakenings from a new noise source based on the 1997 FICAN results. As shown in this exhibit, at an indoor Sound Exposure Level (SEL) of 100 dB, the probability of awakenings would be expected to exceed 15 percent for a new noise source; yet for long-term noise sources, the probability of awakening is expected to be less than 10 percent.

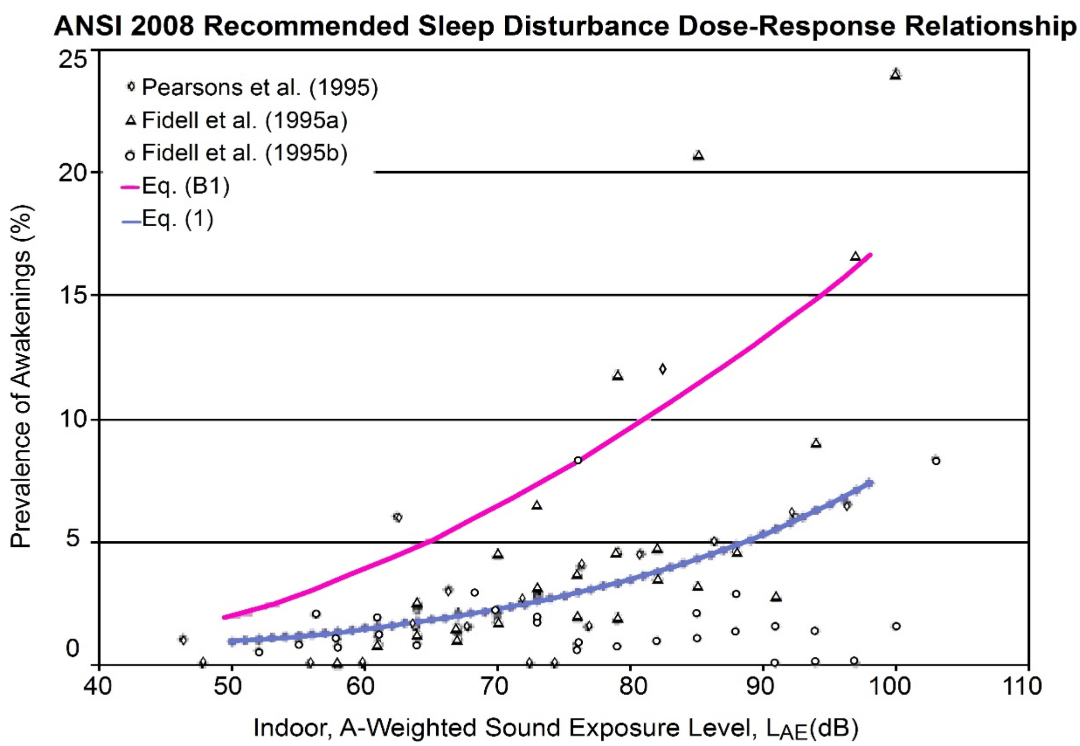
The numerous studies and reports that have been developed on the subject of sleep disturbance related to environmental noise over the past several decades have produced varied results. A review of past studies conducted by the Airport Cooperative Research Program suggests that in-home sleep disturbance studies clearly demonstrate that it requires more noise to cause awakenings than was previously theorized based on laboratory sleep disturbance studies.[9] The 2018 WHO Environmental Noise Guidelines references six studies that attempted to measure sleep disturbance at noise levels between 40 dB and 65 dB. Over 11% of the population was characterized as highly sleep-disturbed at nighttime levels of 40 dB. These studies were based on self-reporting and the "…evidence was rated moderate quality…" for an association between aircraft noise and probability of awakenings.[10]

Due to the variability of study methodologies, particularly studies outside of a laboratory, and other influencing factors, it is difficult to determine the noise level at which a high percentage of the population would be expected to be awakened by aircraft noise. No definitive conclusions have been drawn on the percent of a population that is estimated to be awakened by a certain level of aircraft noise and recent studies have cautioned about the over interpretation of the data.[11]

8 ANSI S12.9-2008, 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, 2008.
9 Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.
10 World Health Organization, Regional Office for Europe, Environmental Noise Guidelines for the European Region, 2018.
11 Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.

EXHIBIT 4-1, SLEEP DISTURBANCE DOSE-RESPONSE CURVES





Sources: Federal Interagency Committee on Aviation Noise (FICAN), June 1997; American National Standards Institute, 2008.

4.4 Communication Interference

Communication interference can impact activities such as personal conversations, classroom learning, and listening to radio and television. Most studies have focused on communication interference due to continual noise sources. In 1974, the USEPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, which is one of the few studies to focus on intermittent noise. The study concluded that for voice communication, an indoor Leq of 45 dB allows normal conversation at distances up to 2 meters with 95 percent sentence intelligibility. **Exhibit 4-2** shows the required distance between talker and listener based on the type of speech communication (normal voice, loud voice, etc.) and the environmental noise level from the 1974 USEPA report.

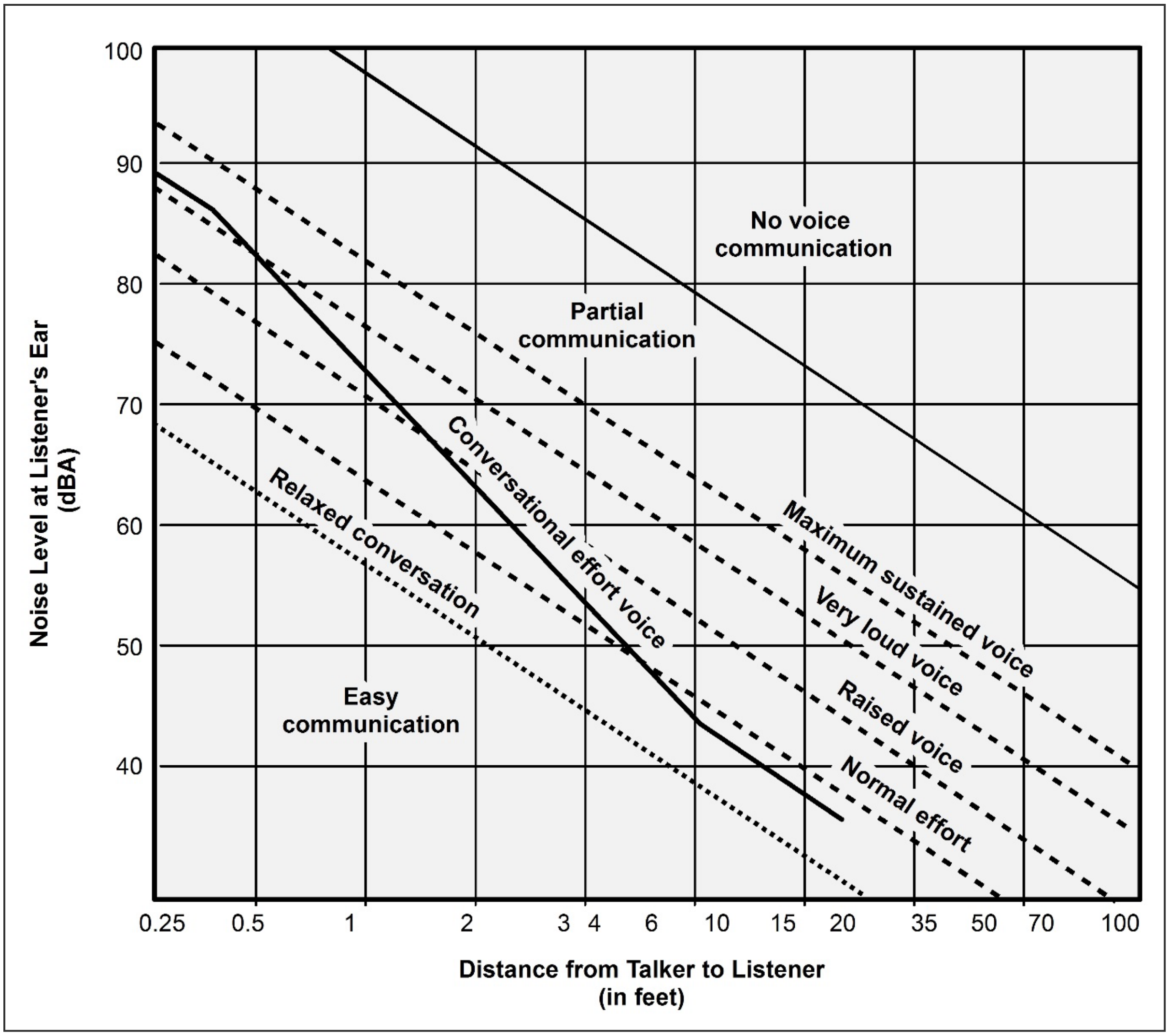
Noise can also impact communication between student and teacher necessary for learning in a classroom setting. It is usually accepted that noise levels above a certain Leq may affect a child's learning experiences. Research has shown a "decline in reading when outdoor noise levels equal or exceed Leq of 65 dBA."[12] Furthermore, a study conducted by FICAN in 2007 found: "(1) a substantial association between noise reduction and decreased failure (worst-score) rates for high-school students, and (2) significant association between noise reduction and increased average test scores for student/test subgroups. In general, the study found little dependence upon student group and upon test type."[13] A study of noise exposure and the effects on school test scores between 2000/01 and 2008/09 found "…statistically significant associations between airport noise and student mathematics and reading test scores, after taking demographic and school factors into account."[14] This study also found that schools that had been provided sound insulation had better test scores than schools that were not sound insulated. This Study made no recommendation regarding the noise level at which impacts upon learning may occur.

[12] Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.

[13] Federal Interagency Committee on Aviation Noise (FICAN), Findings of the FICAN Pilot Study on the Relationship between Aircraft Noise Reduction and Changes in Standardized Test Scores, July 2007.

[14] National Academies of Sciences, Engineering, and Medicine; Assessing Aircraft Noise Conditions Affecting Student Learning, Volume 1: Final Report; 2014.

EXHIBIT 4-2, NOISE EFFECTS ON DISTANCE NECESSARY FOR SPEECH COMMUNICATION



Source: FICON, 1992; from USEPA, 1974.

5 Noise Modeling Methodology

This memo summarizes the methodology and data input for the noise contour modeling for this Environmental Assessment (EA). The analysis of noise exposure around CLT was prepared using the latest version of the FAA's Aviation Environmental Design Tool (AEDT) Version 3b.[15] Inputs to the AEDT include runway definition, number of aircraft operations during the time period evaluated, the types of aircraft flown, the time of day when they are flown, how frequently each runway is used for arriving and departing aircraft, the routes of flight used when arriving to and departing from the runways, and ground run-up activity. The AEDT calculates noise exposure for the area around the airport and outputs contours of equal noise exposure using the Day-Night Average Sound Level (DNL) metric. For this EA, equal noise exposure contours for the levels of 65, 70, and 75 DNL were calculated and represent average-annual day conditions.

[15] AEDT Version 3b was the most recent version of AEDT when the noise modeling began.

5.1 2028 No Action Alternative Noise Exposure Contour

Runway Definition

The Airport currently has four runways: three parallel runways (18L/36R, 18C/36C, and 18R/36L), and a crosswind runway (05/23). This runway configuration would remain under the 2028 No Action Alternative. The airfield layout for the 2028 No Action Alternative at CLT is shown on **Exhibit 5-1**. The runways and lengths at CLT for the 2028 No Action Alternative are listed below:

Runway	Length (feet)
05/23	7,502
18L/36R	8,676
18C/36C	10,000
18R/36L	9,000

Number of Operations and Fleet Mix

The number of annual operations modeled for the 2028 No Action Alternative was based on the latest forecast of aviation activity prepared for CLT.[16] That forecast included 639,783 total annual operations in 2028, or 1,752.8 average-annual day operations. Specific aircraft types and times of operation for commercial aircraft were developed from the future design day schedules prepared for that forecast. The future design day flight schedules provided peak operating levels by aircraft type and time of day. These peak levels were converted to an average-annual day for modeling the 2028 No Action Alternative. **Table 5-1** shows the number of aircraft operations during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) that was used to model the 2028 No Action Alternative noise exposure contour.

[16] Forecast Technical Memorandum, Technical Memorandum – Final, Charlotte Douglas International Airport Environmental Impact Statement, VHB in association with InterVISTAS, April 18, 2018.

EXHIBIT 5-1, AIRPORT LAYOUT PLAN – 2028 NO ACTION ALTERNATIVE

Source: Landrum & Brown

TABLE 5-1, DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT CATEGORY 2028 NO ACTION ALTERNATIVE

AEDT Airframe Type	AEDT Engine Code	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Heavy Passenger Jets						
Airbus A330-200 Series	2RR023	3.6	0.0	3.6	0.0	7.3
Airbus A350-900 series	14RR075	0.7	0.0	0.7	0.0	1.5
Boeing 787-9 Dreamliner	12GE155	3.6	0.0	3.6	0.0	7.3
Subtotal		*8.0*	*0.0*	*8.0*	*0.0*	*16.0*
Cargo Jet						
Airbus A300F4-600 Series	1PW048	1.7	1.0	1.2	1.5	5.5
Airbus A300F4-600 Series	2GE039	1.3	0.8	0.9	1.1	4.1
Boeing MD-10-1 Freighter	1GE001	0.5	0.3	0.4	0.4	1.6
Subtotal		*3.5*	*2.1*	*2.5*	*3.1*	*11.2*
Large Passenger Jet						
Airbus A319-100 Series	2CM019	59.1	5.2	56.9	7.4	128.7
Airbus A319-100 Series	3IA007	40.1	3.6	38.6	5.0	87.2
Airbus A320-100 Series	1IA003	5.6	0.5	5.4	0.7	12.3
Airbus A320-100 Series	2CM014	5.8	0.5	5.6	0.7	12.5
Airbus A320-200 Series	1CM009	2.7	0.2	2.6	0.3	5.8
Airbus A320-200 Series	1IA003	0.7	0.1	0.6	0.1	1.5
Airbus A321-200 Series	3CM025	40.2	3.6	38.7	5.0	87.5
Airbus A321-200 Series	3IA008	60.3	5.3	58.1	7.5	131.3
Airbus A321-NEO	8CM053	19.4	1.7	18.7	2.4	42.3
Boeing 717-200 Series	4BR002	4.7	0.4	4.5	0.6	10.2
Boeing 737 MAX 7	18CM087	0.7	0.1	0.6	0.1	1.5
Boeing 737 MAX 8	18CM084	25.5	2.3	24.5	3.2	55.4
Boeing 737 MAX 9	18CM086	1.3	0.1	1.3	0.2	2.9
Boeing 737-700 Series	3CM031	5.4	0.5	5.2	0.7	11.7
Boeing 737-800 Series	3CM033	7.4	0.7	7.1	0.9	16.0
Boeing MD-90	1IA002	1.3	0.1	1.3	0.2	2.9
Bombardier CRJ-700-ER	5GE083	114.6	10.2	110.4	14.3	249.5
Bombardier CRJ-700-LR	6GE092	1.3	0.1	1.3	0.2	2.9
Bombardier CRJ-900-ER	6GE092	146.7	13.0	141.4	18.4	319.5
Embraer ERJ170	6GE094	3.3	0.3	3.2	0.4	7.3
Embraer ERJ175	6GE094	42.9	3.8	41.3	5.4	93.4
Embraer ERJ190-AR	10GE129	5.4	0.5	5.2	0.7	11.7
Subtotal		*594.3*	*52.7*	*572.6*	*74.4*	*1294.0*
Regional Jet						
Bombardier Challenger 300	11HN003	2.5	0.1	2.5	0.2	5.4
Bombardier Challenger 300	8HN001	2.3	0.1	2.2	0.2	4.8
Bombardier CRJ-200-LR	5GE084	111.9	6.3	108.9	9.3	236.3
Bombardier Global Express	4BR009	3.3	0.2	3.2	0.3	7.0
Bombardier Learjet 45	1AS001	5.1	0.3	4.9	0.4	10.7
Cessna 525 Citation Jet	1PW035	2.5	0.1	2.5	0.2	5.4
Cessna 560 Citation XLS	1PW037	2.5	0.1	2.5	0.2	5.4
Cessna 750 Citation X	6AL021	7.6	0.4	7.4	0.6	16.1
Dassault Falcon 2000	7PW080	7.1	0.4	6.9	0.6	14.9
Dassault Falcon 50	1AS002	3.3	0.2	3.2	0.3	7.0
Dornier 328 Jet	7PW078	2.5	0.1	2.5	0.2	5.4
Embraer 505	PW530	10.2	0.6	9.9	0.8	21.5
Embraer ERJ145	6AL008	5.1	0.3	4.9	0.4	10.7

TABLE 5-1, DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT CATEGORY 2028 NO ACTION ALTERNATIVE *(CONTINUED)*

AEDT Airframe Type	AEDT Engine Code	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Regional Jet (*continued*)						
Raytheon Hawker 800	1AS002	2.5	0.1	2.5	0.2	5.4
Subtotal		*168.4*	*9.4*	*163.9*	*13.9*	*355.7*
Commuter / Cargo Prop						
Embraer EMB120 Brasilia	PW118	4.8	0.5	3.8	1.6	10.7
Raytheon Super King Air 300	PT6A60	2.4	0.3	1.9	0.8	5.4
Subtotal		*7.2*	*0.8*	*5.6*	*2.4*	*16.1*
General Aviation Jet						
Bombardier Challenger 600	5GE084	0.8	0.0	0.7	0.1	1.6
Bombardier Learjet 60	7PW077	0.8	0.0	0.7	0.1	1.6
Cessna 525A Citation Jet	PW610F	0.8	0.0	0.7	0.1	1.6
Cessna 525B Citation Jet	1PW036	0.8	0.0	0.7	0.1	1.6
Cessna 550 Citation II	1PW036	1.5	0.1	1.5	0.1	3.2
Cessna 560 Citation Excel	PW530	3.8	0.2	3.7	0.3	7.9
Cessna 560 Citation V	1PW037	2.3	0.1	2.2	0.2	4.8
Dassault Falcon 900	1AS002	0.8	0.0	0.7	0.1	1.6
Gulfstream G150	1AS002	0.8	0.0	0.7	0.1	1.6
Gulfstream G200	TFE731	0.8	0.0	0.7	0.1	1.6
Gulfstream G280	11HN005	1.5	0.1	1.5	0.1	3.2
Gulfstream G500	3BR001	0.8	0.0	0.7	0.1	1.6
Gulfstream G650	11BR011	0.8	0.0	0.7	0.1	1.6
Subtotal		*15.8*	*0.9*	*15.4*	*1.3*	*33.3*
General Aviation Prop						
Cessna 303 Crusader (FAS)	TIO540	0.7	0.1	0.6	0.2	1.6
Cirrus SR22	TIO540	0.7	0.1	0.6	0.2	1.6
DAHER TBM 900/930	PT6A66	0.7	0.1	0.6	0.2	1.6
Pilatus PC-12	PT6A67	4.3	0.5	3.3	1.4	9.5
Raytheon Beech Baron 58	TIO540	0.7	0.1	0.6	0.2	1.6
Raytheon King Air 90	PT6A60	0.7	0.1	0.6	0.2	1.6
SOCATA TBM 850	PT6A66	0.7	0.1	0.6	0.2	1.6
Subtotal		*8.6*	*1.0*	*6.7*	*2.9*	*19.0*
Military						
Lockheed C-130 Hercules	T56A7	3.7	0.0	3.7	0.0	7.3
Subtotal		*3.7*	*0.0*	*3.7*	*0.0*	*7.3*
Grand Total		**809.5**	**66.9**	**778.4**	**98.0**	**1,752.8**

Notes: Day = 7:00 a.m. to 9:59 p.m., Night = 10:00 p.m. to 6:59 a.m. Totals may not equal sum due to rounding.
Source: OAG, Landing Fee Reports, FAA Operations Network (OPSNET) data, CLT Flight Tracking System Data, Landrum & Brown, 2021.

Runway End Utilization

CLT is operated in one of two primary runway configurations, north flow or south flow. When in north flow, aircraft arrive to CLT from the south in a north direction to land on Runway 36R, Runway 36C, and Runway 36L; and depart heading north from Runway 36R and Runway 36C. When in south flow, aircraft arrive to CLT from the north in a south direction to land on Runway 18L, Runway 18C, and Runway 18R; and depart heading south from Runway 18L and Runway 18C. Runway 05/23 is used on a limited basis. The runway configuration is primarily dictated by wind direction and airfield efficiency. A review of historic runway use data shows that CLT operates in north flow approximately 64 percent of the time in an average year and operates in south flow approximately 36 percent of the time in an average year. It is expected that the ratio of north to south flow would be similar in 2028.

The distribution of landings and take-offs from each runway is determined by airport traffic controllers to maintain airfield and airspace efficiency. The percent use of each runway end for the 2028 No Action Alternative was based on a review of the results of the simulation modeling that was prepared to determine typical usage of the parallel runways when in either north flow or south flow. Adjustments were made to convert simulated conditions during a peak day to average-annual conditions based on the historic ratio of north flow and south flow as well as other variable operating conditions. **Table 5-2** summarizes the percentage of use by each aircraft category on each of the runways at CLT during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) for the 2028 No Action Alternative noise modeling.

