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TECHNICAL MEMORANDUM

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From:	Kate Larson, Senior Consultant Dominic Scarano, Consultant
Date:	May 12, 2021
Subject:	Noise Analysis for Tweed-New Haven Airport (HVN) Master Plan Update
Reference:	HMMH Project Number 311020

Harris Miller Miller & Hanson Inc. (HMMH) is assisting McFarland Johnson (MJ) by preparing the noise analysis and supporting documentation for a Master Plan Update at Tweed-New Haven Airport (HVN). This technical memorandum provides our noise analysis for the Existing Conditions and for the FAA-Approved 2040 Forecast.

This revised Technical Memorandum is organized into two sections: Noise Model Inputs and Noise Analysis Results. The first of these consists of the contents of the Noise Modeling Inputs Memorandum submitted to MJ for approval on February 19, 2021, prior to commencing the model runs. The section discussing stationary aircraft engine noise (runups) has been removed, as requested. The Noise Analysis Results section includes the Day-Night Average Sound Level (DNL) contours revised from those presented to the Advisory Committees on March 8, 2021 and in the Public Information Meeting on March 10, 2021. The contour revisions only removed the engine runup noise; no changes were made to the flight operations noise calculations.

Descriptions of the noise metrics relevant to the analysis of aircraft noise are provided in Appendix A. The analysis of the "High Forecast" scenario for 2040 is contained in Appendix B, which includes documentation of the model input assumptions as well as the resultant DNL contours and land use tabulations.

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1. Noise Model Inputs

The noise modeling for this analysis uses the most current version of the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT) at the date of this memorandum, which is Version 3c, released in June 2020[1]. **Table 1** lists each category of AEDT input data, the source(s) of the data used in this study, and the section of this memorandum containing the detailed assumptions and proposed noise model input.

Table 1. Data Sources for Noise Model Inputs

AEDT Input Category	Data Source(s) – any differences between Existing and Forecast conditions noted	Location in this memo
Physical description of the airfield layout	**Existing:** FAA 5010 data, FAA Airport Diagram, HVN **Forecast:** HVN Airport Master Plan	Section 1.1
Aircraft noise and performance characteristics	Standard AEDT database	Section 1.2
Aircraft flight operations by category	**Existing and Forecast:** McFarland Johnson, HVN Airport Master Plan	Section 1.3.1
Detailed flight operations by aircraft type, including day/night split and stage length	**Existing:** FAA radar track data* from the FAA National Offload Program (NOP) **Forecast:** MJ and HMMH - operations scaled up proportionally by category, with fleet modernization assumptions	Section 1.3.1
Runway utilization rates	FAA radar track data* from the FAA National Offload Program (NOP)	Section 1.4
Flight track geometry and utilization rates	FAA radar track data* from the FAA National Offload Program (NOP)	Section 1.5
Meteorological conditions	AEDT database	Section 1.6.1
Terrain data	USGS National Elevation Dataset (NED) TIFF	Section 1.6.2

* Flight track and aircraft identification data for January 1, 2019 to December 31, 2019 were used for this study.

1.1 Study Area and Physical Description of the Airport Layout

Figure 1 presents a copy of the FAA's Airport Diagram for HVN, with an annotation added to show the modeled helipad location (red dot). All helicopter operations are modeled departing from or arriving to the East Ramp, chosen as a "helipad" for noise modeling purposes only. **Table 2** lists the existing physical runway and helipad layout information that the AEDT requires as inputs.

For the forecast 2040 conditions, the modeled airfield layout assumes a completed Runway 2/20 extension with EMAS installation, and thus the physical runway ends for flight operations are adjusted to the parameters given by **Table 3**. In the forecast case, the Runway 2 end is modeled approximately 699 feet south of its current location, and the Runway 20 end is 336 feet north of its current placement.

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[1] A technical update to AEDT Version 3c was released by the FAA on June 19, 2020

Figure 1. Annotated HVN Airport Diagram

with helipad (red dot)
Sources: FAA, HMMH

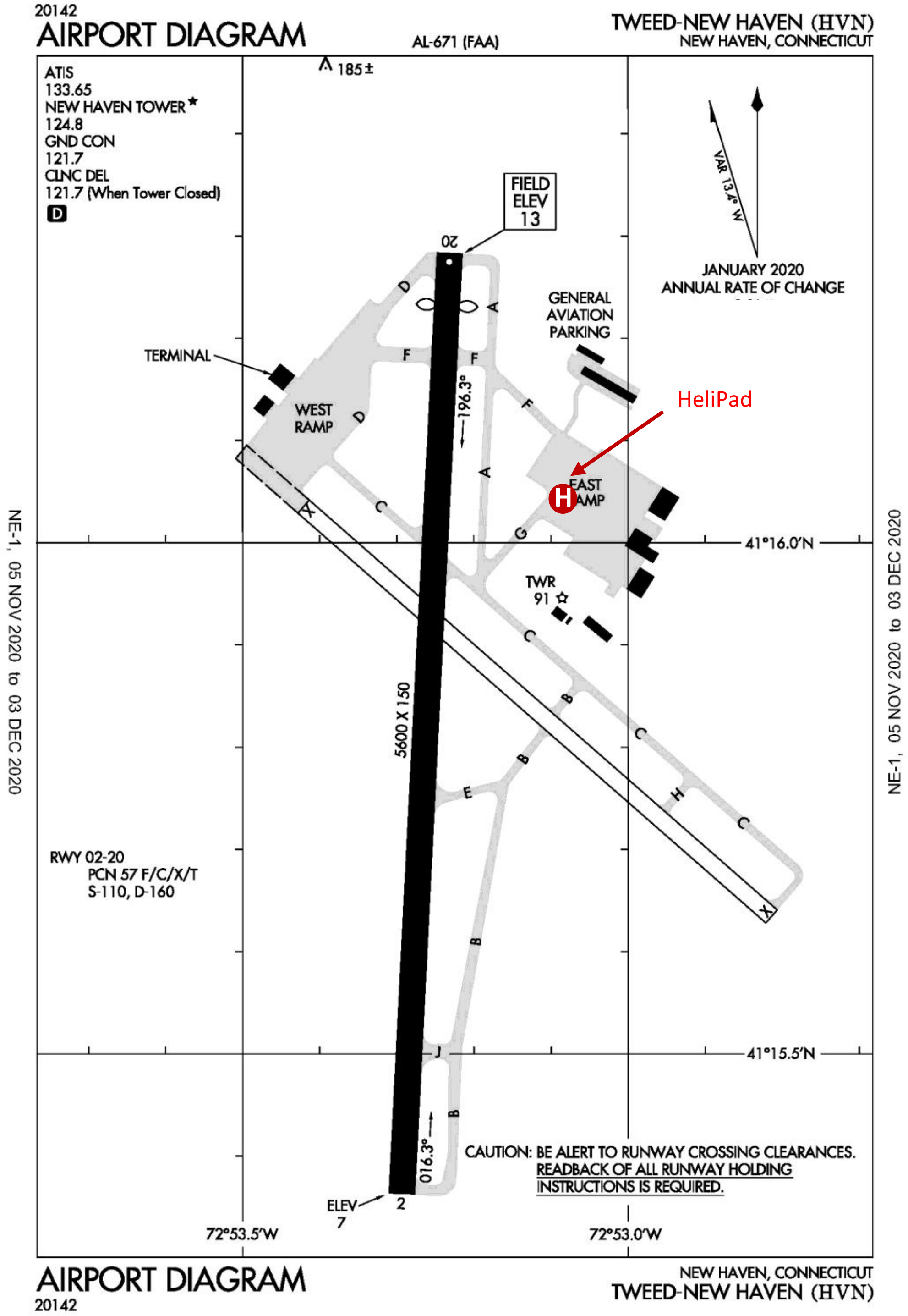

Table 2. Existing HVN Airfield Layout Details

Sources: FAA National Airspace System Resources (NASR) and HVN

Runway	Latitude (degrees)	Longitude (degrees)	Elevation (feet, MSL)	Displaced Landing Threshold (feet)	Glide Slope (degrees)	Threshold Crossing Height (feet)	Magnetic Orientation (degrees)	True Heading (degrees)
2	41.256050	-72.888246	6.5	0	3	50	16	3
20	41.271400	-72.887212	12.6	352	4	57	196	183
14	41.267064	-72.890329	4.9	Runway closed			144	131
32	41.260511	-72.880404	4.4	Runway closed			324	311
PAD_H	41.267259	-72.885026	12	"Helipad" location – start/end of modeled helicopter flight tracks				

Notes: NASR data retrieved from https://www.faa.gov/airports/airport_safety/airportdata_5010/ on April 21, 2020
Magnetic variation from https://www.airnav.com/airport/KHVN accessed 11/17/20

Table 3. Forecast HVN Airfield Layout Details

Sources: FAA National Airspace System Resources (NASR), McFarland Johnson, and HVN

Runway	Latitude (degrees)	Longitude (degrees)	Elevation (feet, MSL)	Displaced Landing Threshold (feet)	Glide Slope (degrees)	Threshold Crossing Height (feet)	Magnetic Orientation (degrees)	True Heading (degrees)
2	41.254133	-72.888375	6.5	235	3	50	16	3
20	41.272319	-72.887150	12.6	336	4	57	196	183
PAD_H	41.267259	-72.885026	12	"Helipad" location – start/end of modeled helicopter flight tracks				

1.2 Aircraft Noise and Performance Characteristics

The AEDT database contains noise and performance data for over three hundred different aircraft types. The program automatically accesses the applicable noise and performance data for operations by those aircraft. Noise data are provided for slant distances[2] from receptor to aircraft from 200 feet to 25,000 feet, for a particular aircraft with engines at a specific thrust level. Performance data include thrust, speed, and altitude profiles for takeoffs and landings. For those aircraft types operating at HVN which are not directly represented in the AEDT database, the FAA has documented appropriate substitutions for noise modeling, so HMMH was not required to request any non-standard modeling approval.

1.3 Aircraft Operations

MJ received FAA approval on their HVN forecast document and forwarded the data to HMMH in October 2020. **Table 4** presents the annual and average annual day totals by category for the Existing Conditions and FAA Approved Forecast 2040 scenarios.

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[2] Direct distance from the aircraft to the receptor being modeled.

Table 4. Annual and Average Annual Daily Aircraft Operations for Existing and Forecast Cases

Source: MJ Airport Master Plan Forecast, 2020

Annual Operations					
Scenario	**Air Carrier /Air Taxi**	**GA Itinerant**	**GA Local**	**Military**	**Total Annual Operations**
Existing Conditions	5,267	10,084	9,411	457	25,219
Approved Forecast 2040	6,351	10,771	10,052	457	27,631
Annual Average Day Operations					
Scenario	**Air Carrier /Air Taxi**	**GA Itinerant**	**GA Local**	**Military**	**Total Average Daily Operations**
Existing Conditions	14.4	27.6	25.8	1.3	69.1
Approved Forecast 2040	17.4	29.5	27.5	1.3	75.7

1.3.1 Aircraft Flight Operations

The required AEDT inputs include counts of arrival and departure operations by each specific aircraft type separated into the day (7 am - 10 pm) and night (10 pm - 7 am) time periods that are used in calculating DNL. HMMH acquired National Offload Program (NOP) radar data from the FAA for calendar year 2019. The 2019 radar track data contained 3,297 flights with enough information to use in deriving fleet mix and day/night split percentages for HVN, which were then applied to the operations totals by category. **Table 5** presents the observed day/night splits.

Table 5. Day/Night Split of Flight Operations

Source: 2019 HVN radar flight track data, HMMH 2020

	Air Carrier & Air Taxi		GA and Military Itinerant		GA Local
	Arrivals	Departures	Arrivals	Departures	
Day	79.5%	81.7%	95.8%	96.5%	99.1%
Night	20.5%	18.3%	4.2%	3.5%	0.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

AEDT uses departure "stage length" (determined by the distance between the departure and arrival airport) as a surrogate for aircraft departure weight, since fuel load is the largest factor affecting variation in aircraft weight, and therefore affecting climb performance. For each of the departures in the radar track data, HMMH used the destination city and great circle distance calculations to determine stage length.[3] If an aircraft type in

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[3] Stage length 1 is defined as distances between 0 and 500 nmi, Stage length 2 is from 501 to 1000 nmi, Stage length 3 is from 1001 to 1500 nmi, Stage length 4 is from 1501 to 2500 nmi, Stage length 5 is from 2501 to 3500 nmi, Stage length 6 is from 3501 to 4500 nmi, and so on.

the 2019 radar track data had fewer than 10 operations for a given stage length, those operations were combined with the counts for the next lower stage length.

The AEDT database includes performance profiles for most commercial aircraft types for a range of stage length values; however, many smaller aircraft types have a single representative weight used for all operations, identified as stage length 1. If the radar track data analysis counted departures by a particular aircraft type with a stage length exceeding the available performance profiles in AEDT, the profile for the greatest stage length available for that aircraft type in AEDT was used instead. The resulting data set includes only stage length 1 (SL1) or stage length 2 (SL2) departures. The air carrier size jet flights, on average, were split at about 95 percent stage length 1 and five percent stage length 2.