Flight Tracks

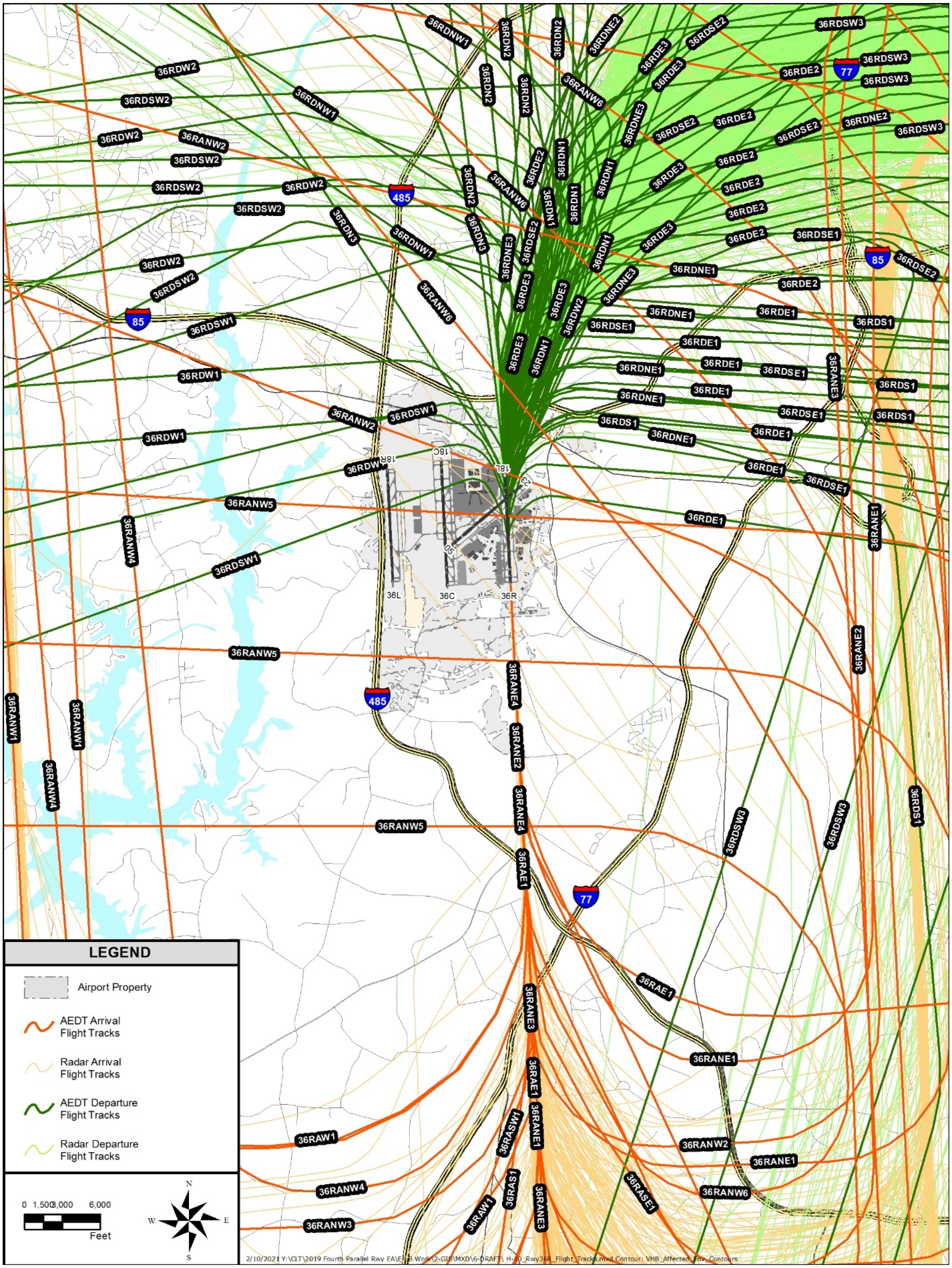
Flight tracks are built in the AEDT to model the noise levels of aircraft along each flight path to and from the runway ends. There are two components to modeling flight tracks, location and percent distribution. Flight track locations were developed based on a review of radar data from the CLT Flight Tracking System. The percent use of each track was based on a review of radar data and previous studies. The AEDT flight tracks modeled for the 2028 No Action Alternative noise exposure contour are shown on **Exhibit 5-2** through **Exhibit 5-8**. **Table 5-3** shows arrival flight track utilization percentages and **Table 5-4** shows departure flight track utilization percentages for the 2028 No Action Alternative noise exposure contour. Each flight track is identified by a track ID that corresponds to the label in the flight track exhibits.

TABLE 5-2, AVERAGE ANNUAL DAY RUNWAY USE – 2028 NO ACTION ALTERNATIVE

Aircraft Category	05	18C	18L	18R	36C	36L	36R	Total
Daytime Arrivals								
Heavy Passenger Jet	0.0%	4.9%	24.9%	6.0%	1.7%	6.3%	56.2%	100.0%
Cargo Jet	0.0%	8.0%	3.8%	24.1%	4.0%	47.4%	12.8%	100.0%
Large Passenger Jet	0.0%	12.3%	10.7%	12.8%	15.3%	29.2%	19.7%	100.0%
Regional / GA Jet	0.1%	9.3%	21.1%	5.4%	8.6%	16.9%	38.7%	100.0%
Commuter / Cargo / GA Prop	0.0%	3.5%	28.6%	3.7%	0.0%	13.0%	51.2%	100.0%
Military	0.0%	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	100.0%
Nighttime Arrivals								
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	0.2%	18.6%	17.3%	1.5%	31.2%	4.8%	26.5%	100.0%
Large Passenger Jet	0.0%	18.0%	12.7%	6.7%	33.3%	10.9%	18.4%	100.0%
Regional / GA Jet	0.2%	11.6%	23.1%	3.9%	21.1%	5.1%	35.0%	100.0%
Commuter / Cargo / GA Prop	0.0%	10.7%	31.2%	0.0%	16.4%	0.7%	40.9%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Daytime Departures								
Heavy Passenger Jet	0.0%	35.8%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Cargo Jet	0.0%	35.8%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Large Passenger Jet	0.0%	21.5%	14.3%	0.0%	39.2%	0.0%	25.0%	100.0%
Regional / GA Jet	0.1%	22.2%	13.6%	0.0%	40.1%	0.0%	24.0%	100.0%
Commuter / Cargo / GA Prop	1.2%	0.0%	35.8%	0.0%	0.0%	0.0%	63.0%	100.0%
Military	0.0%	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	100.0%
Nighttime Departures								
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	0.0%	26.6%	11.6%	0.0%	37.5%	0.0%	24.3%	100.0%
Large Passenger Jet	0.0%	19.7%	22.0%	0.0%	30.7%	0.0%	27.6%	100.0%
Regional / GA Jet	0.3%	16.2%	25.3%	0.0%	29.1%	0.0%	29.1%	100.0%
Commuter / Cargo / GA Prop	0.7%	7.7%	33.7%	0.0%	17.5%	0.0%	40.4%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

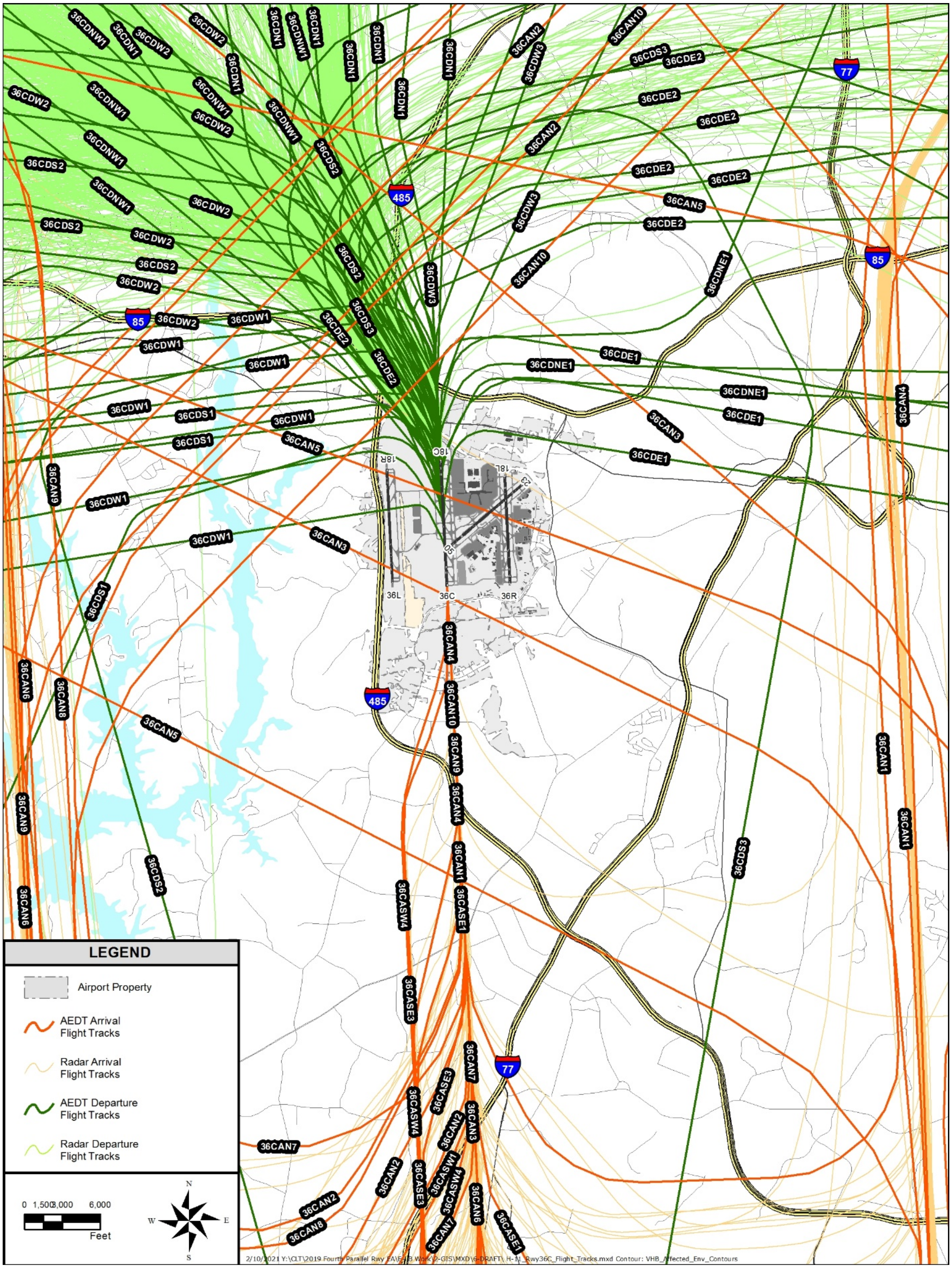
Source: CLT Flight Tracking System Data, Landrum & Brown analysis, 2021.