The tables on the following pages present the annual aircraft operations modeled for the existing conditions, presenting operations detail in categories that the AEDT requires for calculation of DNL:

- AEDT Aircraft Type,
- Type of operation – arrival, departure, or local pattern
- DNL "day" and "night" time periods, and
- Departure stage length (marked as SL1 or SL2).

Table 6 presents the modeled Existing Conditions air carrier and air taxi operations. The helicopter operations categorized as air taxi are medical transport flights. **Table 7** displays the Existing Conditions GA and military itinerant operations. There were very few flights in the radar track data that were identifiable as military operations. According to FAA's Traffic Flow Management System Counts (TFMSC), the military aircraft types at HVN coincide with typical GA aircraft types, so military and GA categories were combined for noise modeling purposes. **Table 8** lists the Existing Conditions GA "local" operations, which are modeled on closed circuit flight paths.

The first column in each of the detailed operations tables is the AEDT aircraft type. As noted in section 1.2 the AEDT database contains noise and performance data for over three hundred different aircraft types, but not for every airframe/engine combination possible. The database also contains FAA pre-approved substitutions for common aircraft types that are not listed. For example, the CRJ-200 is represented in the model by the CL600 and the CRJ-700 is represented in AEDT by the CRJ9-ER. The second column in each table indicates the aircraft category; modeled runway usage rates were developed and applied using these categories.

Table 6. Air Carrier & Air Taxi Aircraft Annual Operations, Existing Conditions

Source: 2019 HVN radar flight track data, HMMH 2020

AEDT Aircraft Type	Aircraft Category	Arrivals		Departures				Total Operations
		Day	Night	Day		Night		
				SL 1	SL 2	SL 1	SL 2	
EC130	Helicopter	11.4	3.0	11.8	0.0	2.6	0.0	**28.8**
BD-700-1A10	Air Carrier Size Jet	19.6	5.1	13.9	6.3	3.1	1.4	**49.3**
CL600	Air Carrier Size Jet	364.3	94.1	374.7	0.0	83.7	0.0	**916.9**
CL601	Air Carrier Size Jet	13.1	3.4	13.4	0.0	3.0	0.0	**32.9**
CRJ9-ER	Air Carrier Size Jet	111.1	28.7	98.7	15.5	22.0	3.5	**279.6**
EMB145	Air Carrier Size Jet	22.9	5.9	13.6	9.9	3.0	2.2	**57.6**
EMB175	Air Carrier Size Jet	434.5	112.3	431.2	15.8	96.3	3.5	**1093.7**
CNA510	Small Jet	21.2	5.5	21.8	0.0	4.9	0.0	**53.5**
CNA525C	Small Jet	124.2	32.1	127.7	0.0	28.5	0.0	**312.5**
CNA55B	Small Jet	117.6	30.4	121.0	0.0	27.0	0.0	**296.0**
CNA560U	Small Jet	99.7	25.8	102.5	0.0	22.9	0.0	**250.8**
CNA560XL	Small Jet	18.0	4.6	18.5	0.0	4.1	0.0	**45.2**
CNA680	Small Jet	112.7	29.1	116.0	0.0	25.9	0.0	**283.7**
CNA750	Small Jet	63.7	16.5	65.5	0.0	14.6	0.0	**160.4**
FAL900EX	Small Jet	3.3	0.8	2.1	1.2	0.5	0.3	**8.2**
G650ER	Small Jet	4.9	1.3	3.7	1.3	0.8	0.3	**12.3**
GIV	Small Jet	24.5	6.3	25.2	0.0	5.6	0.0	**61.7**
GV	Small Jet	4.9	1.3	5.0	0.0	1.1	0.0	**12.3**
LEAR35	Small Jet	119.3	30.8	122.7	0.0	27.4	0.0	**300.1**
MU3001	Small Jet	49.0	12.7	50.4	0.0	11.3	0.0	**123.3**
CNA208	Turboprop	209.1	54.0	215.1	0.0	48.0	0.0	**526.3**
DHC6	Turboprop	68.6	17.7	70.6	0.0	15.8	0.0	**172.7**
BEC58P	Piston	60.4	15.6	62.2	0.0	13.9	0.0	**152.1**
CNA182	Piston	9.8	2.5	10.1	0.0	2.3	0.0	**24.7**
GASEPV	Piston	4.9	1.3	5.0	0.0	1.1	0.0	**12.3**
Air Carrier and Air Taxi Operations Totals		**2,092.7**	**540.8**	**2,102.6**	**50.1**	**469.6**	**11.2**	**5,267.0**

Table 7. GA and Military Itinerant Aircraft Annual Operations, Existing Conditions

Source: 2019 HVN radar flight track data, HMMH 2020

AEDT Aircraft Type	Aircraft Category	Arrivals		Departures				Total Operations
		Day	Night	Day		Night		
				SL 1	SL 2	SL 1	SL 2	
B429	Helicopter	9.7	0.4	9.7	0.0	0.4	0.0	**20.2**
S76	Helicopter	38.7	1.7	39.0	0.0	1.4	0.0	**80.8**
SA330J	Helicopter	12.9	0.6	13.0	0.0	0.5	0.0	**26.9**
BD-700-1A10	Air Carrier Size Jet	54.8	2.4	38.1	17.1	1.4	0.6	**114.4**
CL600	Air Carrier Size Jet	109.7	4.8	110.4	0.0	4.0	0.0	**228.9**
CL601	Air Carrier Size Jet	58.1	2.5	58.5	0.0	2.1	0.0	**121.2**
EMB145	Air Carrier Size Jet	6.5	0.3	3.8	2.7	0.1	0.1	**13.5**
CNA500	Small Jet	38.7	1.7	39.0	0.0	1.4	0.0	**80.8**
CNA510	Small Jet	25.8	1.1	26.0	0.0	0.9	0.0	**53.8**
CNA525C	Small Jet	80.6	3.5	81.2	0.0	2.9	0.0	**168.3**
CNA55B	Small Jet	170.9	7.4	172.1	0.0	6.2	0.0	**356.8**
CNA560U	Small Jet	154.8	6.7	155.9	0.0	5.6	0.0	**323.1**
CNA560XL	Small Jet	83.9	3.7	84.4	0.0	3.1	0.0	**175.0**
CNA680	Small Jet	96.8	4.2	97.4	0.0	3.5	0.0	**201.9**
CNA750	Small Jet	90.3	3.9	90.9	0.0	3.3	0.0	**188.5**
ECLIPSE50	Small Jet	19.4	0.8	19.5	0.0	0.7	0.0	**40.4**
FAL900EX	Small Jet	135.5	5.9	87.2	49.2	3.2	1.8	**282.7**
G650ER	Small Jet	29.0	1.3	21.6	7.6	0.8	0.3	**60.6**
GIIB	Small Jet	9.7	0.4	9.7	0.0	0.4	0.0	**20.2**
GIV	Small Jet	145.1	6.3	146.2	0.0	5.3	0.0	**302.9**
GV	Small Jet	93.5	4.1	94.2	0.0	3.4	0.0	**195.2**
IA1125	Small Jet	67.7	3.0	68.2	0.0	2.5	0.0	**141.4**
LEAR35	Small Jet	232.2	10.1	233.9	0.0	8.5	0.0	**484.6**
MU3001	Small Jet	32.3	1.4	32.5	0.0	1.2	0.0	**67.3**
CNA208	Turboprop	190.3	8.3	191.6	0.0	6.9	0.0	**397.1**
CNA441	Turboprop	22.6	1.0	22.7	0.0	0.8	0.0	**47.1**
DHC6	Turboprop	345.1	15.0	347.5	0.0	12.6	0.0	**720.2**
BEC58P	Piston	261.2	11.4	263.1	0.0	9.5	0.0	**545.2**
CNA172	Piston	435.4	19.0	438.5	0.0	15.9	0.0	**908.7**
CNA182	Piston	122.6	5.3	123.4	0.0	4.5	0.0	**255.8**
CNA206	Piston	19.4	0.8	19.5	0.0	0.7	0.0	**40.4**
COMSEP	Piston	464.4	20.2	467.7	0.0	16.9	0.0	**969.3**
GASEPF	Piston	167.7	7.3	168.9	0.0	6.1	0.0	**350.0**
GASEPV	Piston	522.5	22.8	526.2	0.0	19.0	0.0	**1090.4**
PA28	Piston	651.5	28.4	656.1	0.0	23.8	0.0	**1359.7**
PA30	Piston	6.5	0.3	6.5	0.0	0.2	0.0	**13.5**
PA31	Piston	45.2	2.0	45.5	0.0	1.6	0.0	**94.2**
GA and Military Itinerant Operations Totals		**5,050.4**	**220.1**	**5,009.7**	**76.7**	**181.3**	**2.8**	**10,541.0**

Table 8. Local Annual Operations, Existing Conditions

Source: 2019 HVN radar flight track data, HMMH 2020

AEDT Aircraft Type	Aircraft Category	Circuit Patterns		Total Operations
		Day	Night	
BEC58P	Piston	1,923	18	**1,941**
CNA172	Piston	1,321	12	**1,333**
CNA182	Piston	466	4	**471**
CNA206	Piston	97	1	**98**
COMSEP	Piston	2,079	19	**2,098**
GASEPF	Piston	1,049	10	**1,059**
GASEPV	Piston	2,390	22	**2,412**
Circuit Pattern Totals		**9,325**	**86**	**9,411**

In order to model forecast aircraft operations, HMMH and MJ considered how the existing HVN fleet mix is likely to change over the next two decades, focusing on the jet aircraft, which have the greatest effect on the noise contours. In general, the proportions of operations by the various aircraft propulsion categories (air carrier size jets, small jets, turboprop, piston, and helicopter) were maintained from the existing to the forecast scenario. The only exception to this proportional growth is the assumption of 1,005 additional air carrier operations to the Approved Forecast 2040 scenario.

In the air carrier and air taxi operations group, the air carrier size jets were all assumed to be replaced by Airbus 220 aircraft (modeled as 737700), with the additional air carrier operations split equally between Airbus 319 neo (A319-131), Airbus 320 neo[4] (A320-271N), and Boeing 737-800 Max (737MAX8) aircraft. The only other modernization assumption to the air carrier and air taxi operations group is the consolidation of small jet types FAL900EX, GV, and G650ER: collectively modeled as G650ER.

For the GA and military operations group, the air carrier size jet operations are consolidated and modeled as BD-700-1A10 while the small jet types GIIB, GIV, GV, and G650ER were consolidated and modeled as G650ER.

The day/night split proportions and the stage length split proportions observed in the radar flight track data and applied to the Existing Conditions modeled operations were also applied to the forecast operations. **Table 9** through **Table 11** contain the detailed operational data modeled in representation of the Approved Forecast 2040 scenario. **Table 9** presents the air carrier and air taxi operations and **Table 10** contains the breakdown of forecast GA and military itinerant operations. **Table 11** lists the forecast GA “local” operations; it maintains the same proportional split of the total local operations among specific aircraft types as was derived from the 2019 radar data.

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[4] The future critical aircraft for HVN has been approved as the A319/A320.

Table 9. Air Carrier & Air Taxi Aircraft Annual Operations, Approved Forecast 2040 Scenario

Source: 2019 HVN radar flight track data, MJ and HMMH 2021

AEDT Aircraft Type	Aircraft Category	Arrivals		Departures				Total Operations
		Day	Night	Day		Night		
				SL 1	SL 2	SL 1	SL 2	
EC130	Helicopter	11.8	3.0	12.1	0.0	2.7	0.0	**29.6**
A319-131	Air Carrier Size Jet	133.1	34.4	130.4	6.6	29.1	1.5	**335.0**
A320-271N	Air Carrier Size Jet	133.1	34.4	130.4	6.6	29.1	1.5	**335.0**
737MAX8	Air Carrier Size Jet	133.1	34.4	130.4	6.6	29.1	1.5	**335.0**
737700	Air Carrier Size Jet	965.5	249.5	945.6	47.6	211.2	10.6	**2,430.0**
CNA510	Small Jet	21.8	5.6	22.5	0.0	5.0	0.0	**54.9**
CNA525C	Small Jet	127.6	33.0	131.3	0.0	29.3	0.0	**321.2**
CNA55B	Small Jet	120.9	31.2	124.4	0.0	27.8	0.0	**304.3**
CNA560U	Small Jet	102.4	26.5	105.4	0.0	23.5	0.0	**257.8**
CNA560XL	Small Jet	18.5	4.8	19.0	0.0	4.2	0.0	**46.5**
CNA680	Small Jet	115.9	29.9	119.2	0.0	26.6	0.0	**291.6**
CNA750	Small Jet	65.5	16.9	67.4	0.0	15.0	0.0	**164.8**
G650ER	Small Jet	13.4	3.5	11.2	2.6	2.5	0.6	**33.8**
GIV	Small Jet	25.2	6.5	25.9	0.0	5.8	0.0	**63.4**
LEAR35	Small Jet	122.6	31.7	126.1	0.0	28.2	0.0	**308.5**
MU3001	Small Jet	50.4	13.0	51.8	0.0	11.6	0.0	**126.8**
CNA208	Turboprop	214.9	55.5	221.1	0.0	49.4	0.0	**540.9**
DHC6	Turboprop	70.5	18.2	72.5	0.0	16.2	0.0	**177.5**
BEC58P	Piston	62.1	16.1	63.9	0.0	14.3	0.0	**156.4**
CNA182	Piston	10.1	2.6	10.4	0.0	2.3	0.0	**25.4**
GASEPV	Piston	5.0	1.3	5.2	0.0	1.2	0.0	**12.7**
Air Carrier and Air Taxi Operations Totals		**2,523.4**	**652.1**	**2,525.9**	**69.8**	**564.1**	**15.6**	**6,351.0**