EXHIBIT 5-2, RUNWAY 36R FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



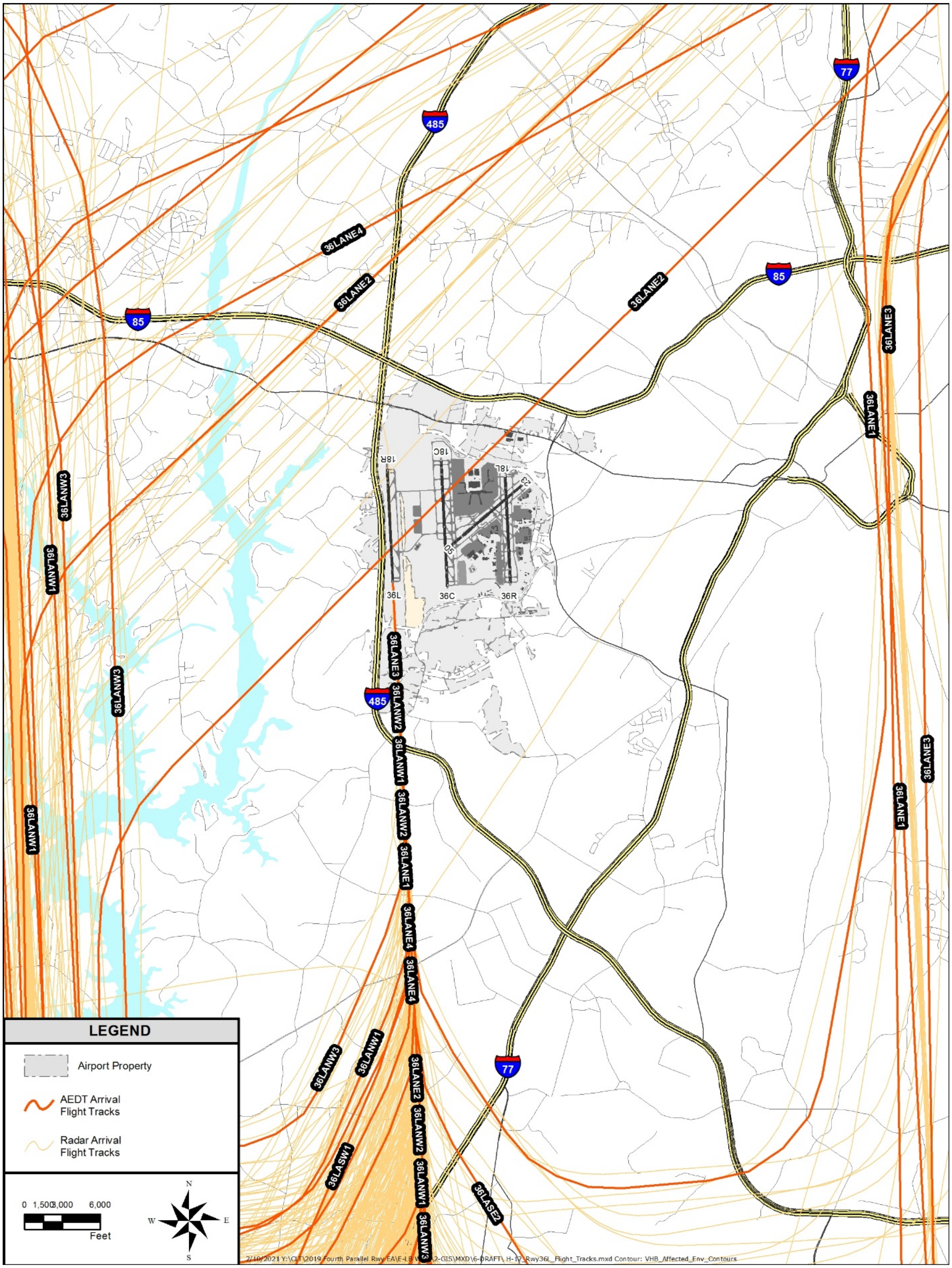
Source: Landrum & Brown

EXHIBIT 5-3, RUNWAY 36C FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



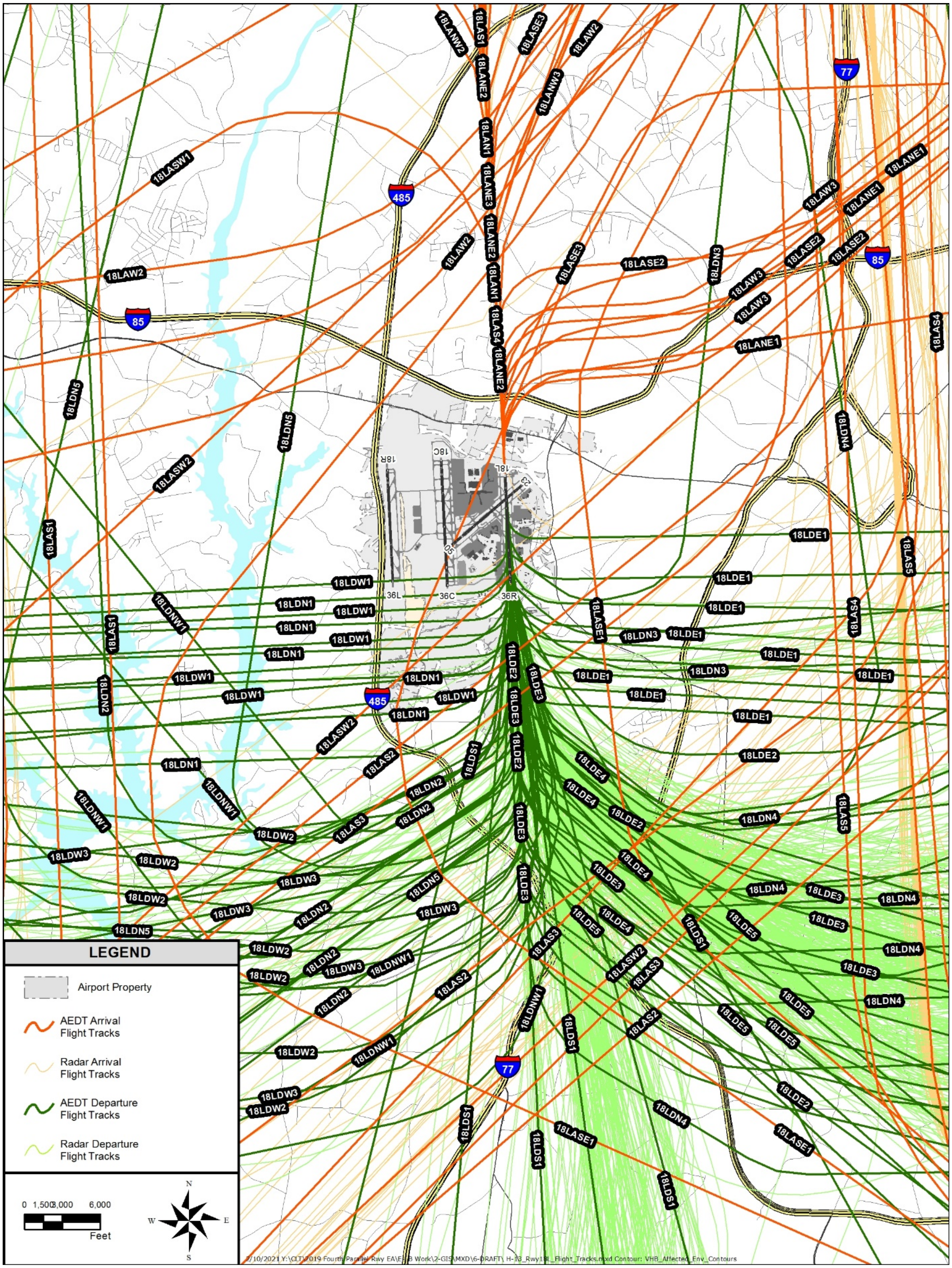
Source: Landrum & Brown, 2020

EXHIBIT 5-4, RUNWAY 36L FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



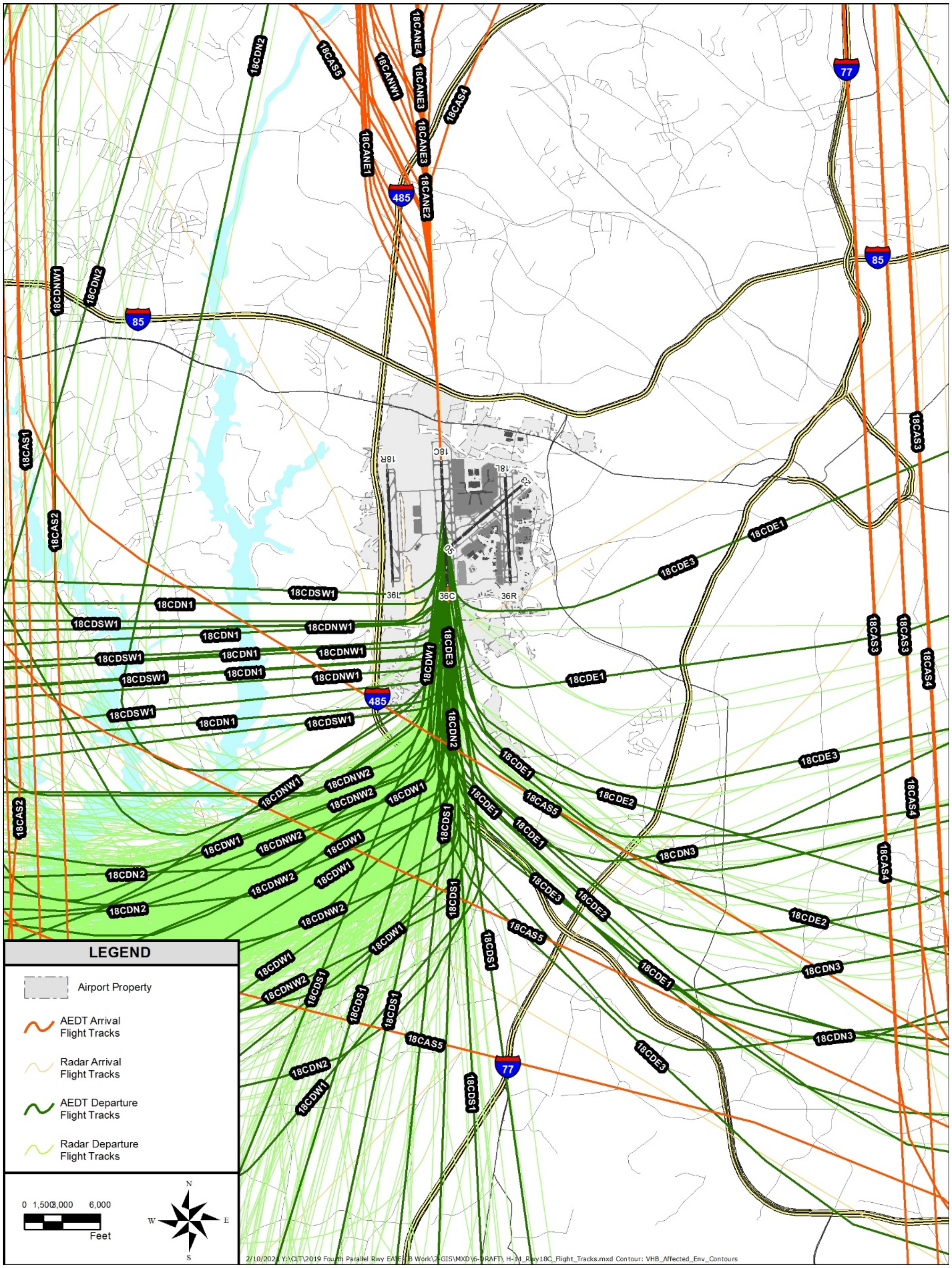
Source: Landrum & Brown, 2020

EXHIBIT 5-5, RUNWAY 18L FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



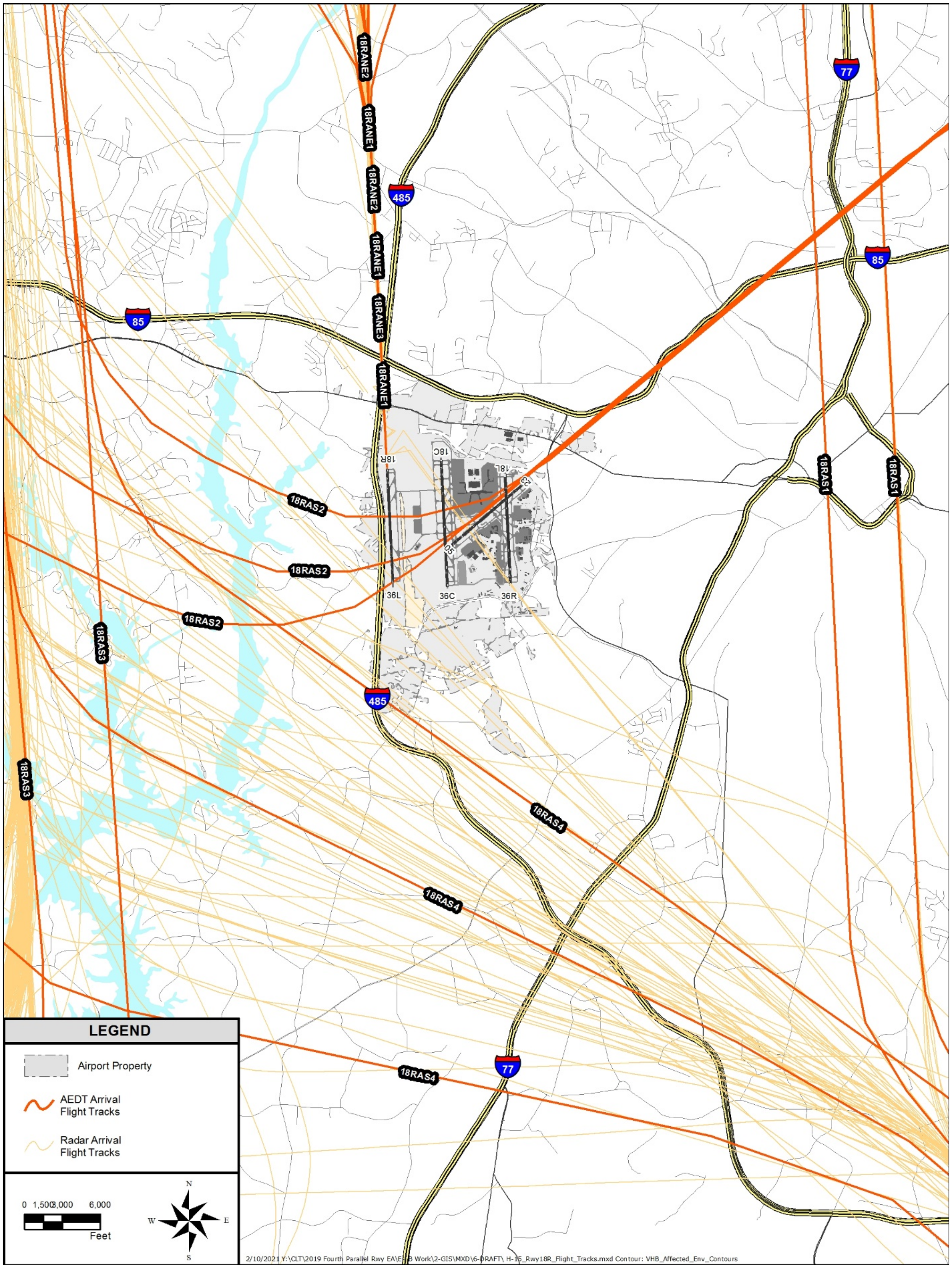
Source: Landrum & Brown , 2020

EXHIBIT 5-6, RUNWAY 18C FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



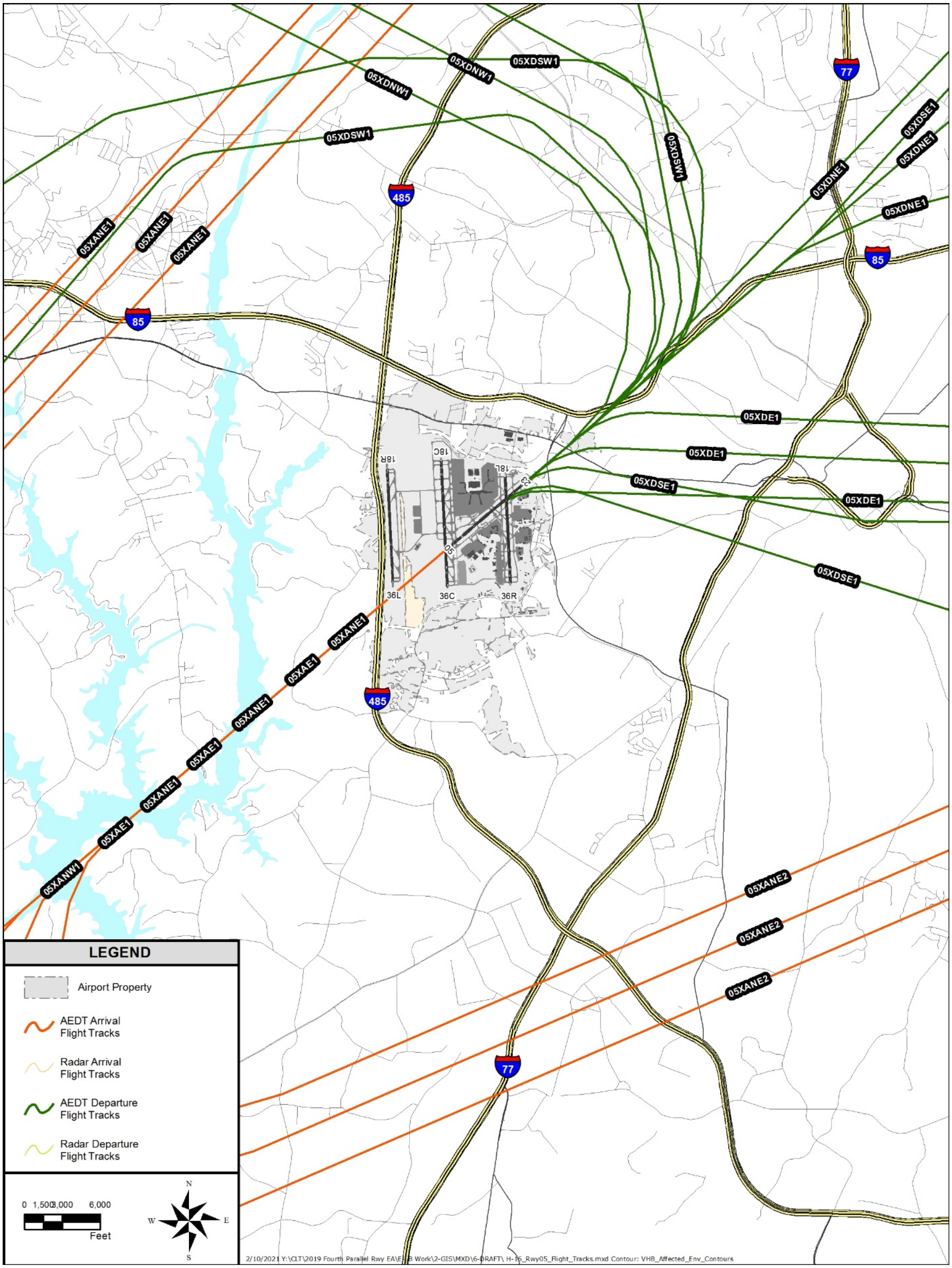
Source: Landrum & Brown, 2020

EXHIBIT 5-7, RUNWAY 18R FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



Source: Landrum & Brown, 2020

EXHIBIT 5-8, RUNWAY 05 FLIGHT TRACKS – 2028 NO ACTION ALTERNATIVE



Source: Landrum & Brown, 2020

TABLE 5-3, ARRIVAL FLIGHT TRACK DISTRIBUTION – 2028 NO ACTION ALTERNATIVE

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
18L	18LAN1	0.3%	3.4%	0.3%	0.1%	0.0%	1.5%	0.0%
	18LANE1	0.0%	1.0%	0.0%	0.1%	0.0%	1.0%	0.0%
	18LANE2	0.0%	1.4%	0.0%	0.1%	0.0%	0.9%	0.0%
	18LANE3	22.8%	14.0%	22.8%	30.0%	29.2%	38.8%	29.2%
	18LANE4	19.6%	18.5%	19.6%	10.6%	8.6%	31.8%	8.6%
	18LANE5	1.3%	3.3%	1.3%	3.8%	3.2%	10.2%	3.2%
	18LANE6	3.2%	2.8%	3.2%	0.1%	0.0%	1.3%	0.0%
	18LANW1	0.3%	3.2%	0.3%	0.2%	0.0%	1.9%	0.0%
	18LANW2	1.0%	5.6%	1.0%	0.2%	0.0%	2.3%	0.0%
	18LANW3	0.1%	0.7%	0.1%	4.8%	5.2%	0.0%	5.2%
	18LAS1	2.4%	4.5%	2.4%	4.9%	5.2%	1.6%	5.2%
	18LAS2	0.9%	3.4%	0.9%	2.8%	3.0%	0.5%	3.0%
	18LAS3	2.5%	2.1%	2.5%	3.9%	4.3%	0.0%	4.3%
	18LAS4	21.6%	9.2%	21.6%	1.8%	1.9%	1.0%	1.9%
	18LAS5	16.8%	13.5%	16.8%	7.8%	8.1%	3.9%	8.1%
	18LASE1	0.8%	0.1%	0.8%	2.9%	3.2%	0.0%	3.2%
	18LASE2	0.1%	0.9%	0.1%	0.0%	0.0%	0.0%	0.0%
	18LASE3	0.0%	0.1%	0.0%	0.0%	0.0%	0.5%	0.0%
	18LASW1	0.6%	0.6%	0.6%	0.0%	0.0%	0.5%	0.0%
	18LASW2	0.0%	0.4%	0.0%	1.1%	1.1%	0.5%	1.1%
	18LAW1	5.8%	9.1%	5.8%	24.6%	26.8%	1.7%	26.8%
	18LAW2	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%
	18LAW3	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%
18L Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
18C	18CANE1	0.4%	0.1%	0.4%	0.0%	0.0%	0.1%	0.0%
	18CANE2	0.8%	0.1%	0.8%	0.1%	0.1%	0.1%	0.1%
	18CANE3	13.6%	5.0%	13.6%	2.0%	1.1%	11.5%	1.1%
	18CANE4	7.6%	4.0%	7.6%	0.9%	0.7%	3.1%	0.7%
	18CANW1	1.1%	1.3%	1.1%	0.1%	0.1%	0.5%	0.1%
	18CANW2	1.2%	1.0%	1.2%	0.1%	0.0%	0.4%	0.0%
	18CANW3	7.1%	9.1%	7.1%	0.4%	0.2%	2.9%	0.2%
	18CANW4	0.6%	1.1%	0.6%	0.0%	0.0%	0.3%	0.0%
	18CANW5	15.3%	23.6%	15.3%	1.8%	1.2%	8.8%	1.2%
	18CAS1	2.3%	6.3%	2.3%	0.2%	0.0%	1.8%	0.0%
	18CAS2	13.7%	14.5%	13.7%	9.2%	9.5%	6.1%	9.5%
	18CAS3	0.2%	0.2%	0.2%	1.4%	1.5%	0.2%	1.5%
	18CAS4	3.0%	1.1%	3.0%	0.1%	0.0%	1.1%	0.0%
	18CAS5	0.7%	0.3%	0.7%	2.2%	2.4%	0.3%	2.4%
	18CASW1	2.2%	0.2%	2.2%	6.6%	7.1%	0.6%	7.1%
	18CAW1	2.5%	4.1%	2.5%	20.0%	21.2%	6.9%	21.2%
	18CAW2	2.5%	3.1%	2.5%	11.3%	11.8%	6.5%	11.8%
	18CAW3	25.1%	25.0%	25.1%	43.5%	43.0%	48.8%	43.0%
18C Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 5-3, ARRIVAL FLIGHT TRACK DISTRIBUTION – 2028 NO ACTION ALTERNATIVE, (CONTINUED)

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
18R	18RANE1	2.3%	1.8%	2.3%	0.0%	0.0%	0.1%	0.0%
	18RANE2	1.0%	1.2%	1.0%	0.0%	0.0%	0.0%	0.0%
	18RANE3	7.6%	6.9%	7.6%	0.0%	0.0%	0.2%	0.0%
	18RANW1	7.3%	13.4%	7.3%	1.3%	0.1%	14.5%	0.0%
	18RANW2	1.1%	1.4%	1.1%	0.3%	0.1%	1.8%	0.0%
	18RANW3	8.2%	12.7%	8.2%	1.3%	0.0%	14.9%	0.0%
	18RANW4	0.3%	0.3%	0.3%	0.8%	0.8%	0.6%	0.0%
	18RAS1	2.2%	0.9%	2.2%	1.5%	1.3%	2.5%	0.0%
	18RAS2	0.1%	0.0%	0.1%	0.2%	0.2%	0.1%	0.0%
	18RAS3	34.3%	18.9%	34.3%	50.1%	50.5%	46.6%	0.0%
	18RAS4	3.7%	1.7%	3.7%	2.2%	2.0%	4.3%	0.0%
	18RAW1	6.0%	8.7%	6.0%	10.6%	10.4%	12.9%	0.0%
	18RAW2	0.2%	0.4%	0.2%	0.5%	0.5%	0.6%	0.0%
	18RAW3	25.8%	31.7%	25.8%	31.1%	34.0%	0.8%	0.0%
18R Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
36R	36RAE1	0.1%	0.4%	0.1%	0.2%	0.2%	0.5%	0.2%
	36RANE1	4.7%	4.5%	4.7%	2.5%	2.1%	6.5%	2.1%
	36RANE2	27.8%	20.2%	27.8%	7.3%	5.4%	28.1%	5.4%
	36RANE3	38.6%	23.1%	38.6%	10.7%	8.3%	35.5%	8.3%
	36RANE4	0.1%	0.8%	0.1%	0.1%	0.0%	1.0%	0.0%
	36RANW1	3.3%	3.5%	3.3%	2.0%	1.7%	5.8%	1.7%
	36RANW2	0.3%	2.3%	0.3%	6.6%	7.0%	2.9%	7.0%
	36RANW3	0.9%	0.5%	0.9%	1.1%	1.2%	0.7%	1.2%
	36RANW4	0.7%	2.0%	0.7%	6.1%	6.7%	0.1%	6.7%
	36RANW5	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%
	36RANW6	3.8%	7.0%	3.8%	12.4%	13.3%	2.8%	13.3%
	36RAS1	0.5%	1.0%	0.5%	0.5%	0.5%	0.4%	0.5%
	36RASE1	12.2%	17.0%	12.2%	25.4%	27.3%	5.1%	27.3%
	36RASE2	5.5%	10.5%	5.5%	15.2%	16.3%	3.6%	16.3%
	36RASW1	1.2%	4.1%	1.2%	9.1%	9.7%	2.5%	9.7%
	36RASW2	0.2%	2.2%	0.2%	0.5%	0.2%	3.7%	0.2%
	36RAW1	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
	36RAW2	0.0%	0.0%	0.0%	0.1%	0.0%	0.6%	0.0%
36R Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 5-3, ARRIVAL FLIGHT TRACK DISTRIBUTION – 2028 NO ACTION ALTERNATIVE, (CONTINUED)

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
36L	36LANE1	2.5%	3.7%	2.5%	49.3%	54.0%	0.0%	0.0%
	36LANE2	2.0%	1.7%	2.0%	0.3%	0.3%	0.0%	0.0%
	36LANE3	0.3%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%
	36LANE4	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
	36LANW1	12.7%	31.0%	12.7%	2.6%	2.8%	0.1%	0.0%
	36LANW2	0.1%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%
	36LANW3	38.3%	31.2%	38.3%	14.6%	15.9%	0.3%	0.0%
	36LASE1	6.1%	2.3%	6.1%	0.6%	0.7%	0.0%	0.0%
	36LASE2	1.9%	0.4%	1.9%	0.2%	0.2%	0.0%	0.0%
	36LASE3	3.6%	1.5%	3.6%	0.4%	0.4%	0.0%	0.0%
	36LASW1	5.1%	5.3%	5.1%	0.7%	0.7%	0.2%	0.0%
	36LASW2	12.5%	11.5%	12.5%	8.8%	9.1%	5.8%	0.0%
	36LASW3	14.9%	10.9%	14.9%	22.4%	15.8%	93.5%	0.0%
36L Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
05	05XAE1	n/a	n/a	n/a	91.4%	n/a	n/a	n/a
	05XANE1	n/a	n/a	n/a	0.0%	n/a	n/a	n/a
	05XANE2	n/a	n/a	n/a	8.6%	n/a	n/a	n/a
	05XANW1	n/a	n/a	n/a	0.0%	n/a	n/a	n/a
	05XASE1	n/a	n/a	n/a	0.0%	n/a	n/a	n/a
05 Subtotal		n/a	n/a	n/a	100.0%	n/a	n/a	n/a

Source: Landrum & Brown, 2020

TABLE 5-4, DEPARTURE FLIGHT TRACK DISTRIBUTION – 2028 NO ACTION ALTERNATIVE

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
18L	18LDE1	0.0%	3.3%	0.2%	0.9%	0.0%	10.1%	33.3%
	18LDE2	0.0%	30.6%	39.6%	45.6%	45.3%	48.6%	5.6%
	18LDE3	0.0%	4.9%	4.2%	21.8%	23.2%	6.8%	0.0%
	18LDE4	0.0%	2.3%	1.0%	7.5%	8.0%	2.3%	0.0%
	18LDE5	0.0%	0.5%	0.8%	3.5%	3.7%	1.0%	0.0%
	18LDN1	0.0%	1.1%	0.0%	1.1%	0.5%	6.6%	0.0%
	18LDN2	0.0%	3.1%	0.9%	1.9%	2.1%	0.2%	0.0%
	18LDN3	0.0%	0.2%	0.0%	0.1%	0.0%	0.9%	0.0%
	18LDN4	0.0%	9.1%	7.2%	1.4%	1.2%	3.5%	0.0%
	18LDN5	0.0%	0.8%	0.9%	0.0%	0.0%	0.2%	0.0%
	18LDNW1	0.0%	3.8%	2.8%	4.7%	4.7%	4.7%	0.0%
	18LDS1	0.0%	22.6%	40.8%	4.9%	4.7%	6.4%	27.8%
	18LDW1	0.0%	2.8%	0.0%	0.3%	0.0%	3.8%	33.3%
	18LDW2	0.0%	7.6%	1.0%	5.6%	5.9%	2.3%	0.0%
	18LDW3	0.0%	7.0%	0.5%	0.7%	0.6%	2.6%	0.0%
18L Subtotal		0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
18C	18CDE1	0.7%	1.3%	0.7%	0.0%	0.0%	0.0%	0.0%
	18CDE2	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
	18CDE3	1.8%	1.4%	1.8%	0.0%	0.0%	0.1%	0.0%
	18CDN1	0.1%	2.0%	0.1%	0.1%	0.0%	0.8%	0.0%
	18CDN2	17.4%	20.5%	17.4%	15.7%	17.1%	0.5%	0.0%
	18CDN3	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
	18CDNW1	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
	18CDNW2	16.7%	22.7%	16.7%	5.1%	3.3%	24.5%	0.0%
	18CDS1	6.0%	2.6%	6.0%	0.5%	0.0%	5.5%	6.4%
	18CDSW1	0.4%	0.2%	0.4%	0.3%	0.0%	3.1%	3.3%
	18CDW1	56.3%	48.7%	56.3%	78.3%	79.5%	65.5%	90.3%
18C Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
36C	36CDE1	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
	36CDE2	3.0%	3.4%	3.0%	2.5%	2.8%	0.1%	0.0%
	36CDN1	17.1%	24.0%	17.1%	46.8%	51.1%	0.8%	0.0%
	36CDNE1	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	36CDNW1	14.8%	19.5%	14.8%	32.7%	33.7%	22.5%	0.0%
	36CDS1	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
	36CDS2	11.2%	6.4%	11.2%	10.0%	9.8%	11.9%	0.0%
	36CDS3	0.1%	0.1%	0.1%	0.0%	0.0%	0.2%	0.0%
	36CDW1	0.4%	0.8%	0.4%	1.1%	0.6%	6.2%	66.7%
	36CDW2	53.3%	45.4%	53.3%	6.8%	2.0%	58.1%	33.3%
	36CDW3	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%
36C Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 5-4, DEPARTURE FLIGHT TRACK DISTRIBUTION – 2028 NO ACTION ALTERNATIVE, (CONTINUED)

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
36R	36RDE1	0.0%	5.1%	0.2%	11.9%	12.5%	6.0%	20.0%
	36RDE2	0.0%	38.6%	51.9%	6.8%	5.5%	21.3%	40.0%
	36RDE3	0.0%	19.1%	22.1%	4.1%	3.6%	9.7%	0.0%
	36RDN1	0.0%	2.2%	0.9%	4.3%	3.5%	13.0%	0.0%
	36RDN2	0.0%	3.4%	0.7%	6.6%	6.6%	6.2%	0.0%
	36RDN3	0.0%	0.2%	0.1%	0.5%	0.5%	0.0%	0.0%
	36RDNE1	0.0%	0.5%	0.0%	1.4%	1.5%	0.0%	0.0%
	36RDNE2	0.0%	0.9%	0.2%	2.0%	2.1%	0.8%	0.0%
	36RDNE3	0.0%	0.3%	0.0%	1.7%	1.6%	3.0%	0.0%
	36RDNW1	0.0%	2.4%	1.0%	15.1%	15.4%	12.3%	0.0%
	36RDS1	0.0%	0.9%	0.4%	10.8%	11.5%	3.0%	40.0%
	36RDSE1	0.0%	0.6%	0.0%	2.3%	2.5%	0.0%	0.0%
	36RDSE2	0.0%	18.8%	9.5%	12.6%	13.6%	2.3%	0.0%
	36RDSW1	0.0%	1.5%	0.1%	1.0%	0.8%	3.0%	0.0%
	36RDSW2	0.0%	1.1%	1.5%	2.9%	2.8%	4.0%	0.0%
	36RDSW3	0.0%	1.7%	8.9%	2.7%	3.0%	0.0%	0.0%
	36RDW1	0.0%	1.1%	0.2%	5.7%	5.9%	3.0%	0.0%
	36RDW2	0.0%	1.7%	2.4%	7.7%	7.2%	12.4%	0.0%
36R Subtotal		0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
05	05XDE1	n/a	n/a	n/a	3.0%	3.0%	3.0%	n/a
	05XDNE1	n/a	n/a	n/a	5.9%	5.9%	5.9%	n/a
	05XDNW1	n/a	n/a	n/a	14.5%	14.5%	14.5%	n/a
	05XDSE1	n/a	n/a	n/a	18.9%	18.9%	18.9%	n/a
	05XDSW1	n/a	n/a	n/a	57.7%	57.7%	57.7%	n/a
05 Subtotal		n/a	n/a	n/a	100.0%	100.0%	100.0%	n/a

Source: Landrum & Brown, 2020

Aircraft Weight and Trip Length

Aircraft weight upon departure is a factor in the dispersion of noise because it impacts the rate at which an aircraft is able to climb. Generally, heavier aircraft have a slower rate of climb and a wider dispersion of noise along their flight routes. Where specific aircraft weights are unknown, the AEDT uses the distance flown to the first stop as a surrogate for the weight, by assuming that the weight has a direct relationship with the fuel load necessary to reach the first destination. The AEDT groups trip lengths into eleven stage categories and assigns standard aircraft weights to each stage category. These categories are:

Stage Category	Stage Length
1	0-500 nautical miles
2	501-1000 nautical miles
3	1001-1500 nautical miles
4	1501-2500 nautical miles
5	2501-3500 nautical miles
6	3501-4500 nautical miles
7	4501-5500 nautical miles
8	5501-6500 nautical miles
9	6501-7500 nautical miles
10	7501-8500 nautical miles
11	8501+ nautical miles

The trip lengths modeled for the 2028 No Action Alternative noise exposure contour are based upon a review of departure destinations from the design day schedule from the forecast of aviation activity prepared for CLT.[17] **Table 5-5** indicates the proportion of the operations that fell within each of the nine trip length categories during this time period. A noise monitoring program was conducted for this EA to compare the departure stage lengths and aircraft departure profiles to actual conditions at CLT. The results of that analysis is included in Section 6 of this Appendix.

TABLE 5-5, DEPARTURE STAGE LENGTH – 2028 NO ACTION ALTERNATIVE

Aircraft Category	Departure Stage Length					
	1	2	3	4	5	6
Heavy Passenger Jet	0%	0%	0%	0%	32%	68%
Cargo Jet	100%	0%	0%	0%	0%	0%
Large Passenger Jet	46%	43%	6%	5%	0%	0%
Regional / GA Jet	98%	1%	0%	0%	0%	0%
Commuter / Cargo / GA Prop	100%	0%	0%	0%	0%	0%
Military	100%	0%	0%	0%	0%	0%

Source: Landrum & Brown, 2020

[17] Forecast Technical Memorandum, Technical Memorandum – Final, Charlotte Douglas International Airport Environmental Impact Statement, VHB in association with InterVISTAS, April 18, 2018.

5.2 2028 Alternative 1 Noise Exposure Contour

This section presents the input data used to model the 2028 Alternative 1 noise exposure contour.

Runway Definition

Alternative 1 includes the construction of a 10,000-foot runway (designated Runway 01/19) in the midfield with 3,100 feet of separation to Runway 18R/36L and 1,200 feet of separation to Runway 18C/36C. This alternative would also include decommissioning Runway 05/23. The airfield layout for 2028 Alternative 1 is shown on **Exhibit 5-9**. The runways and lengths at CLT for the 2028 Alternative 1 are listed below:

Runway	Length (feet)
18L/36R	8,676
18C/36C	10,000
18R/36L	9,000
01/19	10,000

Number of Operations and Fleet Mix

No change to the number of aircraft operations, fleet mix, or operating times are expected as a result of implementing Alternative 1. Therefore, the number of annual operations modeled for the 2028 Alternative 1 are the same as discussed for the 2028 No Action Alternative and presented in Table 5-1.

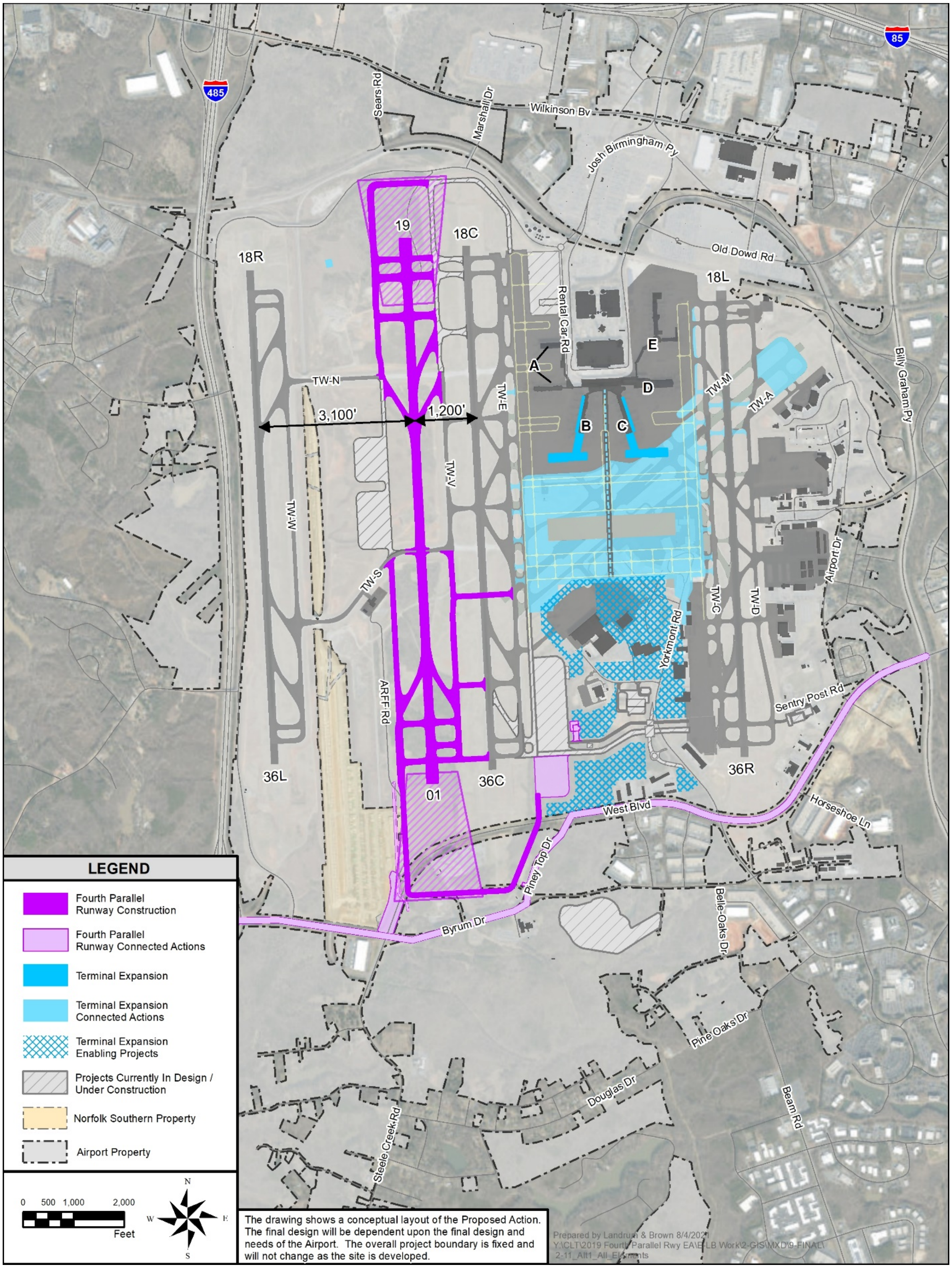
Runway End Utilization

The percent use of each runway end for the 2028 Alternative 1 condition was based on a review of simulation modeling results that was prepared to determine typical usage of the parallel runways under the 2028 Alternative 1 runway layout. Adjustments were made to convert simulated conditions during a peak day to average-annual conditions based on the historic ratio of north flow and south flow as well as other variable operating conditions. **Table 5-6** summarizes the percentage of use by each aircraft category on each of the runways at CLT during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) for the 2028 Alternative 1 noise modeling.

Flight Tracks

Alternative 1 does not include changes to the flight corridors at CLT. It is expected that flight tracks to and from the existing parallel runways would be the same as the 2028 No Action Alternative. For Runway 01/19, it is expected that flight tracks would be similar to flight tracks to and from Runway 18C/36C but shifted laterally to align with the runway 01/19. Therefore, flight tracks were developed in AEDT for Runway 01/19 that are of similar geometry to flight tracks modeled for Runway 18C/36C. These tracks are shown on **Exhibit 5-10** and **Exhibit 5-11**. No changes to aircraft origins/destinations would occur that would cause changes to the percent distribution of flight tracks to and from the existing parallel runways. Therefore, flight track percentages presented for the 2028 No Action Alternative in Tables 5-3 and 5-4 were used to model for the 2028 Alternative 1 . It is expected that flight track distribution on Runway 01/19 would be similar to Runway 18C/36C. Flight track percentages modeled for Runway 01/19 for the 2028 Alternative 1 are shown in **Table 5-7** and **Table 5-8**.

EXHIBIT 5-9, AIRPORT LAYOUT – 2028 ALTERNATIVE 1



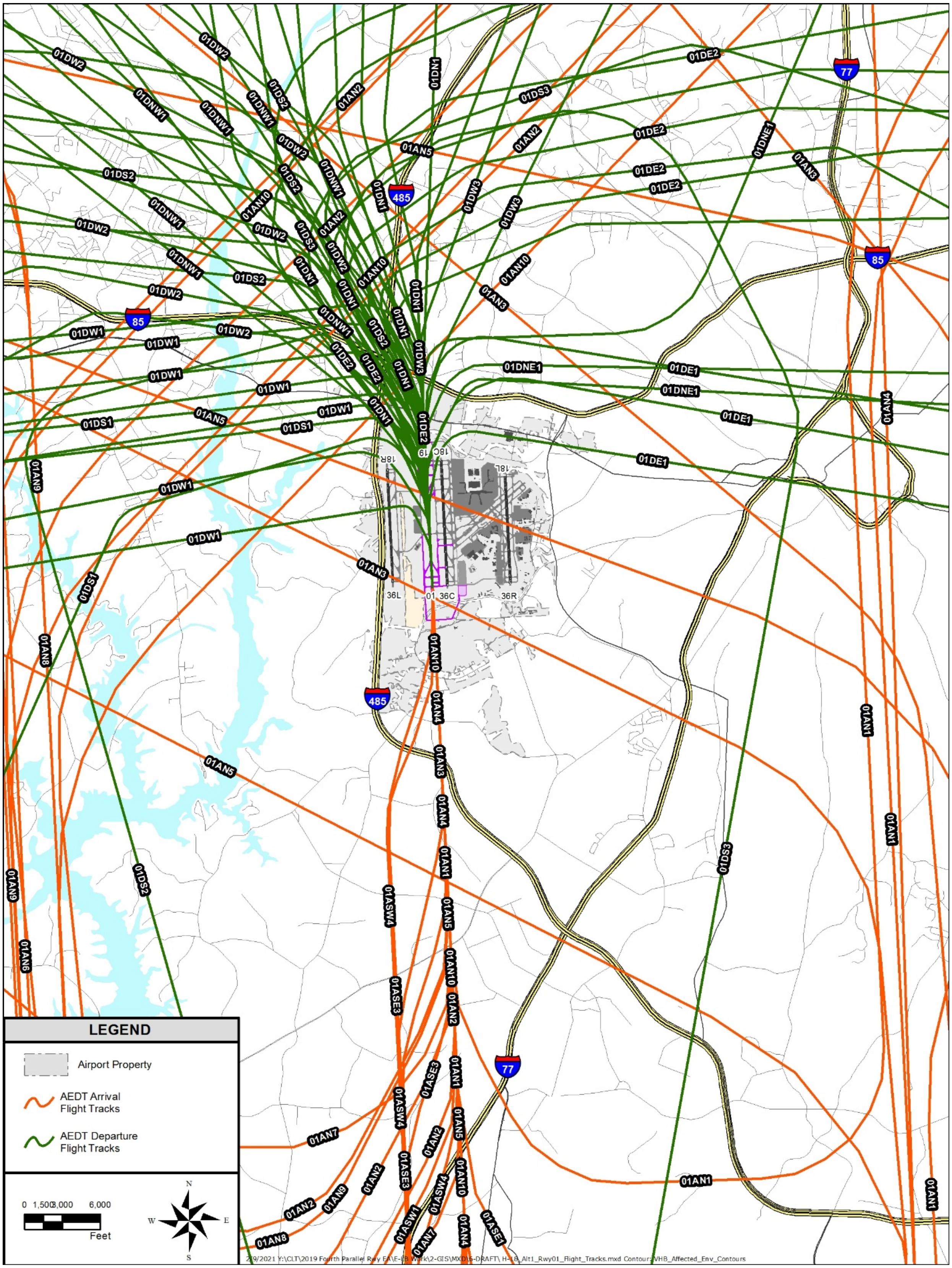
Source: Landrum & Brown, 2021

TABLE 5-6, AVERAGE ANNUAL DAY RUNWAY USE – 2028 ALTERNATIVE 1

Aircraft Category	18C	18L	18R	36C	36L	36R	19	01	Total
Daytime Arrivals									
Heavy Passenger Jet	18.9%	12.3%	3.0%	28.2%	3.2%	31.3%	1.5%	1.5%	100.0%
Cargo Jet	6.1%	1.3%	26.9%	7.0%	51.4%	4.4%	1.5%	1.5%	100.0%
Large Passenger Jet	12.6%	4.4%	17.3%	24.0%	29.4%	9.3%	1.5%	1.5%	100.0%
Regional / GA Jet	6.2%	19.0%	9.1%	10.7%	18.4%	33.5%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	5.2%	28.6%	2.0%	0.0%	13.0%	51.2%	0.0%	0.0%	100.0%
Military	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	0.0%	0.0%	100.0%
Nighttime Arrivals									
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	18.1%	17.3%	1.5%	30.7%	5.0%	26.5%	0.5%	0.5%	100.0%
Large Passenger Jet	16.5%	12.7%	6.7%	31.8%	10.9%	18.4%	1.5%	1.5%	100.0%
Regional / GA Jet	10.1%	23.1%	3.9%	19.6%	5.3%	35.0%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	9.2%	31.2%	0.0%	14.9%	0.7%	40.9%	1.5%	1.5%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Daytime Departures									
Heavy Passenger Jet	0.5%	10.0%	0.0%	0.5%	0.0%	20.0%	25.3%	43.7%	100.0%
Cargo Jet	0.5%	1.0%	0.0%	0.5%	0.0%	6.0%	34.3%	57.7%	100.0%
Large Passenger Jet	0.5%	18.5%	0.0%	0.5%	0.0%	33.2%	16.8%	30.5%	100.0%
Regional / GA Jet	0.6%	16.9%	0.0%	0.6%	0.0%	30.4%	18.3%	33.2%	100.0%
Commuter / Cargo / GA Prop	0.0%	35.8%	0.0%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Military	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	0.0%	0.0%	100.0%
Nighttime Departures									
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	26.1%	11.6%	0.0%	37.0%	0.0%	24.3%	0.5%	0.5%	100.0%
Large Passenger Jet	18.2%	22.0%	0.0%	29.2%	0.0%	27.6%	1.5%	1.5%	100.0%
Regional / GA Jet	14.7%	25.3%	0.0%	27.9%	0.0%	29.1%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	6.2%	33.7%	0.0%	16.7%	0.0%	40.4%	1.5%	1.5%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

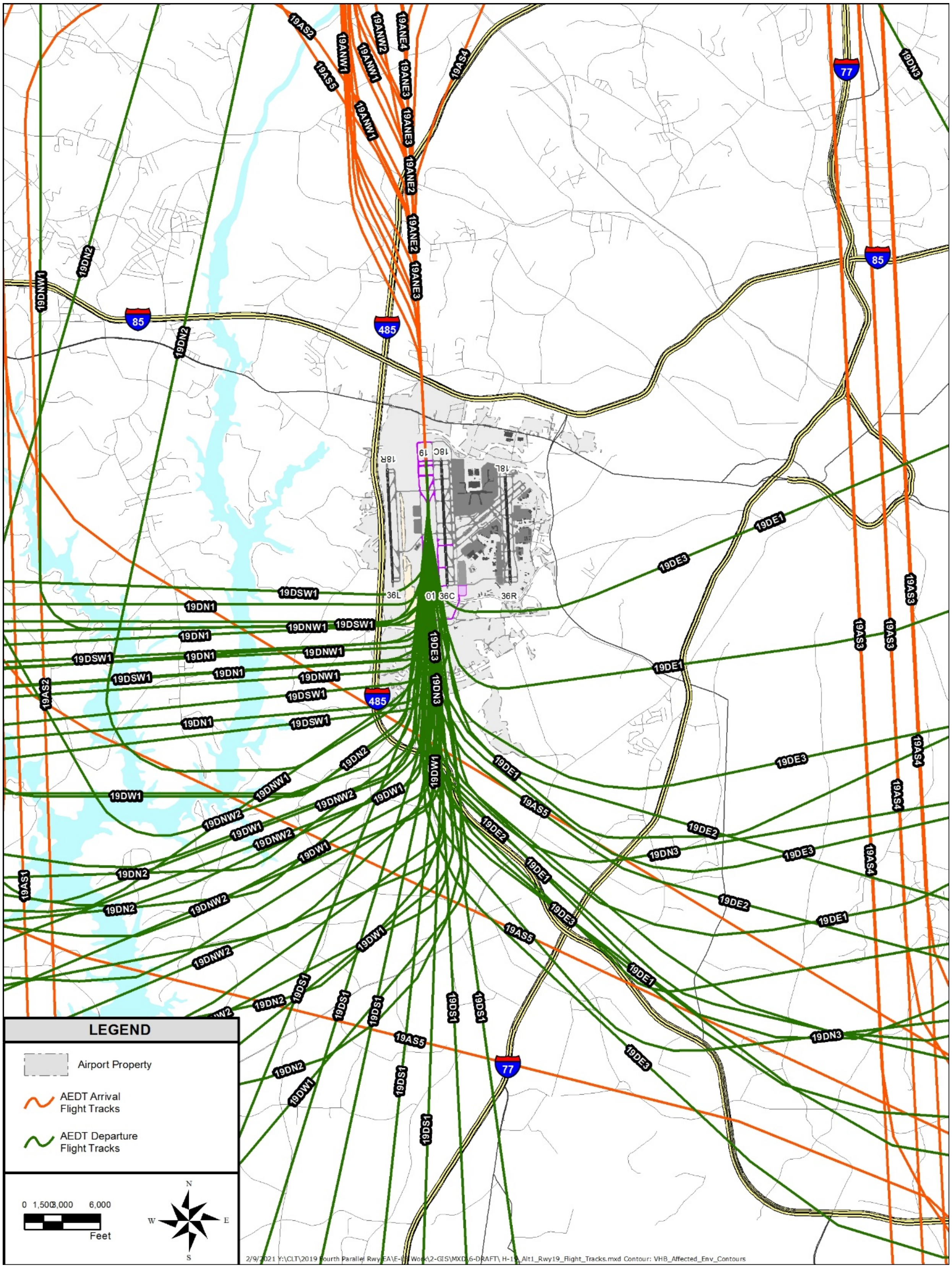
Source: CLT Flight Tracking System Data, Landrum & Brown analysis, 2021.