Table 10. GA and Military Itinerant Aircraft Annual Operations, Approved Forecast 2040 Scenario

Source: 2019 HVN radar flight track data, HMMH 2020

AEDT Aircraft Type	Aircraft Category	Arrivals		Departures				Total Operations
		Day	Night	Day		Night		
				SL 1	SL 2	SL 1	SL 2	
B429	Helicopter	10.3	0.4	10.4	0.0	0.4	0.0	**21.5**
S76	Helicopter	41.2	1.8	41.5	0.0	1.5	0.0	**86.0**
SA330J	Helicopter	13.7	0.6	13.8	0.0	0.5	0.0	**28.7**
BD-700-1A10	Air Carrier Size Jet	243.9	10.6	224.5	21.2	8.1	0.8	**509.1**
CNA500	Small Jet	41.2	1.8	41.5	0.0	1.5	0.0	**86.0**
CNA510	Small Jet	27.5	1.2	27.7	0.0	1.0	0.0	**57.4**
CNA525C	Small Jet	85.9	3.7	86.5	0.0	3.1	0.0	**179.2**
CNA55B	Small Jet	182.1	7.9	183.4	0.0	6.6	0.0	**380.0**
CNA560U	Small Jet	164.9	7.2	166.1	0.0	6.0	0.0	**344.2**
CNA560XL	Small Jet	89.3	3.9	90.0	0.0	3.3	0.0	**186.4**
CNA680	Small Jet	103.1	4.5	103.8	0.0	3.8	0.0	**215.1**
CNA750	Small Jet	96.2	4.2	96.9	0.0	3.5	0.0	**200.8**
ECLIPSE50	Small Jet	20.6	0.9	20.8	0.0	0.8	0.0	**43.0**
FAL900EX	Small Jet	144.3	6.3	92.9	52.4	3.4	1.9	**301.1**
G650ER	Small Jet	295.4	12.9	289.4	8.1	10.5	0.3	**616.6**
IA1125	Small Jet	72.1	3.1	72.7	0.0	2.6	0.0	**150.6**
LEAR35	Small Jet	247.3	10.8	249.1	0.0	9.0	0.0	**516.2**
MU3001	Small Jet	34.4	1.5	34.6	0.0	1.3	0.0	**71.7**
CNA208	Turboprop	202.7	8.8	204.1	0.0	7.4	0.0	**423.0**
CNA441	Turboprop	24.0	1.0	24.2	0.0	0.9	0.0	**50.2**
DHC6	Turboprop	367.6	16.0	370.2	0.0	13.4	0.0	**767.2**
BEC58P	Piston	278.3	12.1	280.2	0.0	10.1	0.0	**580.8**
CNA172	Piston	463.8	20.2	467.1	0.0	16.9	0.0	**967.9**
CNA182	Piston	130.5	5.7	131.5	0.0	4.8	0.0	**272.5**
CNA206	Piston	20.6	0.9	20.8	0.0	0.8	0.0	**43.0**
COMSEP	Piston	494.7	21.6	498.2	0.0	18.0	0.0	**1,032.5**
GASEPF	Piston	178.6	7.8	179.9	0.0	6.5	0.0	**372.8**
GASEPV	Piston	556.5	24.2	560.5	0.0	20.3	0.0	**1,161.5**
PA28	Piston	693.9	30.2	698.9	0.0	25.3	0.0	**1,448.3**
PA30	Piston	6.9	0.3	6.9	0.0	0.3	0.0	**14.3**
PA31	Piston	48.1	2.1	48.4	0.0	1.8	0.0	**100.4**
GA and Military Itinerant Operations		**5,379.6**	**234.4**	**5,336.2**	**81.7**	**193.2**	**3.0**	**11,228.0**

Table 11. Local Annual Operations, Approved Forecast 2040 Scenario

Source: 2019 HVN radar flight track data, HMMH 2021

AEDT Aircraft Type	Aircraft Category	Circuit Patterns		Total Operations
		Day	Night	
BEC58P	Piston	2,054	19	2,073
CNA172	Piston	1,411	13	1,424
CNA182	Piston	498	5	503
CNA206	Piston	104	1	105
COMSEP	Piston	2,220	21	2,241
GASEPF	Piston	1,121	10	1,131
GASEPV	Piston	2,552	24	2,576
Circuit Pattern Totals		**9,960**	**92**	**10,052**

1.3.2 Aircraft Ground Operations

No aircraft maintenance engine runups are included in this noise analysis.

1.4 Runway Utilization Rates

Table 12 presents the runway usage rates modeled for each of the four aircraft categories: air carrier size jets, small jets, turboprops, and piston-engine aircraft. These percentages were derived from the analysis of 2019 radar flight track data, which contained 11,835 arrival and departure operations with enough information to categorize the flight. The radar flight track data also included almost 4,500 flight tracks that were identifiable from their geometry as local circuit patterns and served as the data source for local operations model inputs. The same runway use percentages were applied to the modeled forecast operations.

Table 12. Existing and Future Runway Use Percentages

Source: 2019 HVN radar flight track data, HMMH, 2021

Aircraft Category	Arrivals			Departures			Local Circuits		
	2	20	total	2	20	total	2	20	total
Air Carrier Size Jets	61.4%	38.6%	100%	34.4%	65.6%	100%	0.0%	0.0%	100%
Small jets	51.0%	49.0%	100%	50.4%	49.6%	100%	0.0%	0.0%	100%
Turboprops	55.5%	44.5%	100%	56.5%	43.5%	100%	0.0%	0.0%	100%
Pistons	34.8%	65.2%	100%	36.8%	63.2%	100%	40.7%	59.3%	100%

In addition to flight operations using Runway 2/20, the East Ramp was used as a “helipad” (landing and takeoff location, marked with a red dot on **Figure 1**) for modeling the small number of helicopter operations at HVN. There were about 50 identifiable helicopter flights in the 2019 radar flight track data, which informed the modeling assumptions for 157 annual helicopter flights in the Existing Conditions. The same helicopter usage was applied to the forecast helicopter operations.

1.5 Flight Track Geometry and Utilization Rates

HMMH developed flight track geometry and utilization rates using flight track and aircraft identification information from the 2019 radar data. The flight tracks were first sorted into six groups: jet arrivals, jet departures, non-jet fixed-wing aircraft arrivals, non-jet fixed-wing aircraft departures, local circuit operations (all of which were by non-jets) and helicopters. Each group of flight tracks was then separated into "bundles" by general direction and waypoints, except for the helicopter group, due to lack of data. Statistical analysis of each bundle produced a "backbone" track with an equal number of dispersion tracks to either side. This process led to the development of 74 bundles of model tracks, each consisting of 3 or 5 individual model flight tracks, for a total of 262 tracks overall.

Table 13 through **Table 15** provide the distribution information regarding the modeling of flights to and from HVN, separating departures, arrivals, and local circuits into separate tables, separating jets from non-jets, and then splitting track groups by runway direction. Each resulting group is mapped in its own flight track map figure (**Figure 2** through **Figure 10**) on which the radar tracks are overlaid by the model tracks. The backbone track for each bundle is portrayed by a bold line, the associated dispersion tracks by dashed lines. The name of the bundle is marked on each backbone track. **Table 13** lists the departure flight track bundle names, the percentage of operations assigned to each bundle, and the number of model tracks within the bundle. **Table 14** presents similar information for the arrival model tracks. Local circuit pattern model flight track information is given in **Table 15.**

Very few helicopter operations could be identified in the flight track and aircraft identification data; the few helicopter operations that are modeled are placed equally on north-bound and south-bound paths. All helicopter operations are modeled as arriving to or departing from the location identified as a "helipad" in **Figure 1**.

The same flight track geometry and track use percentages were applied to the modeled forecast operations. The flight track points near the runway were modified to adjust to the new runway thresholds resulting from the planned runway extensions at both ends of Runway 2/20; the model flight tracks did not shift in relation to locations on the ground beneath the flight paths.

Table 13. Model Departure Flight Tracks

Source: 2019 HVN radar flight track data, HMMH, 2021

Aircraft Category	Departure Track Bundles					
	Runway	Flight Track Map	# of Bundles	Bundle Names	# tracks	Percent Usage
Jet	2	Figure 2	4	DJ02E010	3	6.0%
				DJ02N010	5	44.2%
				DJ02S010	3	31.9%
				DJ02W010	3	17.9%
Jet	20	Figure 3	10	DJ20E010	3	1.4%
				DJ20E02C0	3	2.9%
				DJ20E040	3	2.2%
				DJ20N010	3	3.8%
				DJ20S010	5	51.5%
				DJ20S02C0	3	10.1%
				DJ20S04C0	3	5.5%
				DJ20S070	3	1.4%
				DJ20S080	3	8.8%
				DJ20W010	3	12.3%
Non-jet	2	Figure 4	13	DP02E010	3	7.6%
				DP02E020	5	19.3%
				DP02E040	3	6.8%
				DP02N010	3	7.3%
				DP02N020	3	12.6%
				DP02N030	3	1.4%
				DP02S010	3	5.7%
				DP02S020	3	2.9%
				DP02W010	3	12.4%
				DP02W020	3	3.0%
				DP02W030	3	6.5%
				DP02W040	3	2.9%
				DP02W050	3	11.7%
Non-jet	20	Figure 5	10	DP20E01C0	5	14.0%
				DP20E02C0	5	11.0%
				DP20E030	5	13.2%
				DP20N01C0	5	7.7%
				DP20N030	3	4.6%
				DP20N040	3	2.8%
				DP20S010	5	11.0%
				DP20S020	3	5.0%
				DP20W010	5	23.9%
				DP20W02C0	3	6.8%

Table 14. Model Arrival Flight Tracks

Source: 2019 HVN radar flight track data, HMMH, 2021

Aircraft Category	Arrival Track Bundles					
	Runway	Flight Track Map	# of Bundles	Bundle Names	# tracks	Percent Usage
Jet	2	Figure 6	7	AJ02N010	3	1.9%
				AJ02N020	3	3.6%
				AJ02S010	5	73.4%
				AJ02W010	3	5.3%
				AJ02W020	3	3.0%
				AJ02W03C0	3	5.7%
				AJ02W050	3	7.1%
Jet	20	Figure 7	9	AJ20E010	3	3.0%
				AJ20N01C0	3	3.5%
				AJ20N030	3	12.5%
				AJ20S01C0	5	25.8%
				AJ20S020	5	22.4%
				AJ20S030	3	9.9%
				AJ20W010	3	9.9%
				AJ20W020	3	6.1%
				AJ20W030	3	6.8%
Non-jet	2	Figure 8	5	AP02N110	3	9.5%
				AP02N010	3	10.8%
				AP02S010	3	31.9%
				AP02E010	3	22.6%
				AP02W010	3	25.2%
Non-jet	20	Figure 9	12	AP20E010	5	24.1%
				AP20E020	3	3.7%
				AP20E030	5	8.3%
				AP20N010	5	20.1%
				AP20N020	3	3.8%
				AP20S010	3	3.0%
				AP20S020	3	7.2%
				AP20W010	5	15.4%
				AP20W020	3	4.7%
				AP20W030	3	4.0%
				AP20w040	3	3.7%
				AP20W050	3	1.9%

Table 15. Model Circuit Flight Tracks

Source: 2019 HVN radar flight track data, HMMH, 2021

Aircraft Category	Circuit Track Bundles					
	Runway	Flight Track Map	# of Bundles	Bundle Names	# tracks	Percent Usage
Non-jet	2	Figure 10	2	CP02C010	5	88.7%
				CP02C020	5	11.3%
Non-jet	20		2	CP20C010	5	60.3%
				CP20C020	5	39.7%