EXHIBIT 5-10, RUNWAY 01 FLIGHT TRACKS – 2028 ALTERNATIVE 1



Source: Landrum & Brown, 2021

EXHIBIT 5-11, RUNWAY 19 FLIGHT TRACKS – 2028 ALTERNATIVE 1



Source: Landrum & Brown, 2021

TABLE 5-7, RUNWAY 01/19 ARRIVAL FLIGHT TRACK PERCENTAGES – 2028 ALTERNATIVE 1

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
19	19ANE1	0.4%	0.1%	0.4%	0.0%	0.0%	0.1%	0.0%
	19ANE2	0.8%	0.1%	0.8%	0.1%	0.1%	0.1%	0.0%
	19ANE3	13.6%	5.0%	13.6%	2.0%	1.1%	11.5%	0.0%
	19ANE4	7.6%	4.0%	7.6%	0.9%	0.7%	3.1%	0.0%
	19ANW1	1.1%	1.3%	1.1%	0.1%	0.1%	0.5%	0.0%
	19ANW2	1.2%	1.0%	1.2%	0.1%	0.0%	0.4%	0.0%
	19ANW3	7.1%	9.1%	7.1%	0.4%	0.2%	2.9%	0.0%
	19ANW4	0.6%	1.1%	0.6%	0.0%	0.0%	0.3%	0.0%
	19ANW5	15.3%	23.6%	15.3%	1.8%	1.2%	8.8%	0.0%
	19AS1	2.3%	6.3%	2.3%	0.2%	0.0%	1.8%	0.0%
	19AS2	13.7%	14.5%	13.7%	9.2%	9.5%	6.1%	0.0%
	19AS3	0.2%	0.2%	0.2%	1.4%	1.5%	0.2%	0.0%
	19AS4	3.0%	1.1%	3.0%	0.1%	0.0%	1.1%	0.0%
	19AS5	0.7%	0.3%	0.7%	2.2%	2.4%	0.3%	0.0%
	19ASW1	2.2%	0.2%	2.2%	6.6%	7.1%	0.6%	0.0%
	19AW1	2.5%	4.1%	2.5%	20.0%	21.2%	6.9%	0.0%
	19AW2	2.5%	3.1%	2.5%	11.3%	11.8%	6.5%	0.0%
	19AW3	25.1%	25.0%	25.1%	43.5%	43.0%	48.8%	0.0%
19 Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
01	01AN1	13.0%	6.1%	13.0%	0.3%	0.1%	2.4%	0.0%
	01AN10	0.3%	0.2%	0.3%	0.0%	0.0%	0.1%	0.0%
	01AN2	0.4%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%
	01AN3	0.7%	0.7%	0.7%	0.0%	0.0%	0.1%	0.0%
	01AN4	1.1%	1.4%	1.1%	7.7%	8.4%	0.4%	0.0%
	01AN5	0.0%	1.5%	0.0%	0.0%	0.0%	0.3%	0.0%
	01AN6	0.5%	1.4%	0.5%	0.1%	0.0%	1.1%	0.0%
	01AN7	3.9%	0.5%	3.9%	0.4%	0.0%	3.9%	0.0%
	01AN8	26.6%	26.7%	26.6%	3.8%	0.3%	40.8%	0.0%
	01AN9	14.3%	14.3%	14.3%	1.9%	0.0%	21.9%	0.0%
	01ASE1	3.7%	5.1%	3.7%	0.7%	0.0%	7.2%	0.0%
	01ASE2	5.7%	15.0%	5.7%	1.5%	0.1%	16.1%	0.0%
	01ASE3	0.4%	0.5%	0.4%	1.5%	1.6%	0.0%	0.0%
	01ASW1	11.6%	3.4%	11.6%	4.6%	4.9%	0.7%	0.0%
	01ASW2	7.1%	17.4%	7.1%	41.4%	44.8%	4.3%	0.0%
	01ASW3	6.0%	2.1%	6.0%	24.6%	26.8%	0.4%	0.0%
	01ASW4	1.1%	0.7%	1.1%	4.4%	4.8%	0.1%	0.0%
	01ASW5	3.7%	3.0%	3.7%	7.4%	8.0%	0.3%	0.0%
01 Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%

TABLE 5-8, RUNWAY 01/19 DEPARTURE FLIGHT TRACK PERCENTAGES – 2028 ALTERNATIVE 1

Runway End	Track ID	Heavy Passenger Jet	Cargo Jet	Large Passenger Jet	Regional / GA Jet	Commuter / Cargo Prop	General Aviation Prop	Military
19	19DE1	0.7%	1.3%	0.7%	0.0%	0.0%	0.0%	0.0%
	19DE2	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
	19DE3	1.8%	1.4%	1.8%	0.0%	0.0%	0.1%	0.1%
	19DN1	0.1%	2.0%	0.1%	0.1%	0.0%	0.8%	0.8%
	19DN2	17.4%	20.5%	17.4%	15.7%	17.1%	0.5%	0.5%
	19DN3	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
	19DNW1	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
	19DNW2	16.7%	22.7%	16.7%	5.1%	3.3%	24.5%	24.5%
	19DS1	6.0%	2.6%	6.0%	0.5%	0.0%	5.5%	5.5%
	19DSW1	0.4%	0.2%	0.4%	0.3%	0.0%	3.1%	3.1%
	19DW1	56.3%	48.7%	56.3%	78.3%	79.5%	65.5%	65.5%
19 Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
01	01DE1	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
	01DE2	3.0%	3.4%	3.0%	2.5%	2.8%	0.1%	0.1%
	01DN1	17.1%	24.0%	17.1%	46.8%	51.1%	0.8%	0.8%
	01DNE1	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	01DNW1	14.8%	19.5%	14.8%	32.7%	33.7%	22.5%	22.5%
	01DS1	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%
	01DS2	11.2%	6.4%	11.2%	10.0%	9.8%	11.9%	11.9%
	01DS3	0.1%	0.1%	0.1%	0.0%	0.0%	0.2%	0.2%
	01DW1	0.4%	0.8%	0.4%	1.1%	0.6%	6.2%	6.2%
	01DW2	53.3%	45.4%	53.3%	6.8%	2.0%	58.1%	58.1%
	01DW3	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%
01 Subtotal		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Landrum & Brown, 2021

Aircraft Weight and Trip Length

No changes to aircraft origins/destinations would occur that would cause changes to the aircraft stage lengths. Therefore, the stage length percentages presented for the 2028 No Action Alternative in Table 5-5 were modeled for the 2028 Alternative 1 noise exposure contour.

5.3 2028 Alternative 2 Noise Exposure Contour

This section presents the input data used to model the 2028 Alternative 2 noise exposure contour.

Runway Definition

Alternative 2 includes the construction of a 10,000-foot runway (designated Runway 01/19) in the Midfield with 3,200 feet of separation to Runway 18R/36L and 1,100 feet of separation to Runway 18C/36C. This alternative would also include decommissioning Runway 05/23. The airfield layout for 2028 Alternative 2 is shown on **Exhibit 5-12**. The runways and lengths at CLT for the 2028 Alternative 2 are listed below:

Runway	Length (feet)
18L/36R	8,676
18C/36C	10,000
18R/36L	9,000
01/19	10,000

Number of Operations and Fleet Mix

No change to the number of aircraft operations, fleet mix, or operating times are expected as a result of implementing Alternative 2. Therefore, the number of annual operations modeled for the 2028 Alternative 2 are the same as discussed for the 2028 No Action Alternative and presented in Table 5-1.

Runway End Utilization

The percent use of each runway end for the 2028 Alternative 2 would be expected to be the same as runway use for the 2028 Alternative 1. Therefore, the same runway use percentages shown in Table 5-6 were used to model the 2028 Alternative 2 noise exposure contour.

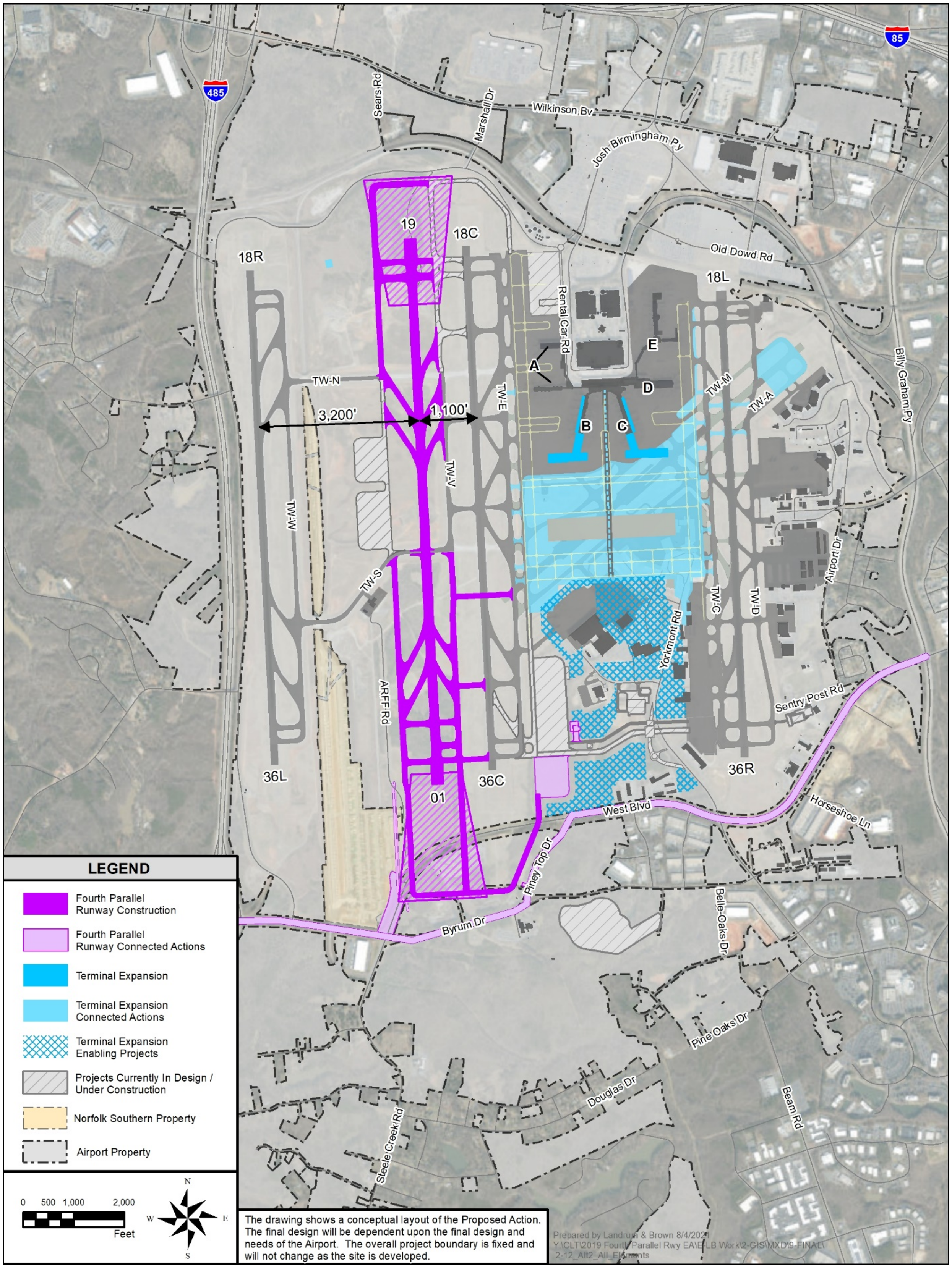
Flight Tracks

The flight track locations for the 2028 Alternative 2 runway layout would be expected to be the same as those for 2028 Alternative 1 but with shifting the Runway 01/19 flight tracks 100 feet east to align with the runway. The flight tracks for Runway 01/19 for Alternative 2 are shown in **Exhibit 5-13** and **Exhibit 5-14**. The flight tracks for the existing parallel runways are shown in Exhibits 5-2 through 5-7. Flight track distribution percentages would be expected to be the same as those modeled for the 2028 Alternative 1 noise exposure contour as shown in Tables 5-3 and 5-4 for the existing three parallel runways and Tables 5-7 and 5-8 for Runway 01/19.

Aircraft Weight and Trip Length

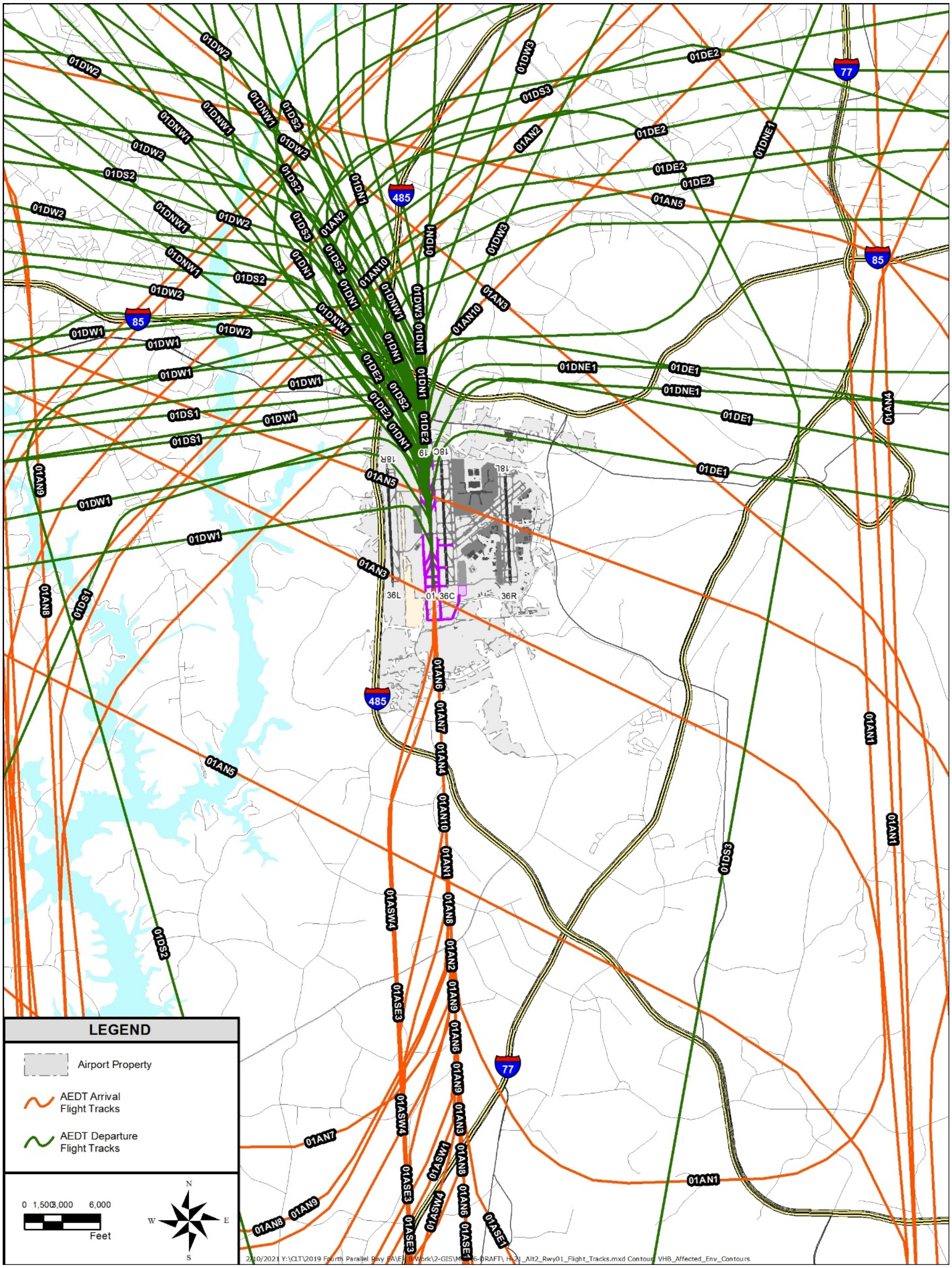
No changes to aircraft origins/destinations would occur that would cause changes to the aircraft stage lengths. Therefore, the stage length percentages presented for the 2028 No Action Alternative in Table 5-5 were modeled for the 2028 Alternative 2 noise exposure contour.

EXHIBIT 5-12, AIRPORT LAYOUT – 2028 ALTERNATIVE 2



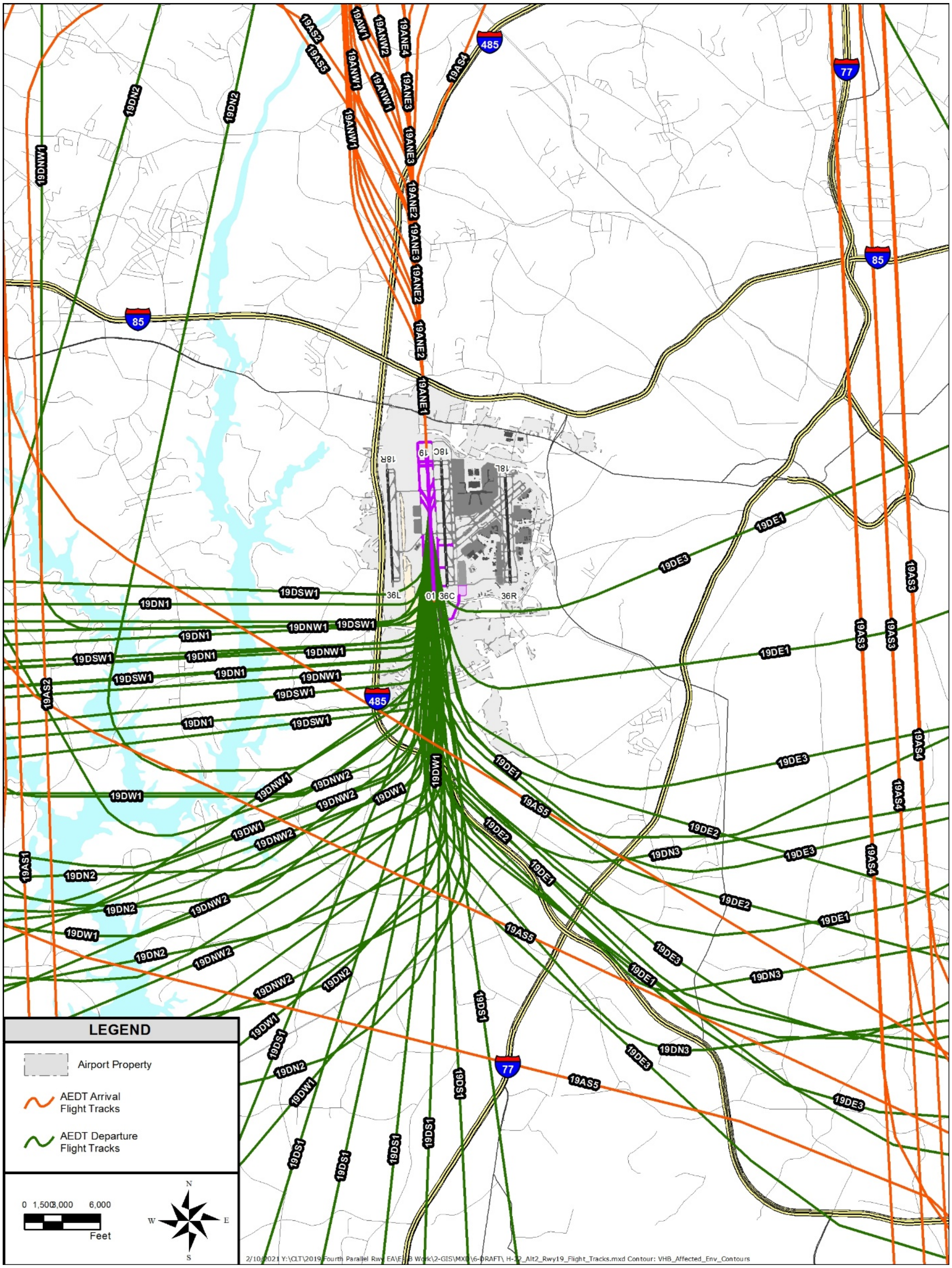
Source: Landrum & Brown, 2021

EXHIBIT 5-13, RUNWAY 01 FLIGHT TRACKS – 2028 ALTERNATIVE 2



Source: Landrum & Brown, 2021

EXHIBIT 5-14, RUNWAY 19 FLIGHT TRACKS – 2028 ALTERNATIVE 2



Source: Landrum & Brown, 2021

5.4 2028 Alternative 3 Noise Exposure Contour

This section presents the input data used to model the 2028 Alternative 3 noise exposure contour.

Runway Definition

Alternative 3 includes the construction of an 8,900-foot Runway 01/19 in the midfield with 3,400 feet of separation to Runway 18R/36L and 900 feet of separation to Runway 18C/36C. This alternative would also include decommissioning Runway 05/23. The airfield layout for 2028 Alternative 3 is shown on **Exhibit 5-15**. The runways and lengths at CLT for the 2028 Alternative 3 are listed below:

Runway	Length (feet)
18L/36R	8,676
18C/36C	10,000
18R/36L	9,000
01/19	8,900

Number of Operations and Fleet Mix

No change to the number of aircraft operations, fleet mix, or operating times are expected as a result of implementing Alternative 3. Therefore, the number of annual operations modeled for the 2028 Alternative 3 are the same as discussed for the 2028 No Action Alternative and presented in Table 5-1.

Runway End Utilization

The percent use of each runway end for the 2028 Alternative 3 condition was based on a review of simulation modeling results that was prepared to determine typical usage of the parallel runways under the 2028 Alternative 3 runway layout. Adjustments were made to convert simulated conditions during a peak day to average-annual conditions based on the historic ratio of north flow and south flow as well as other variable operating conditions. **Table 5-9** summarizes the percentage of use by each aircraft category on each of the runways at CLT during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) for the 2028 Alternative 3 noise modeling.

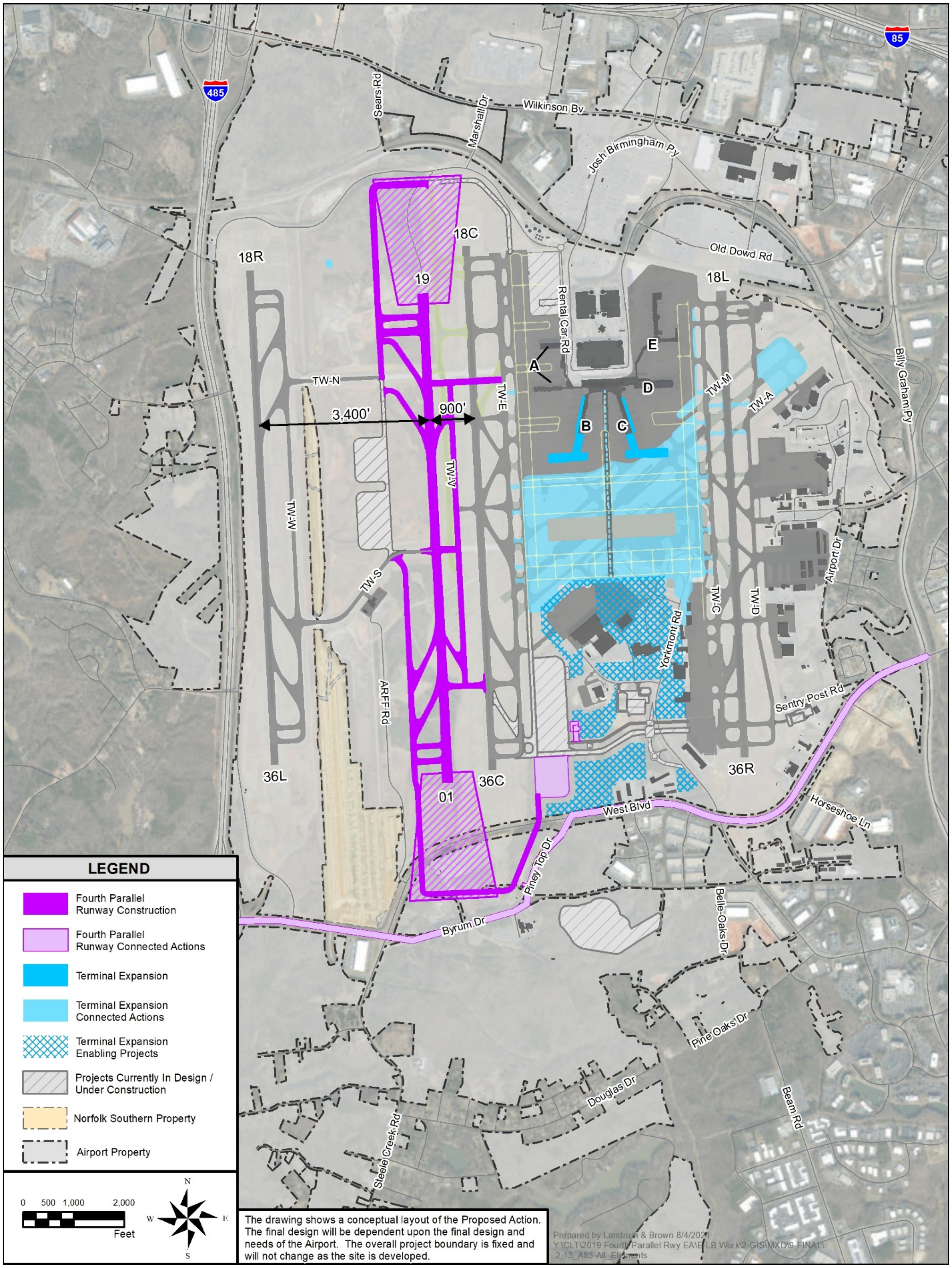
Flight Tracks

The flight track locations for the 2028 Alternative 3 runway layout would be expected to be the similar to those for 2028 Alternative 1, but with Runway 01/19 flight tracks being shifted in relation to the runway alignment. The flight tracks for Runway 01/19 for Alternative 3 are shown in **Exhibit 5-16** and **Exhibit 5-17**. The flight tracks for the existing parallel runways are shown in Exhibits 5-2 through 5-7. Flight track distribution percentages would be expected to be the same as those modeled for the 2028 Alternative 1 noise exposure contour as shown in Tables 5-3 and 5-4 for the existing three parallel runways and Tables 5-7 and 5-8 for Runway 01/19.

Aircraft Weight and Trip Length

No changes to aircraft origins/destinations would occur that would cause changes to the aircraft stage lengths. Therefore, the stage length percentages presented for the 2028 No Action Alternative in Table 5-5 were modeled for the 2028 Alternative 3 noise exposure contour.

EXHIBIT 5-15, AIRPORT LAYOUT – 2028 ALTERNATIVE 3



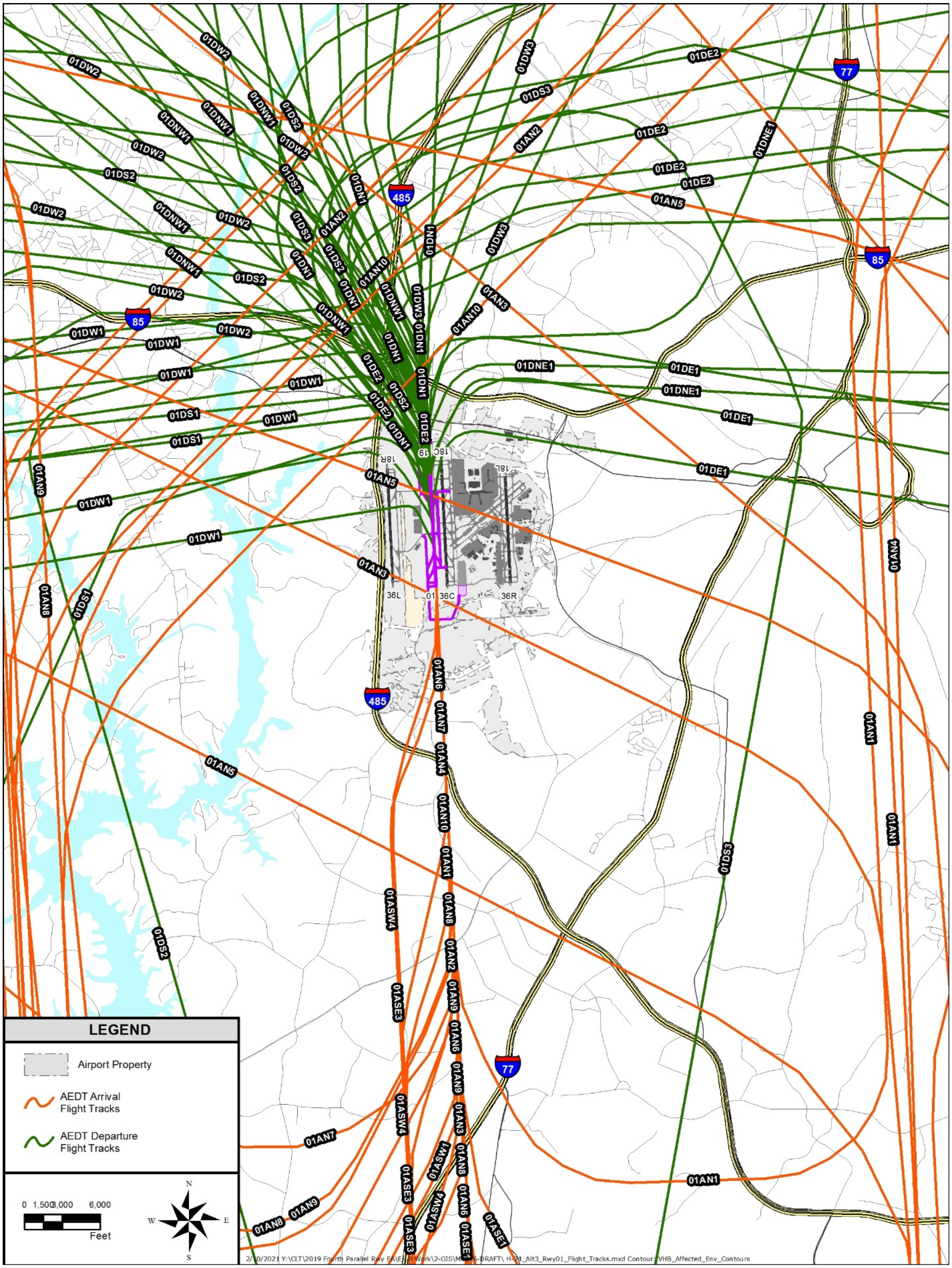
Source: Landrum & Brown, 2021

TABLE 5-9, AVERAGE ANNUAL DAY RUNWAY USE – 2028 ALTERNATIVE 3

Aircraft Category	18C	18L	18R	36C	36L	36R	19	01	Total
Daytime Arrivals									
Heavy Passenger Jet	1.0%	1.9%	39.6%	0.3%	36.7%	5.1%	4.3%	11.1%	100.0%
Cargo Jet	0.7%	28.6%	2.7%	0.3%	0.5%	66.1%	0.2%	0.8%	100.0%
Large Passenger Jet	1.9%	5.6%	13.7%	3.9%	29.3%	16.2%	8.9%	20.6%	100.0%
Regional / GA Jet	1.9%	9.6%	13.6%	0.9%	11.7%	20.9%	12.0%	29.5%	100.0%
Commuter / Cargo / GA Prop	1.7%	16.6%	46.1%	1.2%	14.9%	19.5%	0.0%	0.0%	100.0%
Military	1.1%	5.0%	16.9%	16.3%	32.3%	28.3%	0.0%	0.0%	100.0%
Nighttime Arrivals									
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	0.9%	6.5%	0.9%	0.3%	32.4%	8.7%	13.6%	36.6%	100.0%
Large Passenger Jet	1.7%	4.2%	18.6%	4.8%	40.5%	8.2%	12.5%	9.5%	100.0%
Regional / GA Jet	1.5%	11.6%	6.0%	2.5%	19.4%	1.8%	16.3%	40.9%	100.0%
Commuter / Cargo / GA Prop	1.3%	9.5%	0.5%	2.3%	23.2%	14.4%	21.5%	27.3%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Daytime Departures									
Heavy Passenger Jet	10.9%	13.1%	0.0%	36.9%	0.0%	35.8%	0.2%	3.0%	100.0%
Cargo Jet	1.8%	2.0%	0.0%	35.2%	0.0%	60.9%	0.1%	0.0%	100.0%
Large Passenger Jet	16.7%	9.5%	0.0%	38.9%	0.0%	33.0%	1.0%	0.8%	100.0%
Regional / GA Jet	4.9%	2.8%	0.0%	31.9%	0.0%	59.9%	0.2%	0.4%	100.0%
Commuter / Cargo / GA Prop	0.0%	12.5%	0.0%	0.0%	0.0%	87.1%	0.4%	0.0%	100.0%
Military	2.9%	71.2%	0.0%	25.7%	0.0%	0.2%	0.0%	0.0%	100.0%
Nighttime Departures									
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	16.4%	21.2%	0.0%	34.7%	0.0%	26.7%	0.7%	0.3%	100.0%
Large Passenger Jet	27.3%	36.3%	0.0%	20.9%	0.0%	14.4%	0.7%	0.4%	100.0%
Regional / GA Jet	23.5%	28.8%	0.0%	34.4%	0.0%	12.0%	0.5%	0.8%	100.0%
Commuter / Cargo / GA Prop	22.7%	52.6%	0.0%	12.9%	0.0%	1.8%	3.1%	6.8%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

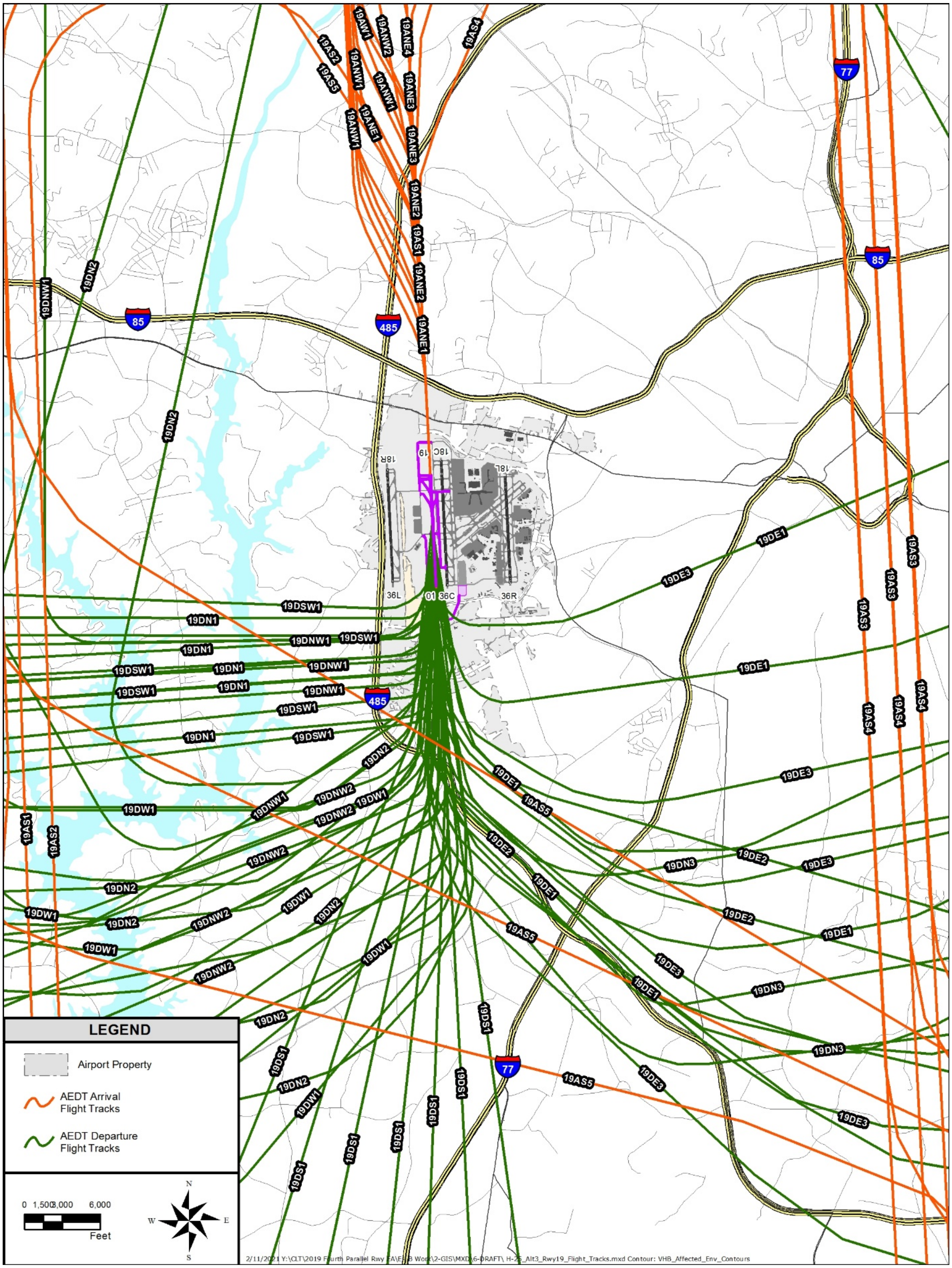
Source: CLT Flight Tracking System Data, Landrum & Brown analysis, 2021.

EXHIBIT 5-16, RUNWAY 01 FLIGHT TRACKS – 2028 ALTERNATIVE 3



Source: Landrum & Brown, 2021

EXHIBIT 5-17, RUNWAY 19 FLIGHT TRACKS – 2028 ALTERNATIVE 3



Source: Landrum & Brown, 2021

5.5 2033 No Action Alternative Noise Exposure Contour

Runway Definition

No changes to the airfield layout would occur under the 2033 No Action Alternative. Therefore, the airfield layout would remain the same as described for the 2028 No Action Alternative and shown on Exhibit 5-1.

Number of Operations and Fleet Mix

The number of annual operations modeled for the 2033 No Action Alternative was based on the latest forecast of aviation activity prepared for CLT.[18] That forecast included 675,643 total annual operations in 2033, or 1,851.1 average-annual day operations. Specific aircraft types and times of operation for commercial aircraft were developed from the future design day schedules prepared for that forecast. The future design day flight schedules provided peak operating levels by aircraft type and time of day. These peak levels were converted to an average-annual day for modeling the 2033 No Action Alternative. **Table 5-10** shows the number of aircraft operations during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) that was used to model the 2033 No Action Alternative noise exposure contour.

TABLE 5-10 DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT CATEGORY 2033 NO ACTION ALTERNATIVE

AEDT Airframe Type	AEDT Engine Code	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Heavy Jet						
Airbus A330-200 Series	2RR023	3.6	0.0	3.3	0.4	7.2
Airbus A350-900 series	14RR075	0.7	0.0	0.7	0.1	1.4
Boeing 787-9 Dreamliner	12GE155	3.6	0.0	3.3	0.4	7.2
Boeing 787-8 Dreamliner	11RR049	0.7	0.0	0.7	0.1	1.4
Subtotal		*8.6*	*0.0*	*7.8*	*0.9*	*17.3*
Cargo Jet						
Airbus A300F4-600 Series	1PW048	1.5	1.2	1.3	1.4	5.4
Airbus A300F4-600 Series	2GE039	1.1	0.9	1.0	1.0	4.0
Boeing MD-10-1 Freighter	1GE001	0.9	0.7	0.8	0.8	3.1
Subtotal		*3.5*	*2.8*	*3.0*	*3.2*	*12.5*
Regional Jet						
Bombardier Challenger 300	11HN003	2.8	0.2	2.8	0.2	6.0
Bombardier Challenger 300	8HN001	2.2	0.1	2.2	0.2	4.7
Bombardier CRJ-200-LR	5GE084	107.2	6.7	106.0	7.9	227.8
Bombardier Global Express	4BR009	3.6	0.2	3.5	0.3	7.6
Bombardier Learjet 45	1AS001	8.5	0.5	8.4	0.6	18.0
Cessna 525 Citation Jet	1PW035	2.8	0.2	2.8	0.2	6.0
Cessna 560 Citation XLS	1PW037	2.8	0.2	2.8	0.2	6.0
Cessna 750 Citation X	6AL021	8.5	0.5	8.4	0.6	18.0
Dassault Falcon 2000	7PW080	7.2	0.5	7.2	0.5	15.4
Dassault Falcon 50	1AS002	3.6	0.2	3.5	0.3	7.6
Dornier 328 Jet	7PW078	2.8	0.2	2.8	0.2	6.0
Embraer 505	pw530	11.3	0.7	11.2	0.8	24.0
Embraer ERJ145	6AL008	5.6	0.4	5.6	0.4	12.0
Raytheon Hawker 800	1AS002	2.8	0.2	2.8	0.2	6.0

18 Forecast Technical Memorandum, Technical Memorandum – Final, Charlotte Douglas International Airport Environmental Impact Statement, VHB in association with InterVISTAS, April 18, 2018.