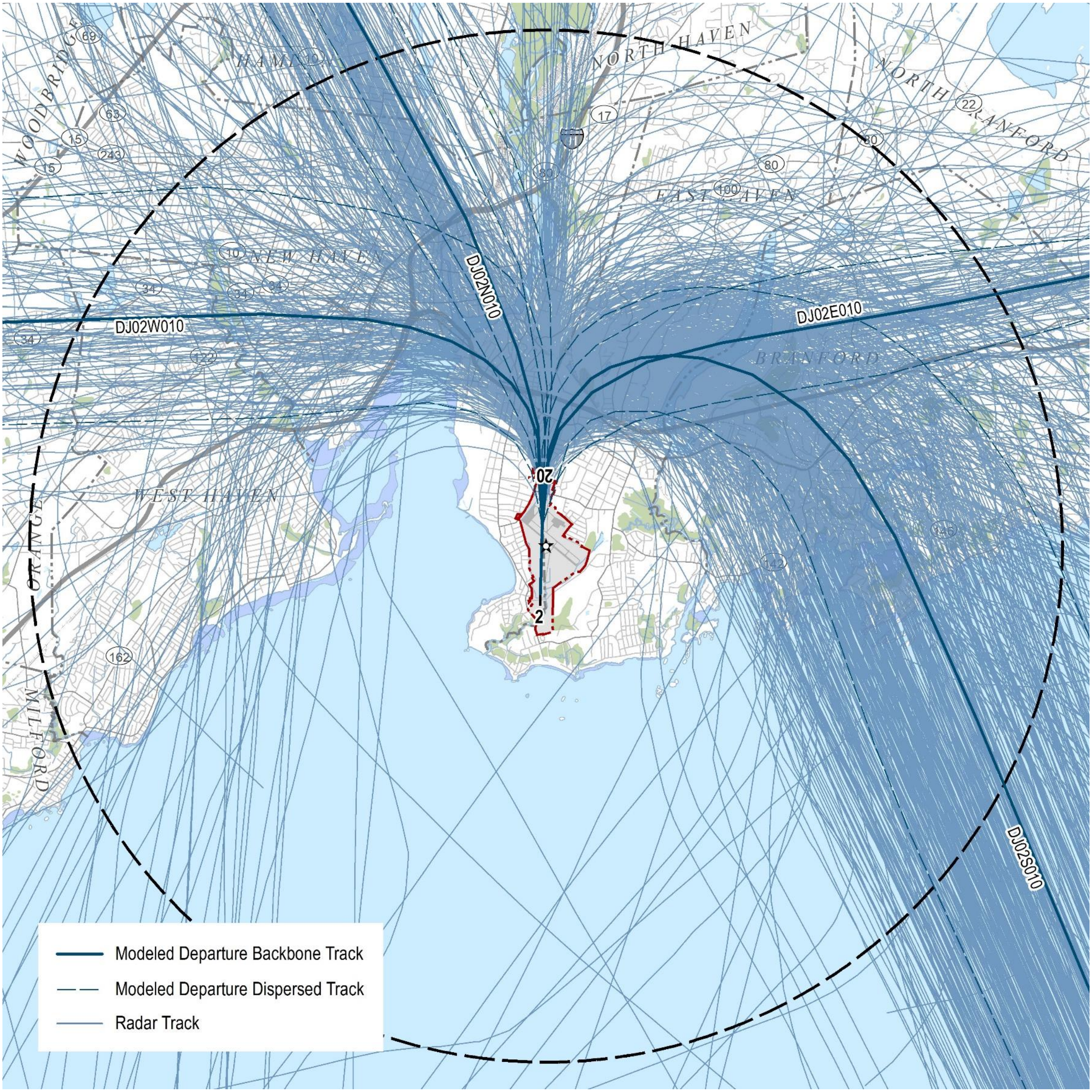

Figure 2. Jet Departure Flight Tracks from Runway 2

Source: HMMH, 2020

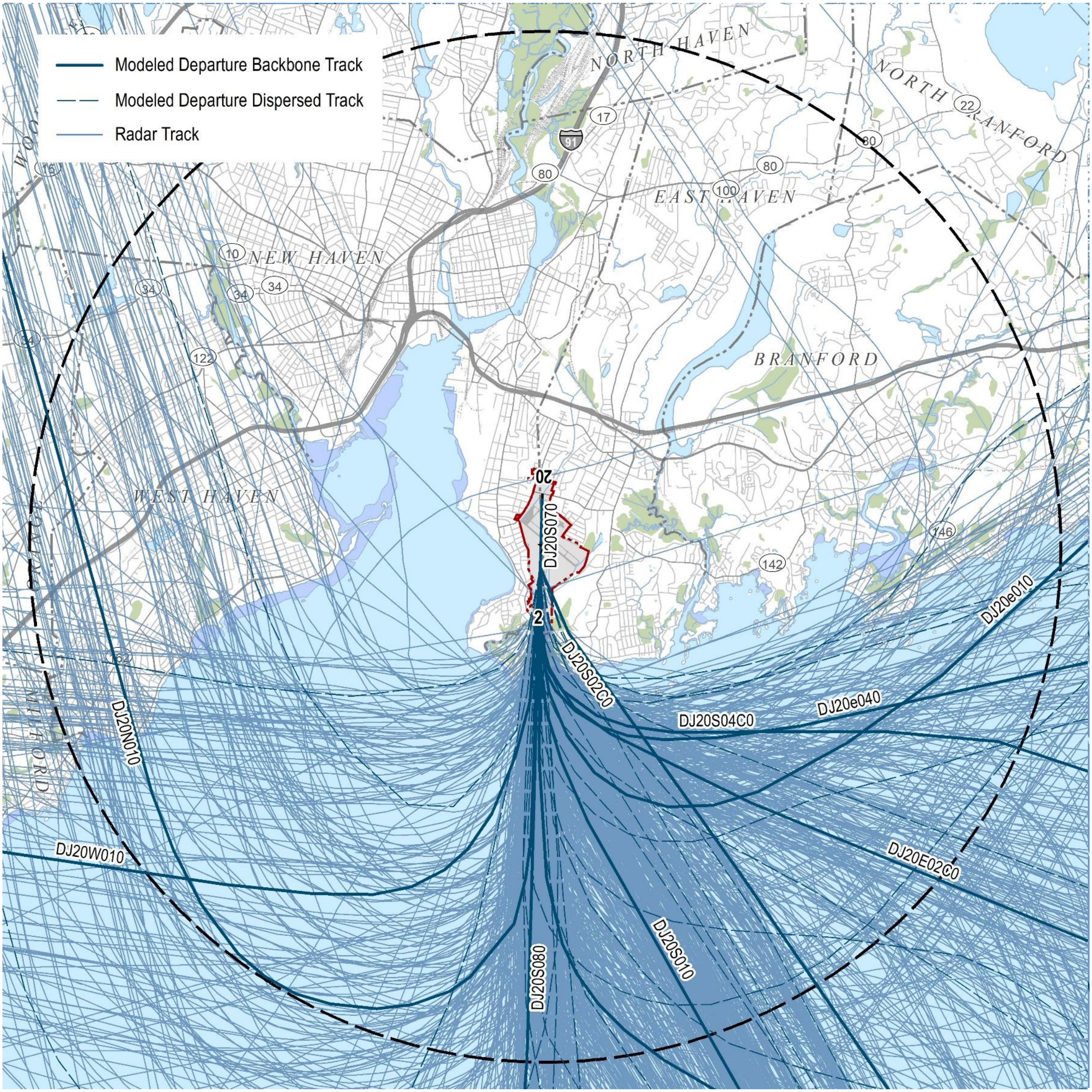

Figure 3. Jet Departure Flight Tracks from Runway 20

Source: HMMH, 2020

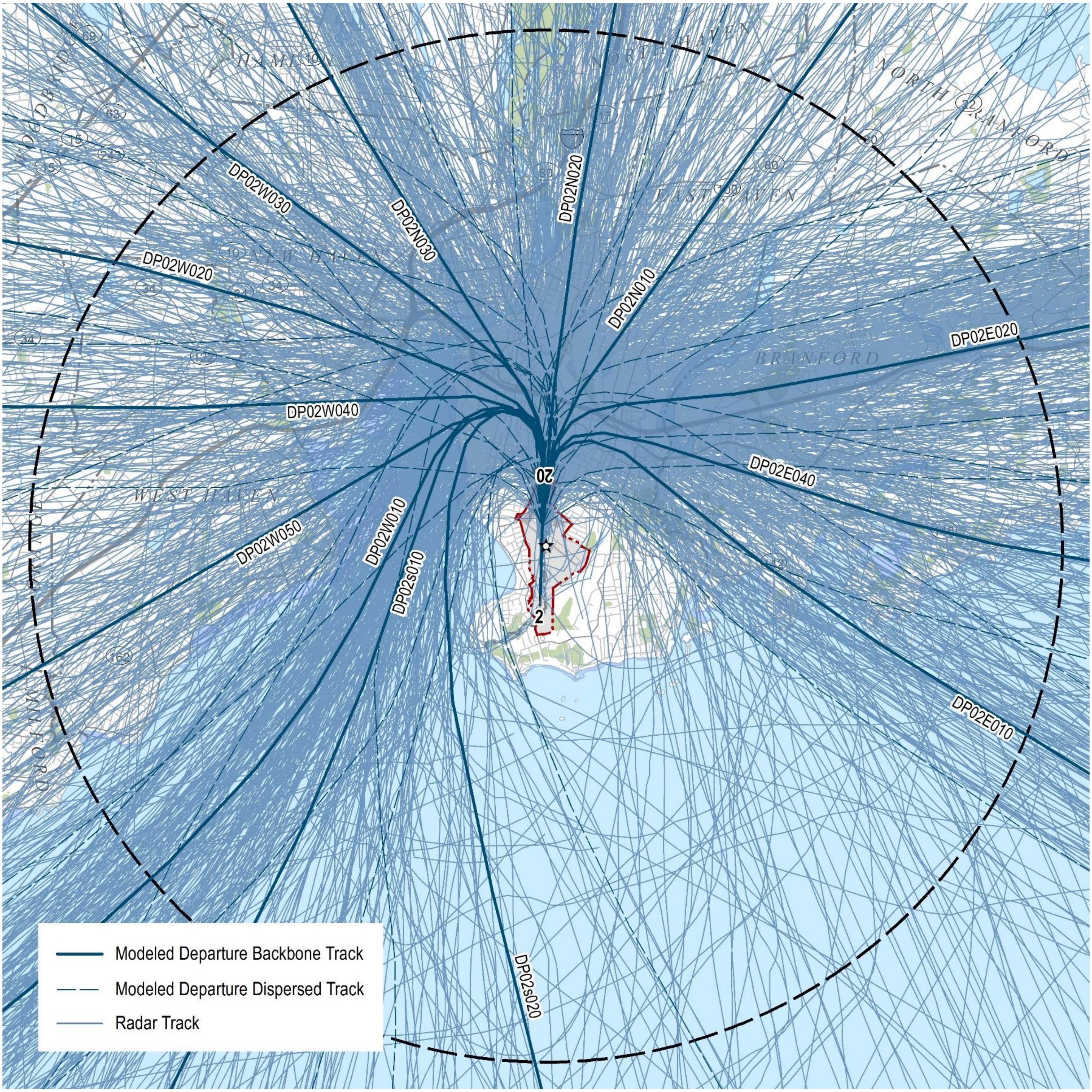

Figure 4. Non-Jet Departure Flight Tracks from Runway 2

Source: HMMH, 2020

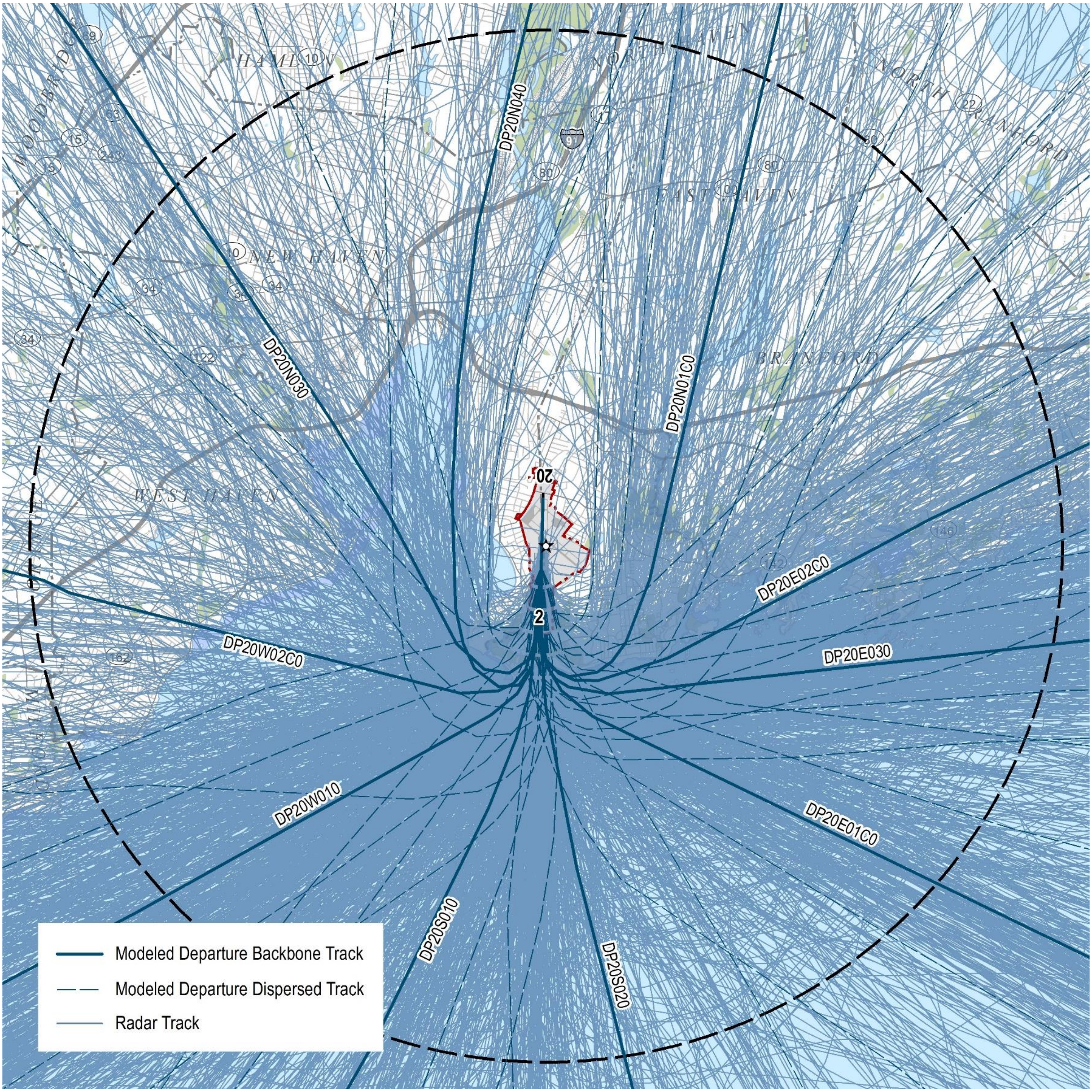

Figure 5. Non-Jet Departure Flight Tracks from Runway 20

Source: HMMH, 2020

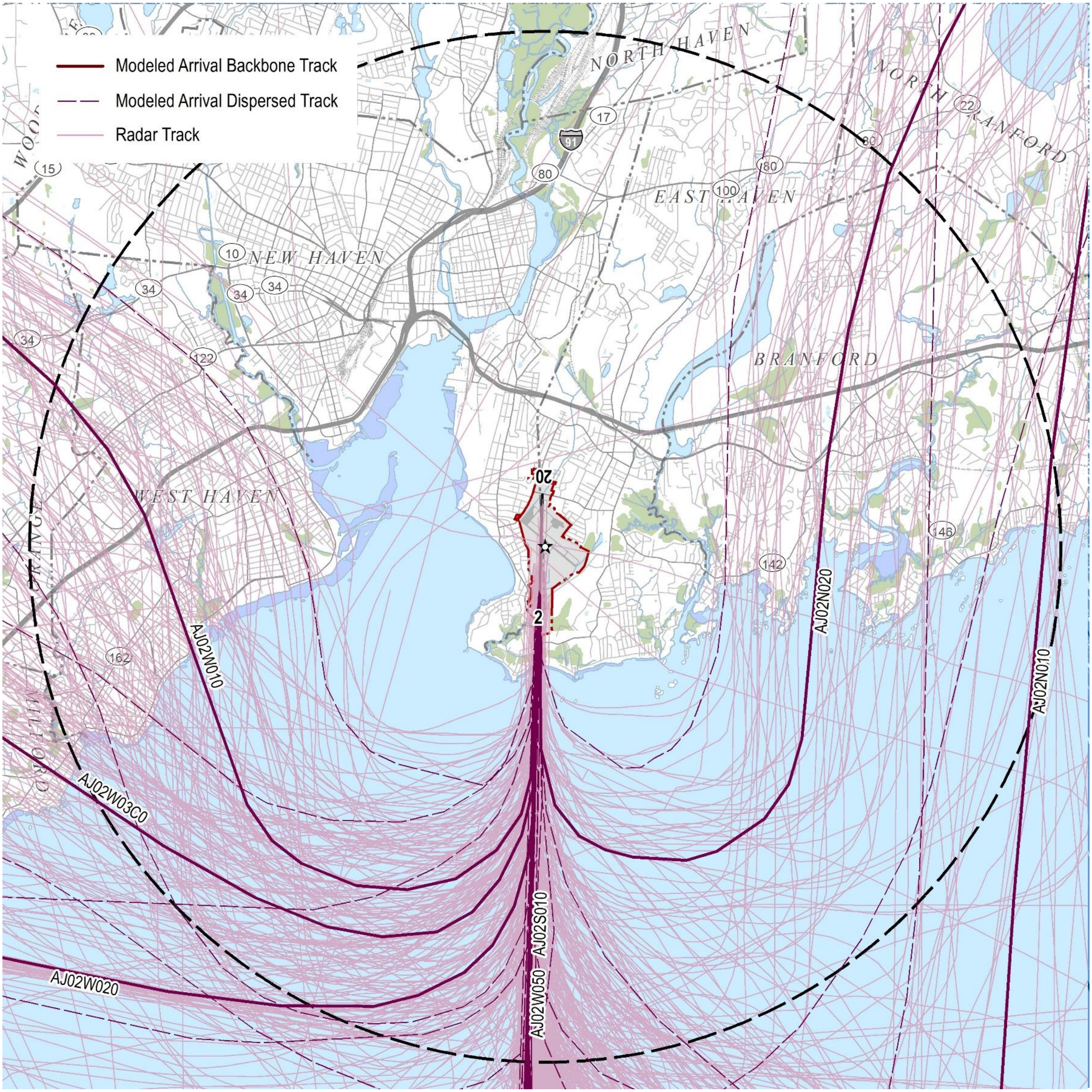

Figure 6. Jet Arrival Flight Tracks to Runway 2

Source: HMMH, 2020

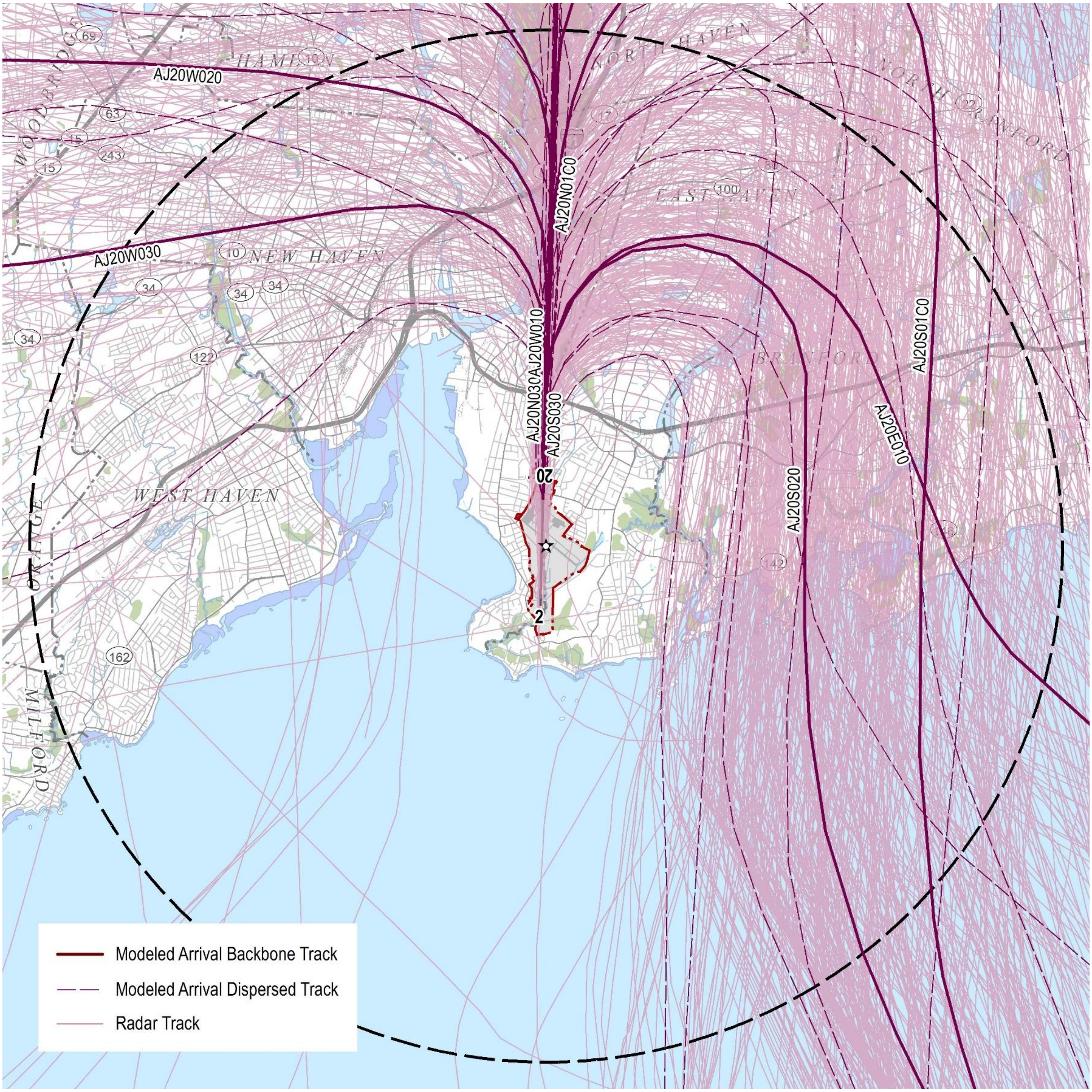

Figure 7. Jet Arrival Flight Tracks to Runway 20

Source: HMMH, 2020

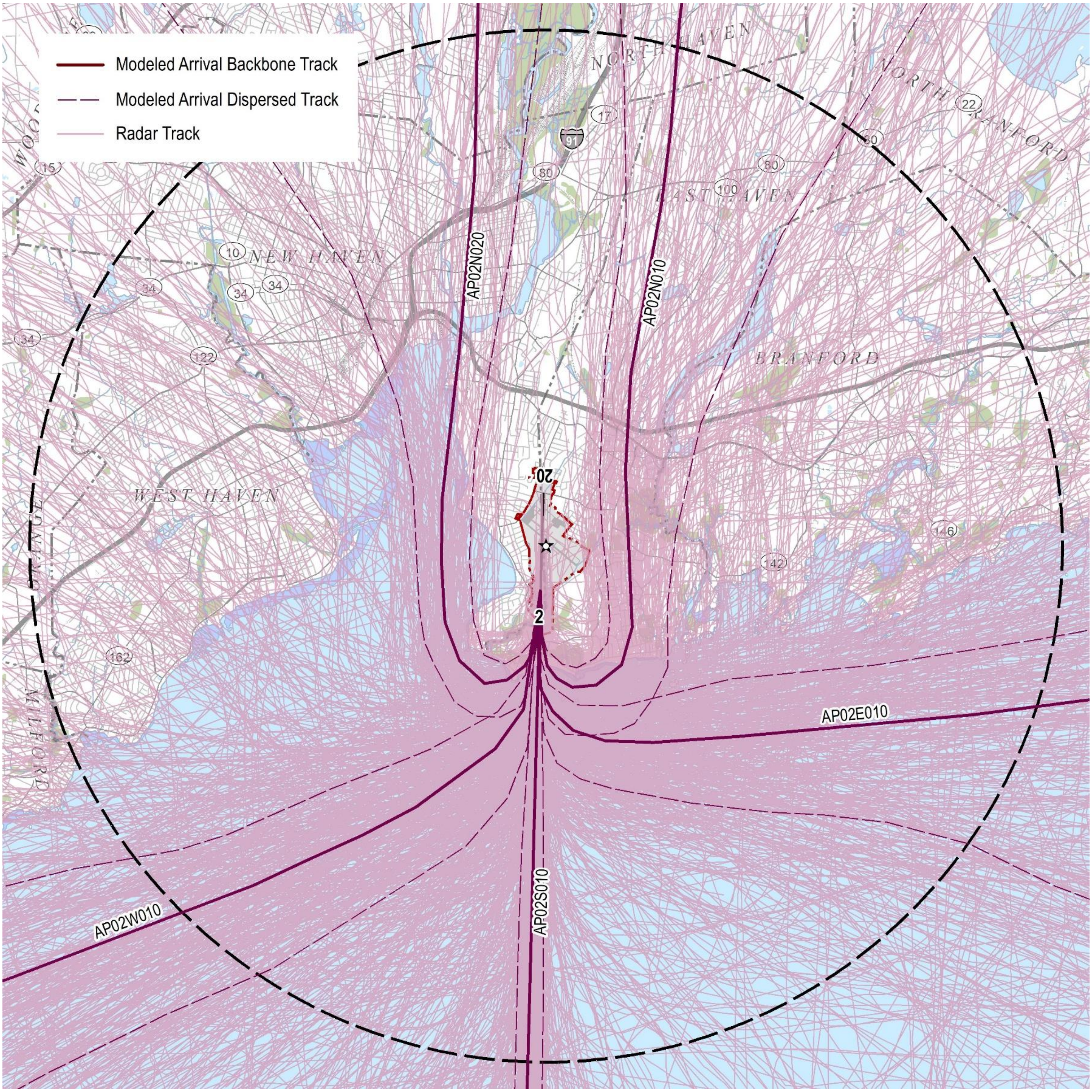

Figure 8. Non-Jet Arrival Flight Tracks to Runway 2

Source: HMMH, 2020

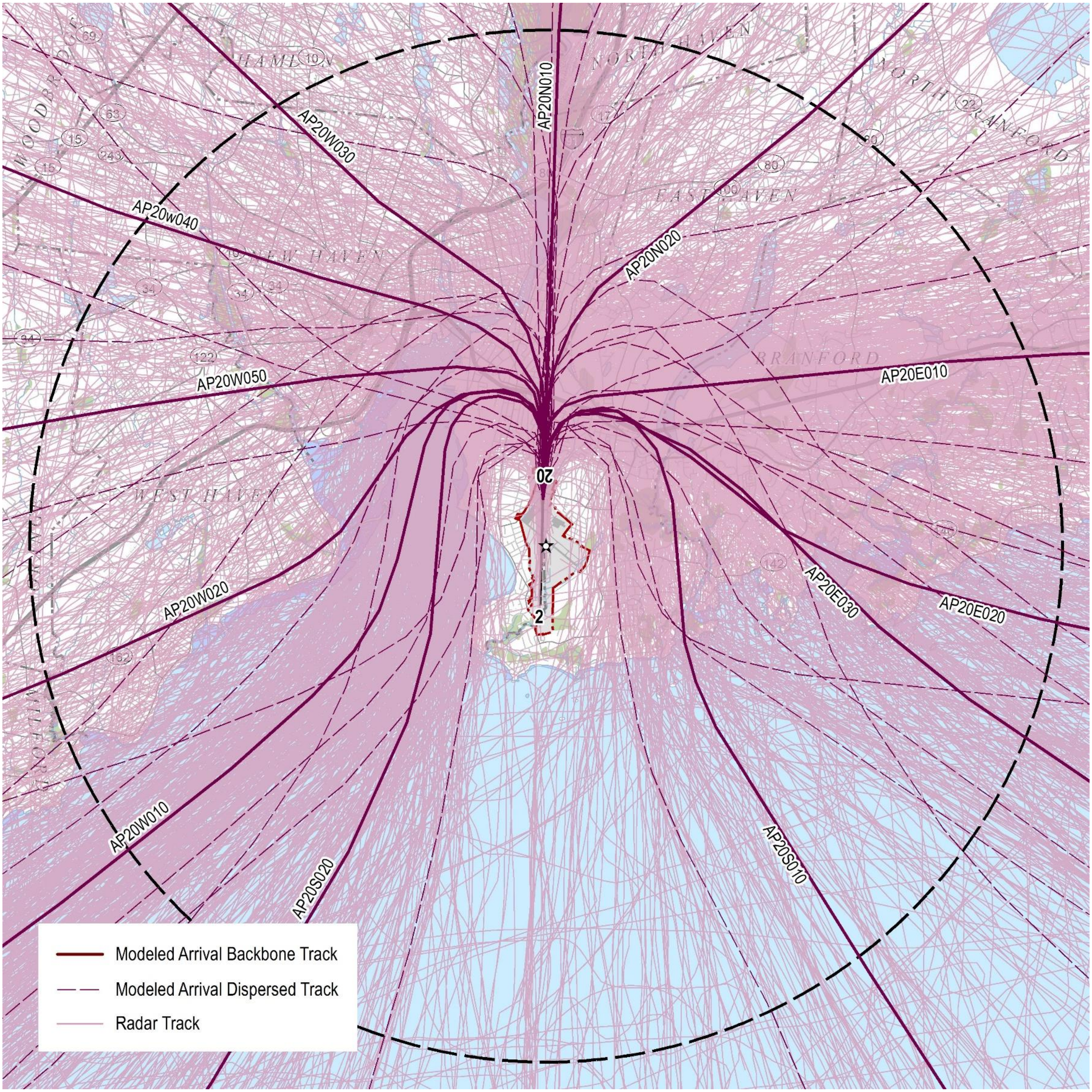

Figure 9. Non-Jet Arrival Flight Tracks to Runway 20

Source: HMMH, 2020

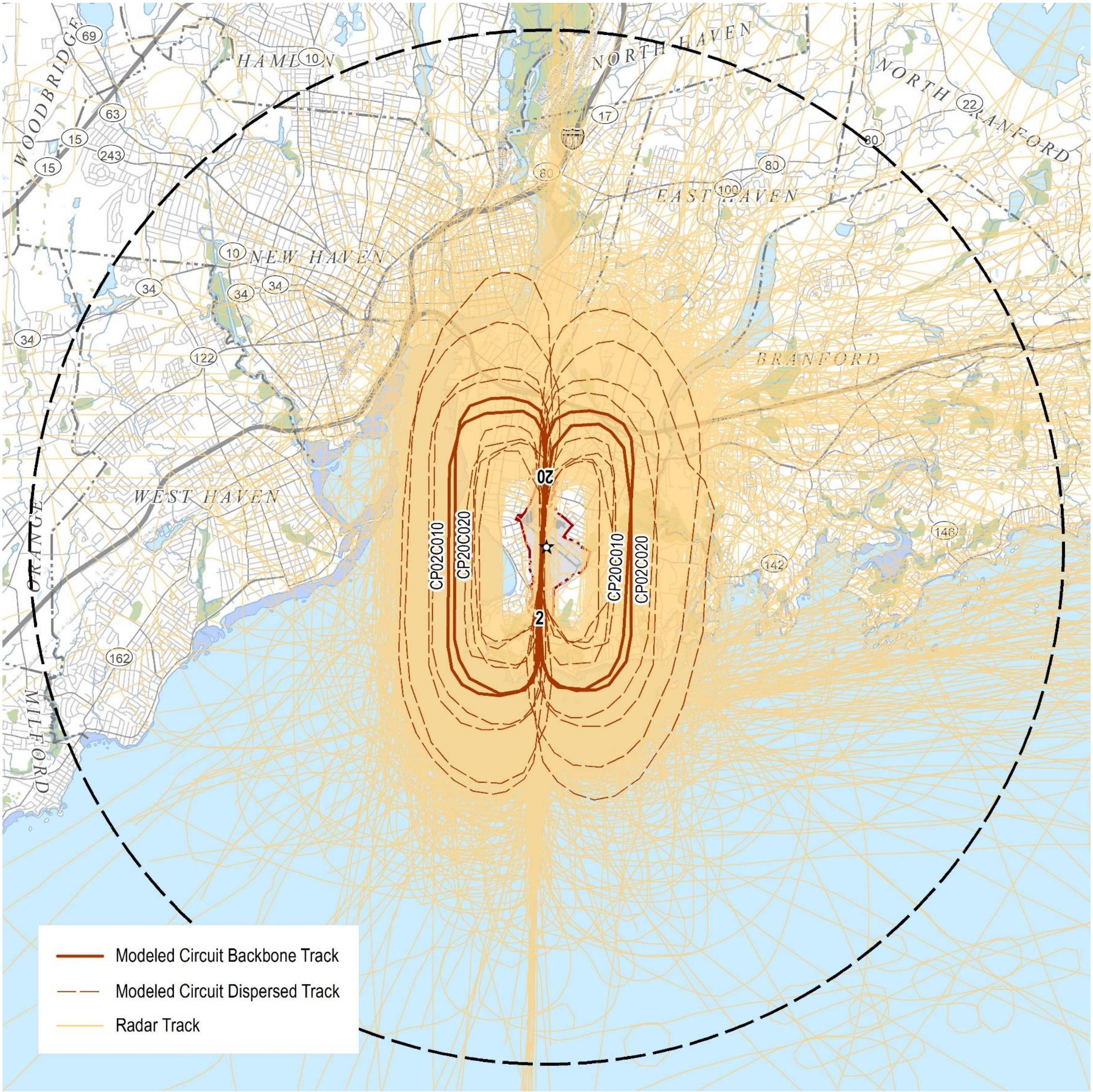

Figure 10. Local Pattern Flight Tracks

Source: HMMH, 2020

1.6 Meteorological and Terrain Data

AEDT also requires data on two sets of local conditions affecting aircraft operations and sound propagation: annual average day meteorological conditions and terrain.

1.6.1 Meteorological Data

AEDT uses meteorological data to adjust aircraft performance and sound propagation. The FAA requires the use of the provided AEDT weather information. The AEDT database includes 10-year average weather (using data from 2009 – 2018) for each airport. These data for HVN are:

- Temperature: 53.35° F
- Station Pressure: 1015.9 mbar
- Sea Level Pressure: 1016.4 mbar
- Dew point: 42.29° F
- Relative humidity: 66.0%
- Wind speed 5.87 knots

1.6.2 Terrain Data

AEDT uses terrain data to adjust the aircraft-to-ground path length, to take into account locations where terrain variation relative to the airfield makes the ground closer to or farther from the aircraft relative to flat-earth conditions.

Terrain data were obtained from the United States Geological Survey National Elevation Dataset with 1/3 arc second (approximately 33 ft.) resolution covering the Study Area.

2. Noise Analysis Results

The AEDT uses the model inputs described above to calculate DNL at every individual point of a large array of grid points around an airport. The program then connects points of equal value to produce the DNL contour lines. **Figure 11** shows the average annual day DNL contours for the Existing Conditions and **Figure 12** displays the DNL contours for the Approved Forecast 2040 scenario. **Figure 13** shows a comparison of the two sets of contours.

The shape of the contours indicate the contributions of aircraft flight operations to the overall noise environment. In **Figure 13**, the elongation of the forecast scenario DNL contours in comparison to the Existing Conditions is reflective of the modeled runway extensions.

Compared to the Existing Conditions, the Approved Forecast 2040 65 DNL contour encompasses a larger area, due to the runway extensions and the expected increase in aircraft operations. **Table 16** presents the calculated land area within each contour interval for both analysis cases. The net increase in land area within DNL 65 is about 35 acres, or 27 percent as compared to the Existing Conditions.