TABLE 5-10, DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT CATEGORY 2033 NO ACTION ALTERNATIVE (CONTINUED)

AEDT Airframe Type	AEDT Engine Code	Arrivals		Departures		Total
		Daytime	Nighttime	Daytime	Nighttime	
Subtotal		*171.7*	*10.8*	*169.9*	*12.6*	*364.9*
Commuter / Cargo Prop						
Embraer EMB120 Brasilia	PW118	5.5	0.5	4.2	1.8	12.0
Raytheon Super King Air 300	PT6A60	2.7	0.3	2.1	0.9	6.0
Subtotal		*8.2*	*0.8*	*6.3*	*2.7*	*18.0*
General Aviation Jet						
Bombardier Challenger 600	5GE084	0.7	0.0	0.7	0.1	1.6
Bombardier Learjet 60	7PW077	0.7	0.0	0.7	0.1	1.6
Cessna 525A Citation Jet	PW610F	0.7	0.0	0.7	0.1	1.6
Cessna 525B Citation Jet	1PW036	0.7	0.0	0.7	0.1	1.6
Cessna 550 Citation II	1PW036	1.5	0.1	1.5	0.1	3.1
Cessna 560 Citation Excel	pw530	3.7	0.2	3.6	0.3	7.8
Cessna 560 Citation V	1PW037	2.9	0.2	2.9	0.2	6.3
Dassault Falcon 900	1AS002	0.7	0.0	0.7	0.1	1.6
Gulfstream G150	1AS002	0.7	0.0	0.7	0.1	1.6
Gulfstream G200	TFE731	0.7	0.0	0.7	0.1	1.6
Gulfstream G280	11HN005	1.5	0.1	1.5	0.1	3.1
Gulfstream G500	3BR001	0.7	0.0	0.7	0.1	1.6
Gulfstream G650	11BR011	0.7	0.0	0.7	0.1	1.6
Subtotal		*16.2*	*1.0*	*16.1*	*1.2*	*34.5*
General Aviation Prop						
Cessna 303 Crusader (FAS)	TIO540	0.7	0.1	0.5	0.2	1.6
Cirrus SR22	TIO540	0.7	0.1	0.5	0.2	1.6
DAHER TBM 900/930	PT6A66	0.7	0.1	0.5	0.2	1.6
Pilatus PC-12	PT6A67	4.3	0.4	3.3	1.4	9.4
Raytheon Beech Baron 58	TIO540	0.7	0.1	0.5	0.2	1.6
Raytheon King Air 90	PT6A60	0.7	0.1	0.5	0.2	1.6
SOCATA TBM 850	PT6A66	0.7	0.1	0.5	0.2	1.6
Subtotal		*8.6*	*0.8*	*6.6*	*2.8*	*18.8*
Military						
Lockheed C-130 Hercules	T56A7	3.7	0.0	3.7	0.0	7.3
Subtotal		*3.7*	*0.0*	*3.7*	*0.0*	*7.3*
Grand Total		**852.1**	**73.5**	**825.5**	**100.1**	**1851.1**

Notes: Day = 7:00 a.m. to 9:59 p.m., Night = 10:00 p.m. to 6:59 a.m. Totals may not equal sum due to rounding.
Source: OAG, Landing Fee Reports, FAA Operations Network (OPSNET) data, CLT Flight Tracking System Data, Landrum & Brown, 2021.

Runway End Utilization

The percent use of each runway end for 2033 No Action Alternative was based on a review of the results of the simulation modeling that was prepared to determine typical usage of the parallel runways when in either north flow or south flow. Adjustments were made to convert simulated conditions during a peak day to average-annual conditions based on the historic ratio of north flow and south flow as well as other variable operating conditions. **Table 5-11** summarizes the percentage of use by each aircraft category on each of the runways at CLT during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) for the 2033 No Action Alternative noise modeling.

Flight Tracks

No changes to flight track locations or percent distribution are expected to occur for the 2033 No Action Alternative. Therefore, the AEDT flight tracks modeled for the 2033 No Action Alternative noise exposure contour are the same as those modeled for the 2028 No Action Alternative shown on Exhibit 5-2 through Exhibit 5-8. Flight track distribution modeled for the 2033 No Action Alternative noise exposure contour are the same as those modeled for the 2028 No Action Alternative shown in Table 5-3 and Table 5-4.

TABLE 5-11, AVERAGE ANNUAL RUNWAY USE – 2033 NO ACTION ALTERNATIVE

Aircraft Category	05	18C	18L	18R	36C	36L	36R	Total
Daytime Arrivals								
Heavy Passenger Jet	0.0%	4.9%	24.9%	6.0%	1.7%	6.3%	56.2%	100.0%
Cargo Jet	0.0%	8.0%	3.8%	24.1%	4.0%	47.4%	12.8%	100.0%
Large Passenger Jet	0.0%	12.3%	10.7%	12.8%	15.3%	29.2%	19.7%	100.0%
Regional / GA Jet	0.1%	9.3%	21.1%	5.4%	8.6%	16.9%	38.7%	100.0%
Commuter / Cargo / GA Prop	0.0%	3.5%	28.6%	3.7%	0.0%	13.0%	51.2%	100.0%
Military	0.0%	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	100.0%
Nighttime Arrivals								
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	0.2%	18.6%	17.3%	1.5%	31.2%	4.8%	26.5%	100.0%
Large Passenger Jet	0.0%	18.0%	12.7%	6.7%	33.3%	10.9%	18.4%	100.0%
Regional / GA Jet	0.2%	11.6%	23.1%	3.9%	21.1%	5.1%	35.0%	100.0%
Commuter / Cargo / GA Prop	0.0%	10.7%	31.2%	0.0%	16.4%	0.7%	40.9%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Daytime Departures								
Heavy Passenger Jet	0.0%	35.8%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Cargo Jet	0.0%	35.8%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Large Passenger Jet	0.0%	21.5%	14.3%	0.0%	39.2%	0.0%	25.0%	100.0%
Regional / GA Jet	0.1%	22.2%	13.6%	0.0%	40.1%	0.0%	24.0%	100.0%
Commuter / Cargo / GA Prop	1.2%	0.0%	35.8%	0.0%	0.0%	0.0%	63.0%	100.0%
Military	0.0%	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	100.0%
Nighttime Departures								
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	0.0%	26.6%	11.6%	0.0%	37.5%	0.0%	24.3%	100.0%
Large Passenger Jet	0.0%	19.7%	22.0%	0.0%	30.7%	0.0%	27.6%	100.0%
Regional / GA Jet	0.3%	16.2%	25.3%	0.0%	29.1%	0.0%	29.1%	100.0%
Commuter / Cargo / GA Prop	0.7%	7.7%	33.7%	0.0%	17.5%	0.0%	40.4%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: CLT Flight Tracking System Data, Landrum & Brown analysis, 2021.

No significant changes to departure stage lengths are expected to occur by 2033. Minor variations in stage length would occur due to changes in scheduled destinations. The trip lengths modeled for the 203 No Action Alternative noise exposure contour are based upon a review of departure destinations from the 2033 design day schedule from the forecast of aviation activity prepared for CLT.[19] **Table 5-12** indicates the proportion of the operations that fell within each of the nine trip length categories during this time period.

TABLE 5-12, DEPARTURE STAGE LENGTH – 2033 NO ACTION ALTERNATIVE

Aircraft Category	Departure Stage Length					
	1	2	3	4	5	6
Heavy Passenger Jet	0%	0%	0%	0%	33%	67%
Cargo Jet	100%	0%	0%	0%	0%	0%
Large Passenger Jet	49%	41%	6%	5%	0%	0%
Regional / GA Jet	98%	2%	0%	0%	0%	0%
Commuter / Cargo / GA Prop	100%	0%	0%	0%	0%	0%
Military	100%	0%	0%	0%	0%	0%

Source: Landrum & Brown, 2021

5.6 2033 Alternative 1 Noise Exposure Contour

This section presents the input data used to model the 2033 Alternative 1 noise exposure contour.

Runway Definition

The runway configuration for the 2033 Alternative 1 is the same as described for the 2028 Alternative 1 in Section 5.2 and shown in Exhibit 5-9.

Number of Operations and Fleet Mix

No change to the number of aircraft operations, fleet mix, or operating times are expected as a result of implementing Alternative 1. Therefore, the number of annual operations modeled for the 2033 Alternative 1 are the same as discussed for the 2033 No Action Alternative and presented in Table 5-10.

Runway End Utilization

The percent use of each runway end for the 2033 Alternative 1 condition was based on a review of simulation modeling results that was prepared to determine typical usage of the parallel runways under the 2033 Alternative 1 runway layout. Adjustments were made to convert simulated conditions during a peak day to average-annual conditions based on the historic ratio of north flow and south flow as well as other variable operating conditions. **Table 5-13** summarizes the percentage of use by each aircraft category on each of the runways at CLT during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) for the 2033 Alternative 1 noise modeling.

19 Forecast Technical Memorandum, Technical Memorandum – Final, Charlotte Douglas International Airport Environmental Impact Statement, VHB in association with InterVISTAS, April 18, 2018.

TABLE 5-13, AVERAGE ANNUAL RUNWAY USE – 2033 ALTERNATIVE 1

Aircraft Category	18C	18L	18R	36C	36L	36R	19	01	Total
Daytime Arrivals									
Heavy Passenger Jet	22.7%	9.3%	2.3%	33.6%	4.2%	24.9%	1.5%	1.5%	100.0%
Cargo Jet	7.1%	1.1%	26.2%	7.2%	51.4%	4.1%	1.5%	1.5%	100.0%
Large Passenger Jet	12.8%	4.2%	17.3%	24.4%	29.8%	8.5%	1.5%	1.5%	100.0%
Regional / GA Jet	5.6%	20.5%	8.2%	11.1%	15.9%	35.7%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	6.3%	28.6%	0.9%	0.0%	12.9%	51.3%	0.0%	0.0%	100.0%
Military	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	0.0%	0.0%	100.0%
Nighttime Arrivals									
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	18.1%	17.3%	1.5%	30.7%	5.0%	26.5%	0.5%	0.5%	100.0%
Large Passenger Jet	16.5%	12.7%	6.7%	31.8%	10.9%	18.4%	1.5%	1.5%	100.0%
Regional / GA Jet	10.1%	23.1%	3.9%	19.6%	5.3%	35.0%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	9.2%	31.2%	0.0%	14.9%	0.7%	40.9%	1.5%	1.5%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Daytime Departures									
Heavy Passenger Jet	0.5%	10.0%	0.0%	0.5%	0.0%	20.0%	25.3%	43.7%	100.0%
Cargo Jet	0.5%	1.0%	0.0%	0.5%	0.0%	6.0%	34.3%	57.7%	100.0%
Large Passenger Jet	0.5%	18.1%	0.0%	0.5%	0.0%	32.4%	17.2%	31.3%	100.0%
Regional / GA Jet	0.6%	18.1%	0.0%	0.9%	0.0%	32.8%	17.0%	30.5%	100.0%
Commuter / Cargo / GA Prop	0.0%	35.8%	0.0%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Military	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	0.0%	0.0%	100.0%
Nighttime Departures									
Heavy Passenger Jet	30.4%	15.8%	0.0%	36.2%	0.0%	16.7%	0.5%	0.5%	100.0%
Cargo Jet	26.1%	11.6%	0.0%	37.0%	0.0%	24.3%	0.5%	0.5%	100.0%
Large Passenger Jet	18.2%	22.0%	0.0%	29.2%	0.0%	27.6%	1.5%	1.5%	100.0%
Regional / GA Jet	14.7%	25.3%	0.0%	27.9%	0.0%	29.1%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	6.2%	33.7%	0.0%	16.7%	0.0%	40.4%	1.5%	1.5%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: CLT Flight Tracking System Data, Landrum & Brown analysis, 2021.

Flight Tracks

Alternative 1 does not include changes to the flight corridors at CLT. It is expected that flight tracks to and from the existing parallel runways would be the same as the 2028 No Action Alternative as shown in Exhibit 5-2 through 5-7. For Runway 01/19, it is expected that flight tracks would be similar to flight tracks to and from Runway 18C/36C as shown on Exhibit 5-10 and Exhibit 5-11. No changes to aircraft origins/destinations would occur that would cause changes to the percent distribution of flight tracks to and from the existing parallel runways. Therefore, flight track percentages presented for the 2028 No Action Alternative in Tables 5-3 and 5-4 were used to model for the 2033 Alternative 1. It is expected that flight track distribution on Runway 01/19 would be similar to Runway 18C/36C. Flight track percentages modeled for Runway 01/19 for the 2033 Alternative 1 are the same as those modeled for the 2028 Alternative 1 shown in Table 5-7 and Table 5-8.

Aircraft Weight and Trip Length

No changes to aircraft origins/destinations would occur that would cause changes to the aircraft stage lengths for the 2033 Alternative 1. Therefore, the stage length percentages presented for the 2033 No Action Alternative in Table 5-12 were modeled for the 2033 Alternative 1 noise exposure contour.

5.7 2033 Alternative 2 Noise Exposure Contour

This section presents the input data used to model the 2033 Alternative 2 noise exposure contour.

Runway Definition

The runway configuration for the 2033 Alternative 2 is the same as described for the 2028 Alternative 2 in Section 5.3 and shown in Exhibit 5-12.

Number of Operations and Fleet Mix

No change to the number of aircraft operations, fleet mix, or operating times are expected as a result of implementing Alternative 2. Therefore, the number of annual operations modeled for the 2033 Alternative 2 are the same as discussed for the 2033 No Action Alternative and presented in Table 5-10.

Runway End Utilization

The percent use of each runway end for the 2033 Alternative 2 would be expected to be the same as runway use for the 2033 Alternative 1. Therefore, the same runway use percentages shown in Table 5-13 were used to model the 2033 Alternative 2 noise exposure contour.

Flight Tracks

The flight track locations for the 2033 Alternative 2 runway layout would be expected to be the same as those for 2028 Alternative 2. The flight tracks for Runway 01/19 for Alternative 2 are shown in Exhibit 5-13 and Exhibit 5-14. The flight tracks for the existing parallel runways are shown in Exhibits 5-2 through 5-7. Flight track distribution percentages would be expected to be the same as those modeled for the 2028 Alternative 1 noise exposure contour as shown in Tables 5-3 and 5-4 for the existing three parallel runways and Tables 5-7 and 5-8 for Runway 01/19.

Aircraft Weight and Trip Length

No changes to aircraft origins/destinations would occur that would cause changes to the aircraft stage lengths. Therefore, the stage length percentages presented for the 2033 No Action Alternative in Table 5-12 were modeled for the 2033 Alternative 2 noise exposure contour.

5.8 2033 Alternative 3 Noise Exposure Contour

This section presents the input data used to model the 2033 Alternative 3 noise exposure contour.

Runway Definition

The runway configuration for the 2033 Alternative 3 is the same as described for the 2028 Alternative 3 in Section 5.4 and shown in Exhibit 5-15.

Number of Operations and Fleet Mix

No change to the number of aircraft operations, fleet mix, or operating times are expected as a result of implementing Alternative 3. Therefore, the number of annual operations modeled for the 2033 Alternative 3 are the same as discussed for the 2033 No Action Alternative and presented in Table 5-10.

Runway End Utilization

The percent use of each runway end for the 203 Alternative 3 condition was based on a review of simulation modeling results that was prepared to determine typical usage of the parallel runways under the 2033 Alternative 3 runway layout. Adjustments were made to convert simulated conditions during a peak day to average-annual conditions based on the historic ratio of north flow and south flow as well as other variable operating conditions. **Table 5-14** summarizes the percentage of use by each aircraft category on each of the runways at CLT during the daytime (7:00 a.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) for the 2033 Alternative 3 noise modeling.

Flight Tracks

The flight track locations for the 2033 Alternative 3 runway layout would be expected to be the similar to those for 2028 Alternative 3. The flight tracks for Runway 01/19 for Alternative 3 are shown in Exhibit 5-16 and Exhibit 5-17. The flight tracks for the existing parallel runways are shown in Exhibits 5-2 through 5-7. Flight track distribution percentages would be expected to be the same as those modeled for the 2028 Alternative 1 noise exposure contour as shown in Tables 5-3 and 5-4 for the existing three parallel runways and Tables 5-7 and 5-8 for Runway 01/19.

Aircraft Weight and Trip Length

No changes to aircraft origins/destinations would occur that would cause changes to the aircraft stage lengths. Therefore, the stage length percentages presented for the 2033 No Action Alternative in Table 5-12 were modeled for the 2033 Alternative 3 noise exposure contour.

TABLE 5-14, AVERAGE ANNUAL DAY RUNWAY USE – 2033 ALTERNATIVE 3

Aircraft Category	18C	18L	18R	36C	36L	36R	19	01	Total
Daytime Arrivals									
Heavy Passenger Jet	0.5%	10.7%	3.2%	0.5%	4.7%	17.4%	21.4%	41.6%	100.0%
Cargo Jet	0.5%	1.1%	25.4%	0.5%	45.7%	3.6%	8.9%	14.4%	100.0%
Large Passenger Jet	0.5%	4.1%	17.3%	0.5%	29.1%	6.7%	13.9%	27.9%	100.0%
Regional / GA Jet	0.5%	20.7%	7.9%	0.5%	16.6%	35.3%	6.7%	11.8%	100.0%
Commuter / Cargo / GA Prop	0.0%	28.6%	2.2%	0.0%	12.2%	51.4%	5.0%	0.6%	100.0%
Military	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	0.0%	0.0%	100.0%
Nighttime Arrivals									
Heavy Passenger Jet	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo Jet	18.6%	17.3%	1.5%	31.2%	5.0%	26.5%	0.0%	0.0%	100.0%
Large Passenger Jet	16.5%	12.7%	6.7%	31.8%	10.9%	18.4%	1.5%	1.5%	100.0%
Regional / GA Jet	10.1%	23.1%	3.9%	19.6%	5.3%	35.0%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	9.2%	31.2%	0.0%	14.9%	0.7%	40.9%	1.5%	1.5%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Daytime Departures									
Heavy Passenger Jet	25.7%	10.0%	0.0%	44.1%	0.0%	20.0%	0.1%	0.1%	100.0%
Cargo Jet	34.7%	1.0%	0.0%	58.1%	0.0%	6.0%	0.1%	0.1%	100.0%
Large Passenger Jet	17.2%	18.1%	0.0%	31.3%	0.0%	32.4%	0.5%	0.5%	100.0%
Regional / GA Jet	17.2%	18.1%	0.0%	30.9%	0.0%	32.8%	0.5%	0.5%	100.0%
Commuter / Cargo / GA Prop	0.0%	35.8%	0.0%	0.0%	0.0%	64.2%	0.0%	0.0%	100.0%
Military	2.0%	33.8%	0.0%	2.0%	0.0%	62.2%	0.0%	0.0%	100.0%
Nighttime Departures									
Heavy Passenger Jet	30.9%	15.8%	0.0%	36.6%	0.0%	16.7%	0.0%	0.0%	100.0%
Cargo Jet	26.6%	11.6%	0.0%	37.5%	0.0%	24.3%	0.0%	0.0%	100.0%
Large Passenger Jet	18.2%	22.0%	0.0%	29.2%	0.0%	27.6%	1.5%	1.5%	100.0%
Regional / GA Jet	14.7%	25.3%	0.0%	27.9%	0.0%	29.1%	1.5%	1.5%	100.0%
Commuter / Cargo / GA Prop	6.2%	33.7%	0.0%	16.7%	0.0%	40.4%	1.5%	1.5%	100.0%
Military	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: CLT Flight Tracking System Data, Landrum & Brown analysis, 2021.

6 Noise Measurement Program

A temporary noise measurement program was conducted from October 21, 2019 to October 25, 2019. The temporary noise measurement program was conducted in accordance with 14 Code of Federal Regulations (CFR) Part 150 guidelines as provided in Section A150.5. Noise meters were located at different public locations to capture noise from aircraft operations. Noise measurements were taken using two methods, short-term measuring (up to one-hour per site) and long-term measuring (five days). Each site was selected relative to flight patterns, proximity to other measuring sites, areas of past noise concern, and lack of ambient (background) noise sources. The following sections describe the methodologies, locations, and results of the short-term and long-term noise measurement efforts.

6.1 Noise Measurement Methodology

6.1.1 Equipment Type

State of the art equipment used in this program included the Larson Davis LxT and 831 sound level meters. These are Class I Precision Sound Level Meters (as defined by American National Standards Institute (ANSI) and International Electrotechnical Commission (IEC)). The equipment was calibrated in compliance with manufacturer's procedures. Microphones and recording equipment were of the highest quality and capable of recording and calculating the various noise metrics. The equipment settings included the "A" frequency, weighting, filter characteristics, and the "slow response" characteristics. The instrumentation that was used for collecting short-term and long-term measurements as listed in **Table 6-1**.

TABLE 6-1, ACOUSTICAL MEASUREMENT INSTRUMENTATION

Method	Equipment Type		
	Sound Level Meter	Microphone	Pre-amp
Long-Term	Larson Davis 831C	377B02	PRM831
Short-Term	Larson Davis LxT1	377B02	PRMLxT

Source: Landrum & Brown, 2019.

6.1.2 Noise Measurement Site Selection

Noise measurements were taken at seven long-term sites and 28 short-term sites. The long-term and short-term noise measurement sites were chosen based on their proximity to the Airport, the flow of aircraft operations during the measurement program, and areas of past noise concerns. General sites were selected on the basis of ambient noise level (or more specifically, the absence of loud ambient noise such as vehicular traffic), locations of flight tracks derived from radar data, locations of noise complaints received by the Airport, and the locations of concentrations of residential land uses that experience high numbers of aircraft overflights. Specific locations were suggested by Airport staff, as well as through application of consultant experience. Attempts were also made to select sites where noise measurements were taken during previous noise studies. Specific selection criteria included the following:

- Emphasis on areas of numerous aircraft noise events according to earlier evaluations;
- Representative sampling of all major types of operations and aircraft operating at CLT;
- Screening of each site for local (ambient) noise sources or unusual terrain characteristics, which could affect measurements; and
- Location where there are concentrations of residential development.