As indicated by the comparison of contours, noise is expected to increase at both ends of the runway. Much of the increased land area for the 2040 forecast scenario is contained within the airport property boundaries. **Table 16** tabulates land within the airport property line separately from off-airport land; it indicates an increase of less than two acres of off-airport area within the 65 DNL contour. For both the Existing Conditions and the Approved Forecast 2040 scenario, no off-airport land is exposed to DNL 70 or higher.

Table 16. Land Area Enclosed by the Existing Conditions and Approved Forecast DNL Contours

Source: HMMH, 2021

Analysis Scenario	Aircraft Noise Exposure			
	DNL 65-70	DNL 70-75	DNL 75+	Total within DNL 65
Existing Conditions				
On-Airport	65.6 acres	36.9 acres	25.0 acres	127.5 acres
Off-Airport	1.3 acres	0.0 acres	0.0 acres	1.3 acres
land area within contour interval	66.9 acres	36.9 acres	25.0 acres	128.8 acres
Approved Forecast 2040				
On-Airport	83.7 acres	46.3 acres	30.8 acres	160.8 acres
Off-Airport	3.0 acres	0.0 acres	0.0 acres	3.0 acres
land area within contour interval	86.7 acres	46.3 acres	30.8 acres	163.8 acres
difference				
On-Airport	18.1 acres	9.4 acres	5.8 acres	33.3 acres
Off-Airport	1.7 acres	0.0 acres	0.0 acres	1.7 acres
within contour interval	19.8 acres	9.4 acres	5.8 acres	35.0 acres

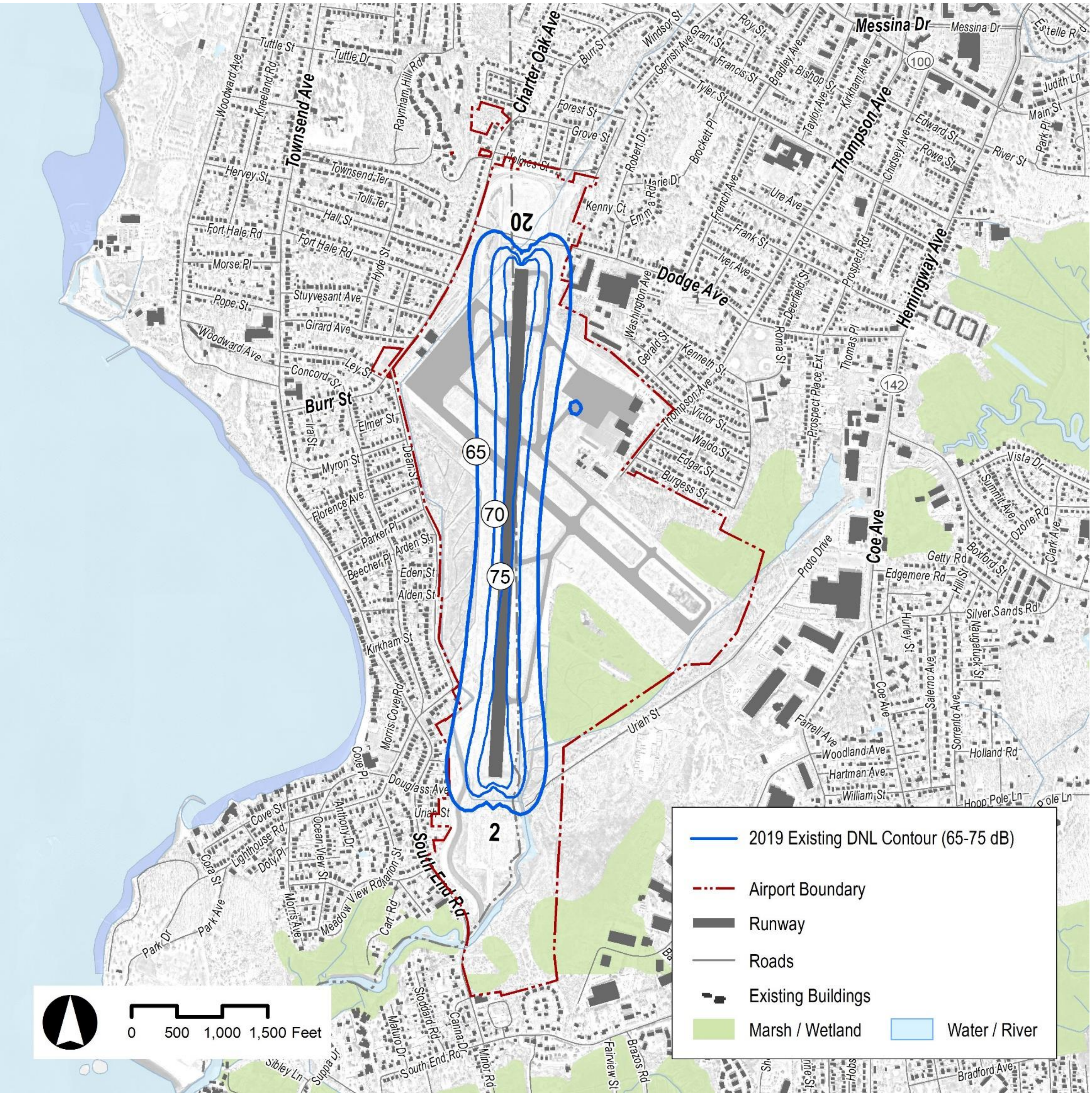

Figure 11. Existing Conditions DNL Contours

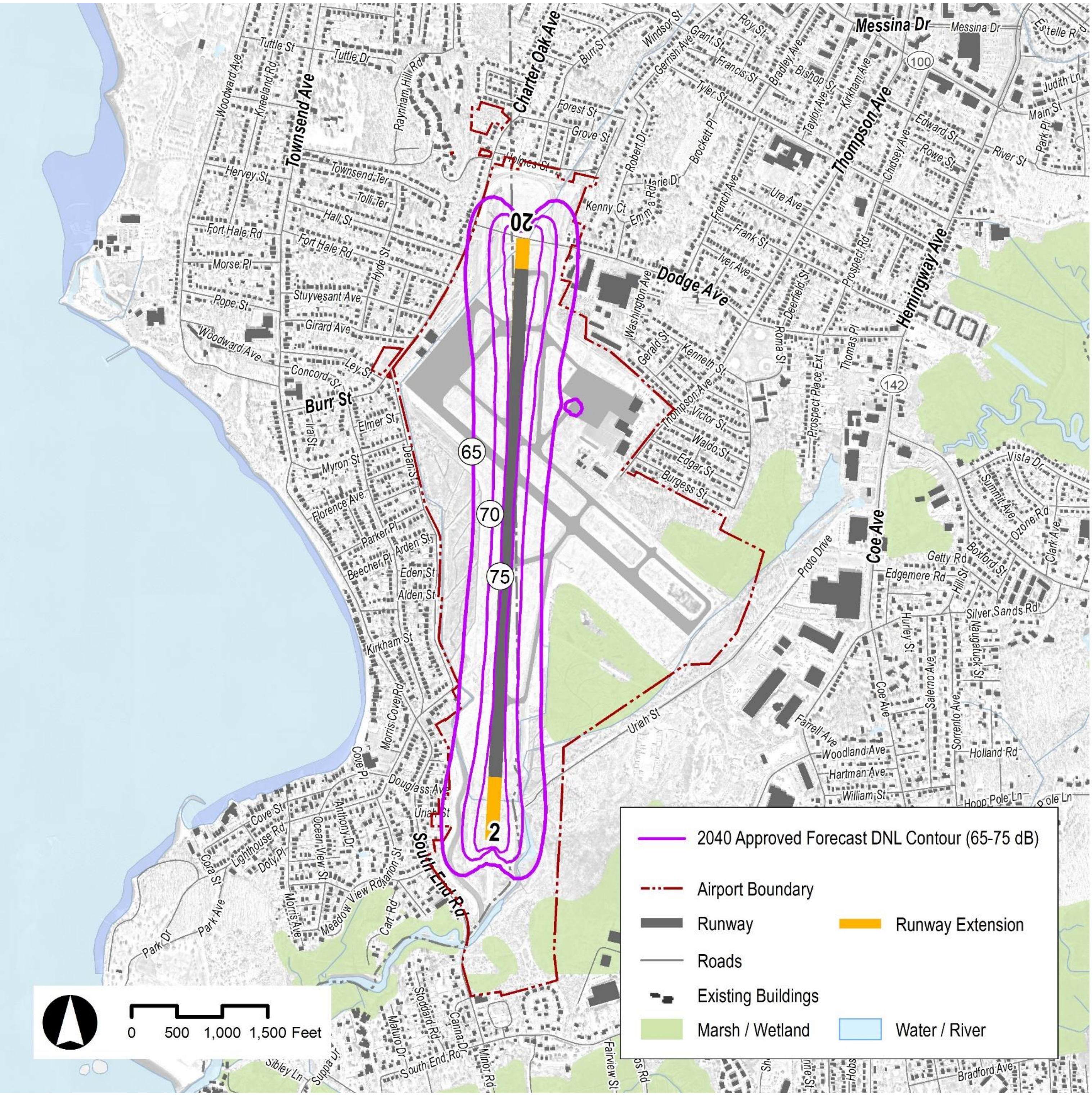

Figure 12. Approved Forecast 2040 DNL Contours

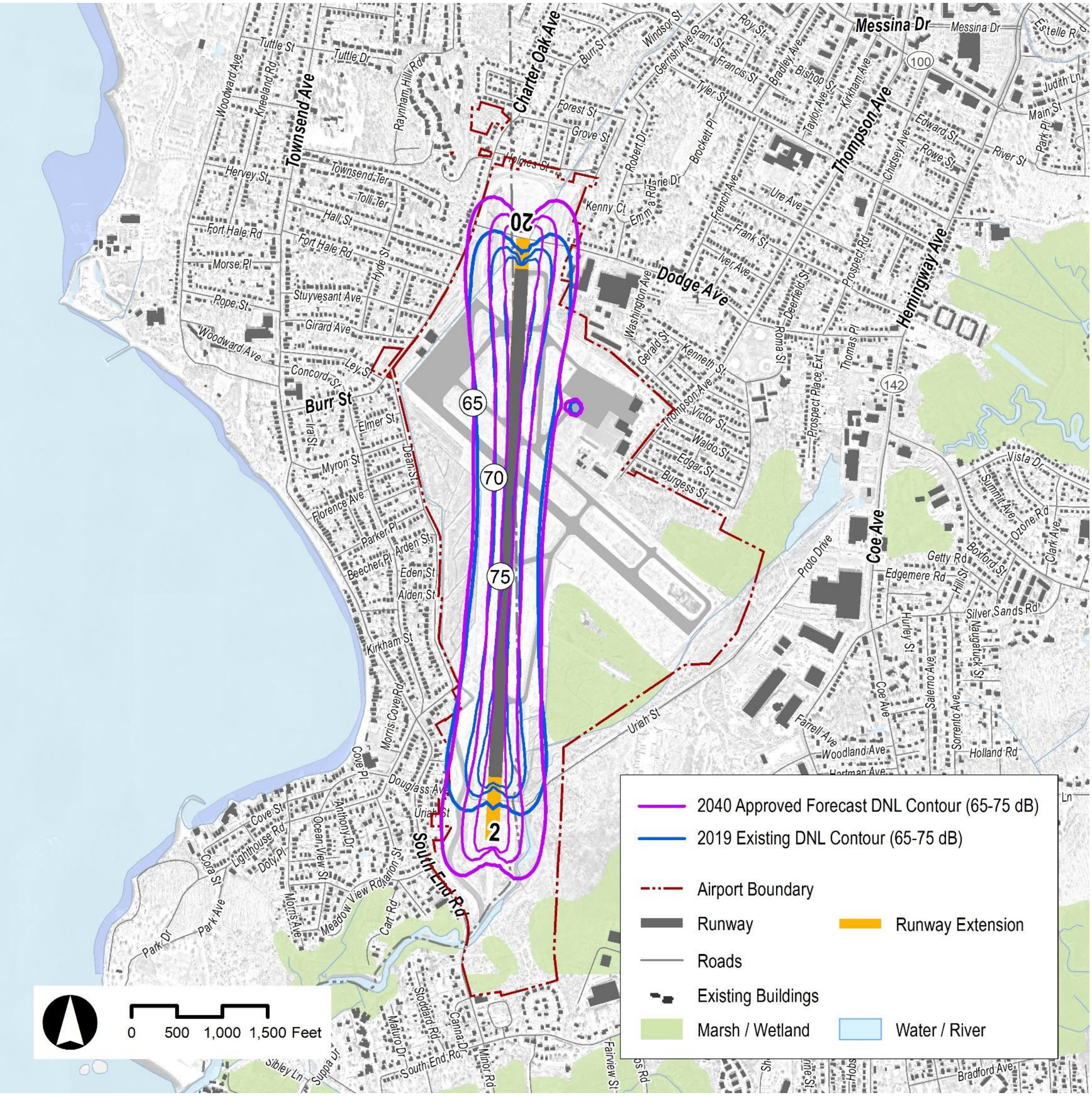

Figure 13. Comparison of Existing Conditions and Approved Forecast 2040 DNL Contours

An inventory of noise sensitive land uses within the 65 DNL contour has been prepared for the Existing Conditions and for the Approved Forecast 2040 scenario. To estimate the population and housing units within each contour interval, the census blocks[5] that are included (completely or partially) within the contour lines are first identified, and a population-per-unit factor[6] is calculated. Then the GIS program selects the property parcels within or crossed by the contour line to arrive at a housing units count. The number of housing units is multiplied by the population factor to arrive at a population estimate.

Table 17 charts the estimated population, number of housing units, and other identified noise-sensitive parcels within the 65 DNL contour, listed by 5-dB contour intervals. For the Existing Conditions, an estimated 16 people live in 7 housing units whose property boundaries are partially within the 65 DNL contour; no residential properties are within the 70 DNL contour. The forecast case analysis shows an estimated 28 people living in 12 housing units whose property boundaries are partially within the 65 DNL contour; again, no people/housing units are within the forecast 70 DNL or higher contour levels. The data in **Table 17** indicate an increase of 12 people in 5 housing units between the Existing Conditions and for the Approved Forecast 2040 scenario.

A review of the most recent FAR Part 150 Noise Exposure Map for HVN indicated that only one non-residential noise sensitive property was within DNL 65; a school[7] location. That property is just outside the 65 DNL contour for both the Existing Conditions and the Approved Forecast 2040 scenario in this analysis.

Table 17. Noise Sensitive Parcels and Estimated Population within 65 DNL contour for the Existing Conditions and Approved Forecast 2040 Contours

Source: HMMH

DNL (dB)	**Existing Conditions**			**Approved Forecast 2040**		
	Estimated Population	Housing Units[Note 1]	Other Noise Sensitive Parcels[Note 2]	Estimated Population	Housing Units[Note 1]	Other Noise Sensitive Parcels[Note 2]
65-70	16	7	0	28	12	0
70-75	0	0	0	0	0	0
75+	0	0	0	0	0	0
Total within 65 DNL	16	7	0	28	12	0

Notes:

1. HVN has undertaken noise mitigation based on the most recent FAR Part 150 Noise Exposure Map but the housing units listed here have not been compared against mitigation records.
2. Noise Sensitive Parcels include schools, places of worship, hospitals, nursing homes, and designated historical sites.

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[5] 2010 census data was used, as 2020 census data not yet available at the time of the analysis

[6] The population per unit factor is 2.28

[7] The FAR Part 150 Noise Compatibility Study for Tweed New Haven Regional Airport, dated November 2012, documents one non-residential noise sensitive land use within the DNL 65 contour, where two schools, the Shoreline Clinical Day School and East Haven Adult Education both rented out the same facility in a commercial/industrial center at 290 Dodge Ave in East Haven. A Google search in 2021 yields no results for the Shoreline Clinical Day School, but the East Haven Adult Education appears to be still operating at that location.

Appendix A. Aircraft Noise Terminology

Noise is a complex physical quantity. The properties, measurement, and presentation of noise involve specialized terminology that can be difficult to understand. To provide a basic reference on these technical issues, this section introduces fundamentals of noise terminology, the effects of noise on human activity, and noise propagation.

Introduction to Noise Terminology

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

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

Sound Pressure Level, SPL, and the Decibel, dB

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

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

Mathematically, SPL is a logarithmic quantity based on the ratio of two sound pressures, the numerator being the pressure of the sound source of interest (P_{source}), and the denominator being a reference pressure ($P_{reference}$) [8]

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

The logarithmic conversion of sound pressure to SPL means that the quietest sound that we can hear (the reference pressure) has a sound pressure level of about 0 dB, while the loudest sounds that we hear without pain have sound pressure levels of about 120 dB. Most sounds in our day-to-day environment have sound pressure levels from about 40 to 100 dB[9].