For the seven long-term noise measurement sites, additional emphasis was placed upon the location of flight corridors for operations arriving and departing each runway end. While there are numerous locations available for measuring, the selected sites fulfil the above criteria and provide a representative sampling of the varying aircraft noise conditions in the vicinity of the Airport. **Exhibit 6-1** illustrates the locations of both the short-term and long-term noise measurement sites. **Table 6-2** lists the seven long-term sites and **Table 6-3** lists the 28 short-term sites.

6.1.3 Weather Information

The temporary noise measuring was conducted for approximately one hour at some sites and five days at other sites. The weather during the measuring period ranged from sunny and clear skies to rainy/overcast conditions. Both north and south air traffic flow occurred during the measurement dates.

TABLE 6-2, SHORT-TERM NOISE MEASUREMENT SITES

Site ID	Site Description
S1	Winget Park
S2	River Cabin Lane
S3	Berewick Commons Parkway near Loch Lomond Drive
S4	Griers Fork Drive & Brown Grier Road
S5	Cades Cove Drive & Steele Meadow Road
S6	O'Hara Drive & Bonnie Blue Lane
S7	Thornfield Road west end cul-de-sac
S8	Central Steele Creek Church
S9	Steele Creek Zion AMC Church
S10	Treetops Apartments
S11	Gerald Drive at Sullivan Trace Drive
S12	Garrison Road
S13	Community west of Sam Wilson Road on Farrhill Road
S14	Harvest Center Church
S15	Berryhill Baptist Church Cemetery
S16	Whisper Lane & Oak Island Court
S17	Chappell Baptist Church
S18	Eagles Landing Drive
S19	1854 Still Pond Court
S20	Renovatus Church
S21	7114 Cabe Lane
S22	St Johns Chapel Baptist Church
S23	Couldwood Drive & Fielding Road
S24	Glenhaven Drive & Craig Street
S25	Peachtree Road & Emmanuel Drive
S26	John Chapel Baptist Church
S27	10324 Prairiegrouse Lane
S28	2507 Taimi Drive

Source: Landrum & Brown, 2019

TABLE 6-3, LONG-TERM NOISE MEASUREMENT SITES

Site ID	Site Description
1	Moore's Chapel United Methodist Church, 10601 Moores Chapel Road, Charlotte, NC 28214
2	Airport-Owned Property, 6900 Wilkinson Boulevard, Charlotte, NC 28214
3	Airport-Owned Property,9517 Markswood Road, Charlotte, NC 28278
4	Mulberry Baptist Church,6450 Tuckaseegee Road, Charlotte, NC 28214
5	Airport-Owned Property on north side of Shopton Road 500 feet east of Lebanon Drive
6	Airport-Owned Property on McAlpine Drive
7	Steele Creek Presbyterian Church (Airport-Owned Property), 7001 Steele Creek Pres Ch., Charlotte, NC 28217

Source: Landrum & Brown, 2019

6.2 Short-Term Measurement Procedures

Aircraft noise levels were recorded using the equipment indicated in Table 6-1 for each of the 28 short-term sites. Radar data was obtained from the Airport flight tracking system to correspond to the times of measurement. The noise-measurement program was designed to provide a sampling of single events throughout the study area. It was not designed to record cumulative noise levels. The measurement equipment was field calibrated at each location at the beginning of each measurement session. The monitors were attended while active to ensure that only aircraft noise events were recorded, or to note instances where a non-aircraft noise event was recorded simultaneously with an aircraft noise event. The measuring procedure called for the operator to enable the noise monitor when an aircraft noise event first became audible and continue measuring that event until the noise level receded back to ambient levels, usually lasting a duration of 30-90 seconds. After the event, the operator recorded the average noise level (Leq), the sound exposure level (SEL), the event duration, and the maximum sound level (Lmax). Other event information, such as aircraft type and operational characteristics, was also annotated, as available. Ambient noise levels, without aircraft noise or intermittent community noise, were recorded at each site. Short-term measurements were suspended during periods of heavy rain.

The short-term noise measurement program provided for the collection of a large number of single-event measurements at a variety of locations throughout the community at distances ranging from several hundred feet to several miles between the aircraft and the measuring site. This information, when correlated with the radar data and operating schedules, allowed for a comparison to the determination of applicable noise curves and performance characteristics within the AEDT database for the most significant aircraft and operators. Section 6.4 discusses the analysis of short-term noise measurement data and comparison to AEDT aircraft profiles based on the initial results of the noise measurement data correlation and further investigation of average aircraft weights upon departure.

6.3 Long-Term Measurement Procedures

For the long-term measurement program, equipment was placed at seven sites and ran continuously for approximately five days. The equipment was set up on October 21, 2019 and taken down on October 25, 2019. This provided for seventy-two consecutive hours of measurements starting at 12:00 am on October 22, 2019 and ending at 11:59 pm on October 24, 2019. Measurement staff coordinated with property owners and caretakers to gain access to these properties; which included churches and undeveloped land in the vicinity of CLT.

The measuring equipment was field calibrated at each location at the beginning of each measurement session. Staff periodically checked the equipment to ensure proper operation. The calibration was checked at the end of the measurement session to confirm the equipment remained in calibration throughout the measurement period.

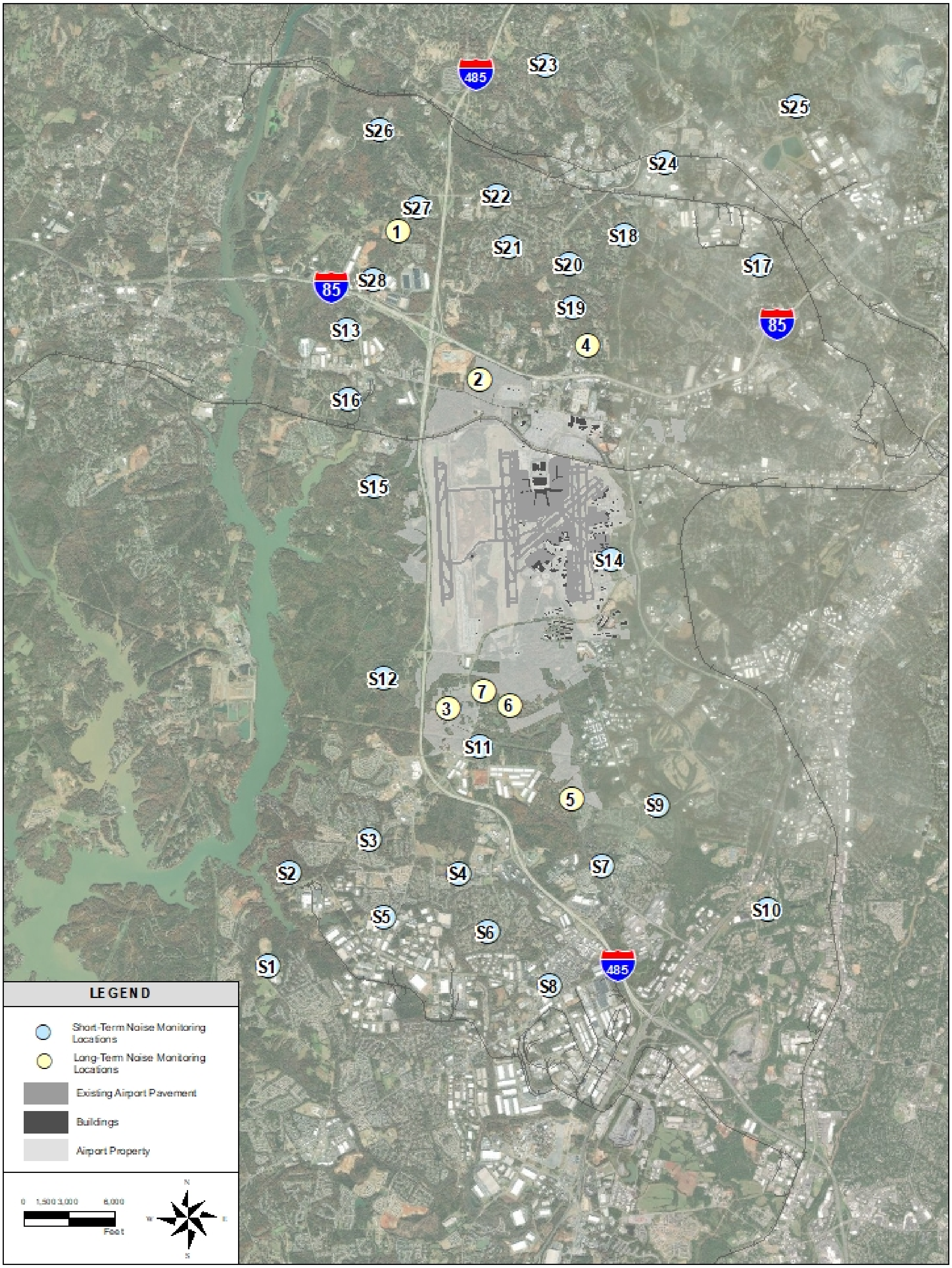
The sound level meters were programmed to record one-second Leq in addition to “event” Leq, SEL, Lmax, and duration. The sound level meters were programmed to classify an “event” as a period of time in which the noise level rose above 65 dB for a duration of at least five seconds. Noise event data was then correlated to radar data to determine if the noise was likely caused by an aircraft overflight that occurred over the site at the time of the noise event.

6.4 Noise Measurement Results

6.4.1 Short-Term Measurement Results

The noise measurement program collected a wide range of noise exposure levels from aircraft activity in the airport environs. The measured noise levels from departing aircraft tended to produce peak decibel levels several decibels higher than those of arriving aircraft. This difference is caused by two characteristics of the separate operations. First, exposure to noise above the background levels from arriving aircraft is typically shorter than from departing aircraft. Second, the power settings used during approach are lower than those necessary to climb during the take-off, resulting in noise levels for arrivals of several decibels less than measured at similar locations during departure. **Table 6-4** provides a summary of the short-term noise measurement results.

EXHIBIT 6-1, NOISE MEASUREMENT SITES



Source: Landrum & Brown, 2019

TABLE 6-4, SHORT-TERM NOISE MEASUREMENT RESULTS

Site ID	Site Description	Date of Measurement	Time of Measurement	Ambient Noise Level	Type of Event	Number of Events	Loudest Event (Lmax)	Loudest Aircraft	SEL Range
S1	Winget Park	10/22/2019	12:28 pm to 1:28 pm	40.8 – 42.1	Departures	28	70.3	A320	53.4 – 80.9
S2	River Cabin Lane	10/22/2019	12:50 pm to 1:50 pm	42.7 – 50.2	Departures	24	69.5	E75S	56.0 – 76.8
S3	10115 Loch Lomond	10/22/2019	2:00 pm to 3:05 pm	41.1	Departures	17	66.6	E75S	62.8 – 76.5
S4	Griers Fork Drive & Brown Grier Road	10/23/2019	1:20 pm to 2:20 pm	53.5	Arrivals	24	74.4	A321	72.4 – 85.1
S5	Cades Cove Drive & Steele Meadow Road	10/22/2019	2:15 pm to 3:18 pm	43.6	Departures & Arrivals	19	74.4	ERJ145	67.5 – 82.4
S6	O'Hara Drive & Bonnie Blue Lane	10/23/2019	2:05 pm to 3:06 pm	43.6	Arrivals	30	67.2	B737	62.4 – 81.7
S7	2532 Thornfield Road	10/22/2019	2:09 pm to 3:09 pm	49.6	Departures	29	75.6	A319	69.0 – 86.1
S8	Central Steele Creek Church	10/22/2019	2:00 pm to 3:00 pm	55.3	Departures	16	67.1	A321	70.7 – 83.7
S9	Steele Creek Zion AMC Church	10/22/2019	12:58 pm to 1:55 pm	54.5 – 57.3	Departures	30	77.7	A320	66.3 – 86.9
S10	Treetops Apartments	10/22/2019	12:50 pm to 1:48 pm	55.9	Departures	24	75.5	A321	65.5 – 84.4
S11	Gerald Drive at Sullivan Trace Drive	10/23/2019	2:12 pm to 3:10 pm	44.8	Arrivals	30	74.2	A319	70.9 – 79.5
S11	Gerald Drive at Sullivan Trace Drive	10/22/2019	3:30 pm to 4:33 pm	48.2	Departures	29	75.9	A319	46.2 – 88.9
S12	Garrison Road	10/22/2019	5:05 pm to 6:05 pm	45.9	Departures	15	66.4	Unknown	57.8 – 77.1
S13	8913 Larchmont Circle	10/23/2019	9:48 am to 10:45 am	48.4	Departures	27	69.8	CRJ9	52.6 – 78.7
S14	Harvest Center Church	10/22/2019	4:55 pm to 5:52 pm	Unknown	Departures & Arrivals	32	75.1	Unknown	61.8 – 85.4
S15	Berryhill Baptist Church Cemetery	10/22/2019	5:13 pm to 6:05 pm	68.9	Arrivals	22	74.6	A321	78.1 – 85.9

TABLE 6-4, SHORT-TERM NOISE MEASUREMENT RESULTS, (CONTINUED)

Site ID	Site Description	Date of Measurement	Time of Measurement	Ambient Noise Level	Type of Event	Number of Events	Loudest Event (Lmax)	Loudest Aircraft	SEL Range
S16	Whisper Lane & Oak Island Court	10/23/2019	9:40 am to 10:40 am	46.2	Departures	30	69.7	B738	59.2 – 76.1
S17	Chappell Baptist Church	10/23/2019	9:45 am to 10:45 am	57.8	Departures	24	66.0	A320	67.3 – 79.5
S18	1521 and 1421 Eagles Landing Drive	10/23/2019	10:51 am to 11:50 am	46 – 52.7	Departures	20	74.3	CRJ9	68.6 – 85.5
S19	1846 Still Pond Court	10/22/2019	4:56 pm to 5:58 pm	48.9 – 49.5	Arrivals	24	77.9	A320	80.2 – 91.7
S20	Renovatus Church	10/22/2019	3:40 pm to 4:40 pm	49.2	Arrivals	21	76.7	A320	79.1 – 89.6
S21	7114 Cabe Lane	10/22/2019	3:51 pm to 4:51 pm	48.6	Arrivals	21	69.0	CRJ2	61.0 – 81.3
S21	7114 Cabe Lane	10/23/2019	12:00 pm to 1:00 pm	41.8	Departures	38	73.8	A321	59.1 – 77.5
S22	St Johns Chapel Baptist Church	10/22/2019	3:50 pm to 4:50 pm	56.2	Arrivals	26	69.7	A359	67.7 – 87.0
S23	Coulwood Drive & Fielding Road	10/23/2019	11:00 am to 11:19 am	42.7 – 48.5	Departures	6	64.8	CRJ9	58.6 – 74.3
S24	Glenhaven Drive & Craig Street	10/23/2019	12:25 pm to 1:35 pm	47.5	Departures	23	75.3	A321	70.5 – 87.8
S25	Peachtree Road & Emmanuel Drive	10/23/2019	9:46 am to 10:33 am	41.9 – 48	Departures	24	73.1	A321	55.7 – 83.7
S26	2239 Belmeade Drive	10/23/2019	12:50 pm to 1:50 pm	43.0	Departures	32	74.2	A321	65.7 – 84.6
S27	10324 Prairiegrouse Lane	10/23/2019	10:50 am to 11:50 am	47.9	Departures	26	74.3	B738	59.1 – 86.1
S28	2507 Taimi Drive	10/23/2019	10:56 am to 11:56 am	52.3	Departures	28	78.9	E170	78.3 – 87.8

Source: Landrum & Brown, 2019.

6.4.2 Long-Term Noise Measurement Results

Noise level readings were used to characterize the noise environment at each location and to distinguish the various noise levels associated with individual aircraft operations. The primary objective of the noise measurement program was to collect a sampling of noise and operational data for specific aircraft events and to measure ambient (background) noise levels. Secondarily, data from the long-term sites also included the average aircraft DNL for the 72 hour period; although, measured DNL levels for short periods of time can differ from average-annual levels due to differences in runway use and the other operational factors, as well as influences from non-aircraft noise sources. **Table 6-5** summarizes the results of the long-term noise measurement program.

TABLE 6-5, LONG-TERM NOISE MEASUREMENT RESULTS

Site ID	Ambient Noise Level (L_{50})	DNL	Average Number of Aircraft Overflights Per Day	Loudest Event (Lmax)	Loudest Aircraft
1	53.3	68.1	462	83.2	DC10
2	58.2	75.6	416	90.7	A333
4	53.7	69.8	319	87.7	A332
5	50.9	60.6	494	83.9	A124
6	47.5	74.6	189	98.2	A124
7	50.5	68.5	410	89.6	A124
8	57.6	66.6	494	82.8	DC10

Source: Landrum & Brown, 2019.

Aircraft Noise

The noise measurement process was designed to capture the noise levels of a representative mix of aircraft operations at CLT. Some of the noise events collected at the measurement sites were produced by non-aircraft, e.g., cars, people, pets, wildlife, etc. However, at each site, the majority of noise events were produced by aircraft operations based on observations and aircraft radar data.

Methods for Noise Event Correlation

Measured noise events were matched to specific aircraft operations from radar data using the following two-step method: (1) Once the noise measurement data was downloaded, noise levels greater than 65 dB for a duration longer than five seconds were identified as individual noise events. Once an event fell below the 65 dB trigger level for more than two seconds, the event was considered to have ended and (2) Using the flight data from the Airport's operations monitoring system, noise events that occurred while an aircraft flight path passed within one nautical mile (6,076 feet) along the ground from the measurement site were correlated and classified as aircraft noise events.

Although this method provided positive identification of aircraft operations and highly accurate correlation with measured noise events, some community noise (e.g. cars, lawnmowers, animals) and aircraft noise occurred simultaneously and correlated as aircraft noise events. Unfortunately, there is currently no technology to separate aircraft noise levels from simultaneous non-aircraft noise levels.

Ambient Noise Levels

The data collected at the long-term noise measurement sites included 50^{th} percentile data (L_{50}), which is the noise level at which 50 percent of the measured levels are higher. The FAA typically recommends using the L_{50} level to determine ambient noise levels (i.e., the noise level that would occur in the absence of identifiable noise events such as continuous automobile traffic, wind, wildlife, etc.). Table 6-5 also shows the L_{50} level at each long-term measurement site. Ambient noise levels were reported for informational purposes and were not incorporated into the noise contour modelling because per Part 150 guidance, ambient noise is not an input requirement for the noise model and ambient noise levels can differ from location to location and between different times of day.

Comparison to AEDT Database

The primary purpose of the noise measurement program was to provide a sample of noise levels generated by individual aircraft events for comparison to the AEDT database. This effort was focused on the five most common aircraft that operate at CLT, and the two largest passenger aircraft that operate at CLT. The five most common aircraft provide for the greatest sample size, and the two largest passenger aircraft are the heaviest, thus having the greatest influence on the Airport's noise contours. For this analysis, data was obtained from the long-term noise measurement sites 1, 2, 4, and 6.

A comparison of the average measured aircraft noise level and the average AEDT predicted aircraft noise level at four sites is shown in **Table 6-6**. As shown, the difference in average measured and modelled noise level for arrivals and departures of these seven aircraft ranges between 0.0 and +/- 3.6 dB; and in most cases, the difference is at the lower end of this range. Analytical models (such as AEDT) often have a 95% confidence interval of ±3 dB to ±5 dB. Therefore, a difference of 3.6 dB between an estimate from measurements and one from an analytical model may not be significant.[20]

TABLE 6-6, AIRCRAFT NOISE SINGLE EVENT DATA

Aircraft Type	AEDT ID	Operation Type	Measured Noise Level*	AEDT Modelled Noise Level	Difference
Airbus A319	A319	Arrival	83.27	86.86	3.6
		Departure	87.20	86.04	-1.2
Airbus A320	A320	Arrival	83.22	86.82	3.6
		Departure	87.01	86.11	-0.9
Airbus A321	A321	Arrival	83.81	87.08	3.3
		Departure	89.03	89.35	0.3
Canadair CRJ700	CRJ7	Arrival	82.42	84.79	2.4
		Departure	84.13	82.93	-1.2
Canadair CRJ900	CRJ9	Arrival	82.73	84.79	2.1
		Departure	85.97	82.93	-3.0
Airbus A330-200	A332	Arrival	88.28	90.02	1.7
		Departure	93.68	94.35	0.7
Airbus A330-300	A333	Arrival	88.30	90.45	2.1
		Departure	94.42	95.95	1.5

Note: The measured noise level represents the average SEL noise levels for each aircraft type at long-term noise measure sites 1, 2, 4, and 6.
Source: Landrum & Brown analysis, 2019.

The comparison of measured and modelled noise levels, both single event and cumulative, are within an acceptable range of tolerance. The results of the temporary noise measurement program identified no significant inconsistencies between measured noise levels and AEDT predicted noise levels. Therefore, no adjustments to the existing aircraft noise profiles in the AEDT database are recommended for this EA.

[20] Sec. 7.7.1, SAE ARP4721 – Part 1, *Monitoring Aircraft Noise and Operations in the Vicinity of Airports: System Description, Acquisition and Operation,* Issued 2006-08.