Because decibels are logarithmic quantities, we cannot use common arithmetic to combine them. For example, if two sound sources each produce 100 dB operating individually, when they operate simultaneously,

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[8] The reference pressure is approximately the quietest sound that a healthy young adult can hear.

[9] The logarithmic ratio used in its calculation means that SPL changes relatively quickly at low sound pressures and more slowly at high pressures. This relationship matches human detection of changes in pressure. We are much more sensitive to changes in level when the SPL is low (for example, hearing a baby crying in a distant bedroom), than we are to changes in level when the SPL is high (for example, when listening to highly amplified music).

they produce 103 dB -- not the 200 dB we might expect. Increasing to four equal sources operating simultaneously will add another three decibels of noise, resulting in a total SPL of 106 dB. For every doubling of the number of equal sources, the SPL goes up another three decibels.

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

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

A-Weighted Decibel

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

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

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

The normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of about 10,000 to 15,000 Hz. Most people respond to sound most readily when the predominant frequency is in the range of normal conversation – typically around 1,000 to 2,000 Hz. The acoustical community has defined several “filters,” which approximate this sensitivity of our ear and thus, help us to judge the relative loudness of various sounds made up of many different frequencies.

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

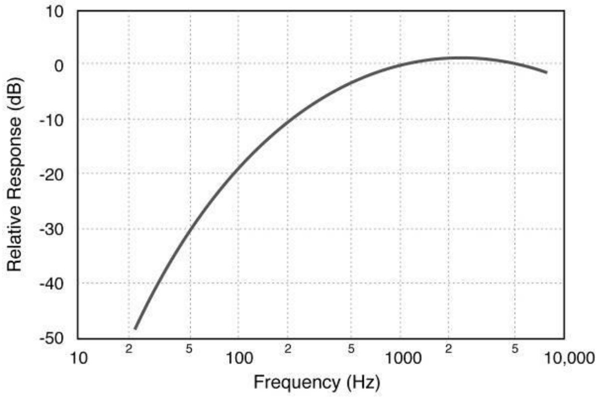

Figure A-1. A-Weighting Frequency Response

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[10] A “10 dB per doubling” rule of thumb is the most often used approximation.

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

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

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

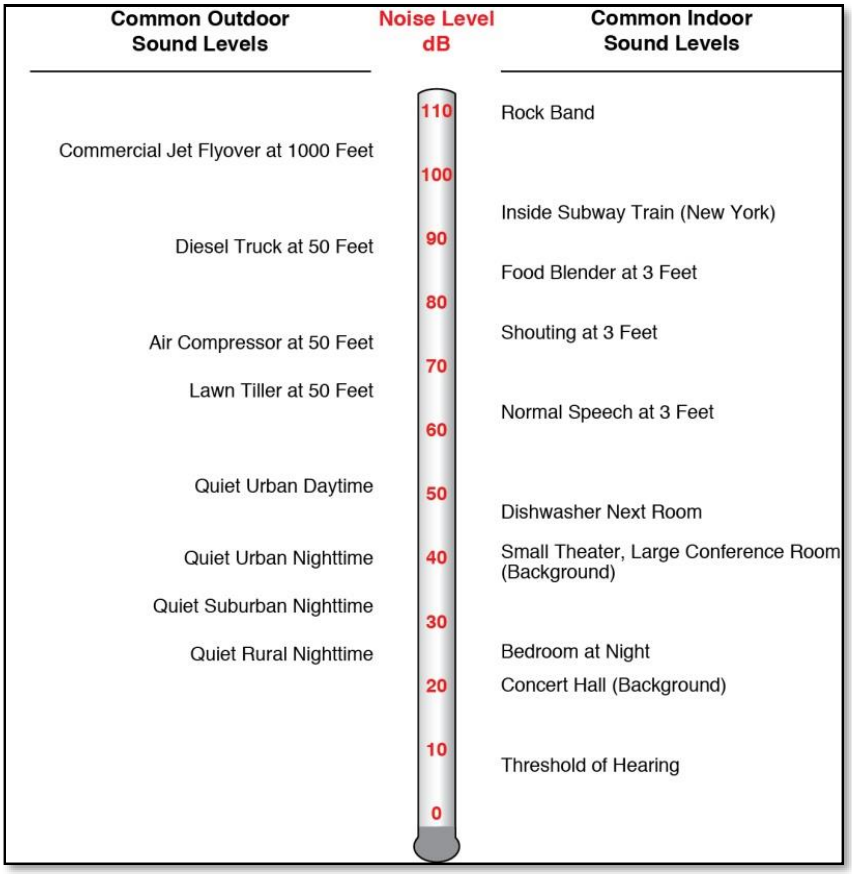

Figure A-2. A-Weighted Sound Levels for Common Sounds

Source: HMMH

Maximum A-Weighted Sound Level, L_{max}

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

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

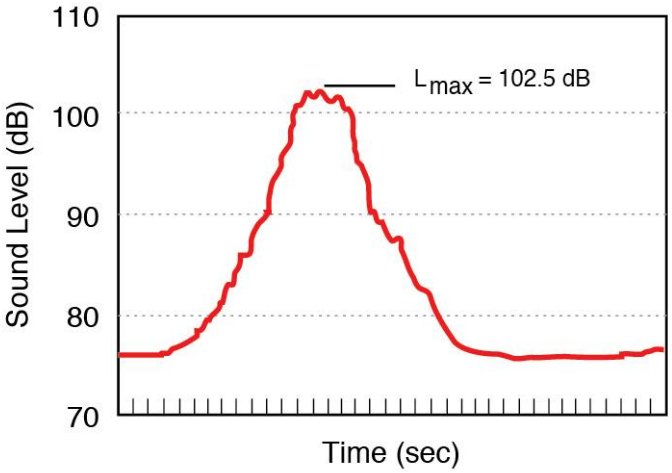

Figure A-3. Variation in A-Weighted Sound Level over Time and Maximum Noise Level

Source: HMMH

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

Sound Exposure Level, SEL

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

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

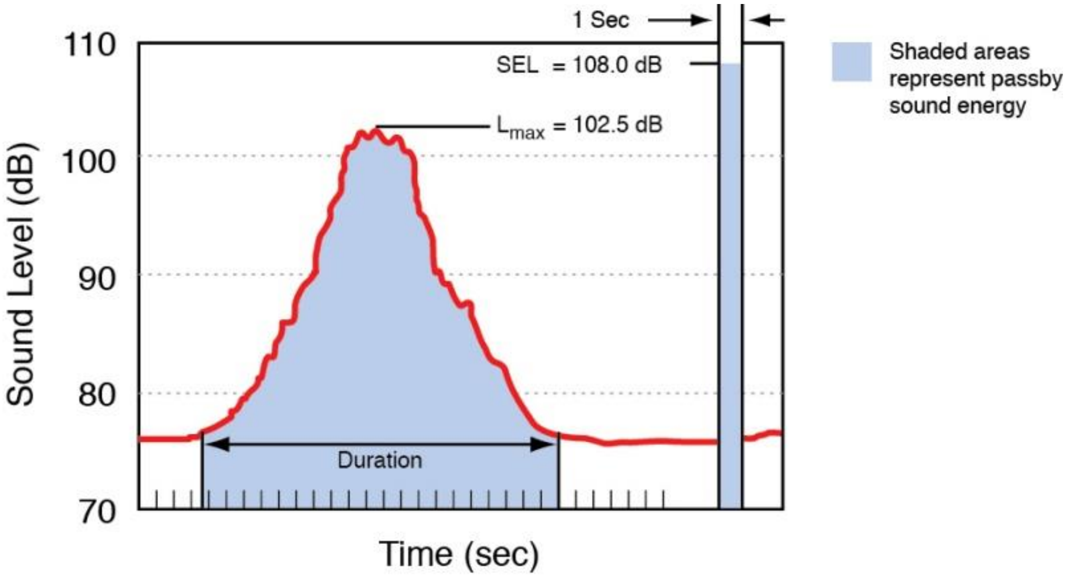

Figure A-4. Graphical Depiction of Sound Exposure Level

Source: HMMH

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

Equivalent A-Weighted Sound Level, L_{eq}

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

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

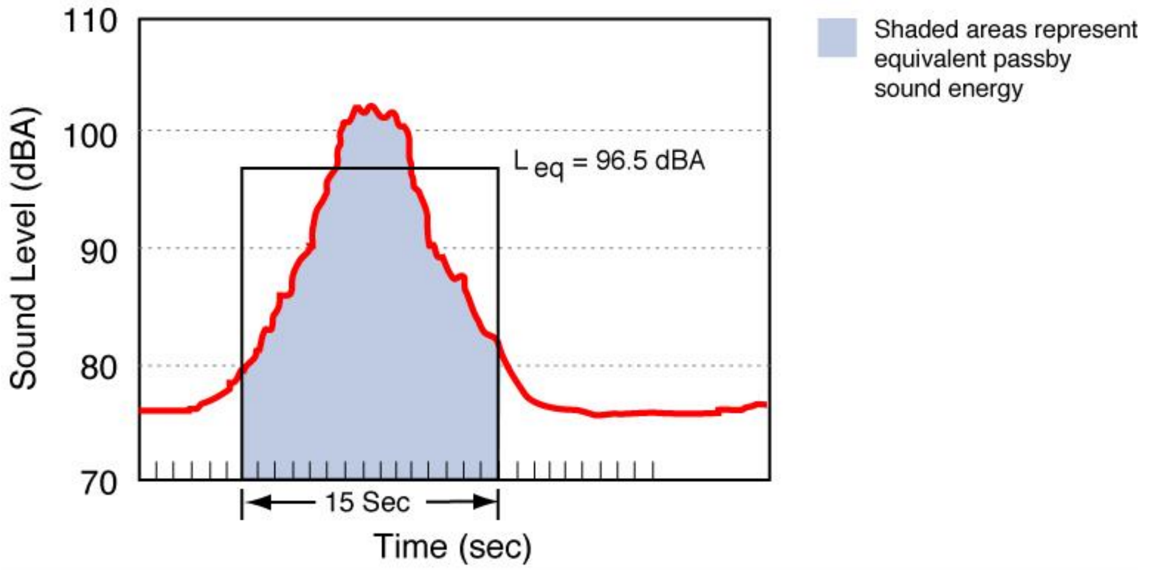

Figure A-5. Example of a 15-Second Equivalent Sound Level

Source: HMMH

Day-Night Average Sound Level, DNL or L_{dn}

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

The U.S. Environmental Protection Agency identified DNL as the most appropriate means of evaluating airport noise based on the following considerations[11].

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

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

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

In 2015, the FAA began a multi-year effort to update the scientific evidence on the relationship between aircraft noise exposure and its effects on communities around airports.[12] This was the most comprehensive study using a single noise survey ever undertaken in the United States, polling communities surrounding 20 airports nationwide. The FAA Reauthorization Act of 2018 under Section 188 and 173, required FAA to complete the evaluation of alternative metrics to the DNL standard within one year. The Section 188 and 173 Report to Congress was delivered on April 14, 2020[13] and concluded that while no single noise metric can cover all situations, DNL provides the most comprehensive way to consider the range of factors influencing exposure to aircraft noise. In addition, use of supplemental metrics is both encouraged and supported to further disclose and aid in the public understanding of community noise impacts. The full study supporting these reports was released in January 2021. If changes are warranted in the use of DNL, which DNL level to assess or the use of supplemental metrics, FAA will propose revised policy and related guidance and regulations, subject to interagency coordination, as well as public review and comment.

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

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

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

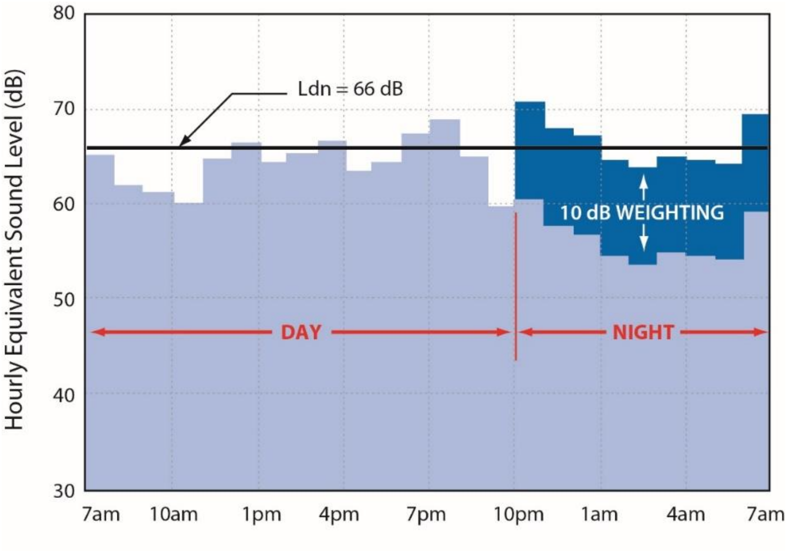

Figure A-6. Example of a Day-Night Average Sound Level Calculation

Source: HMMH

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

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

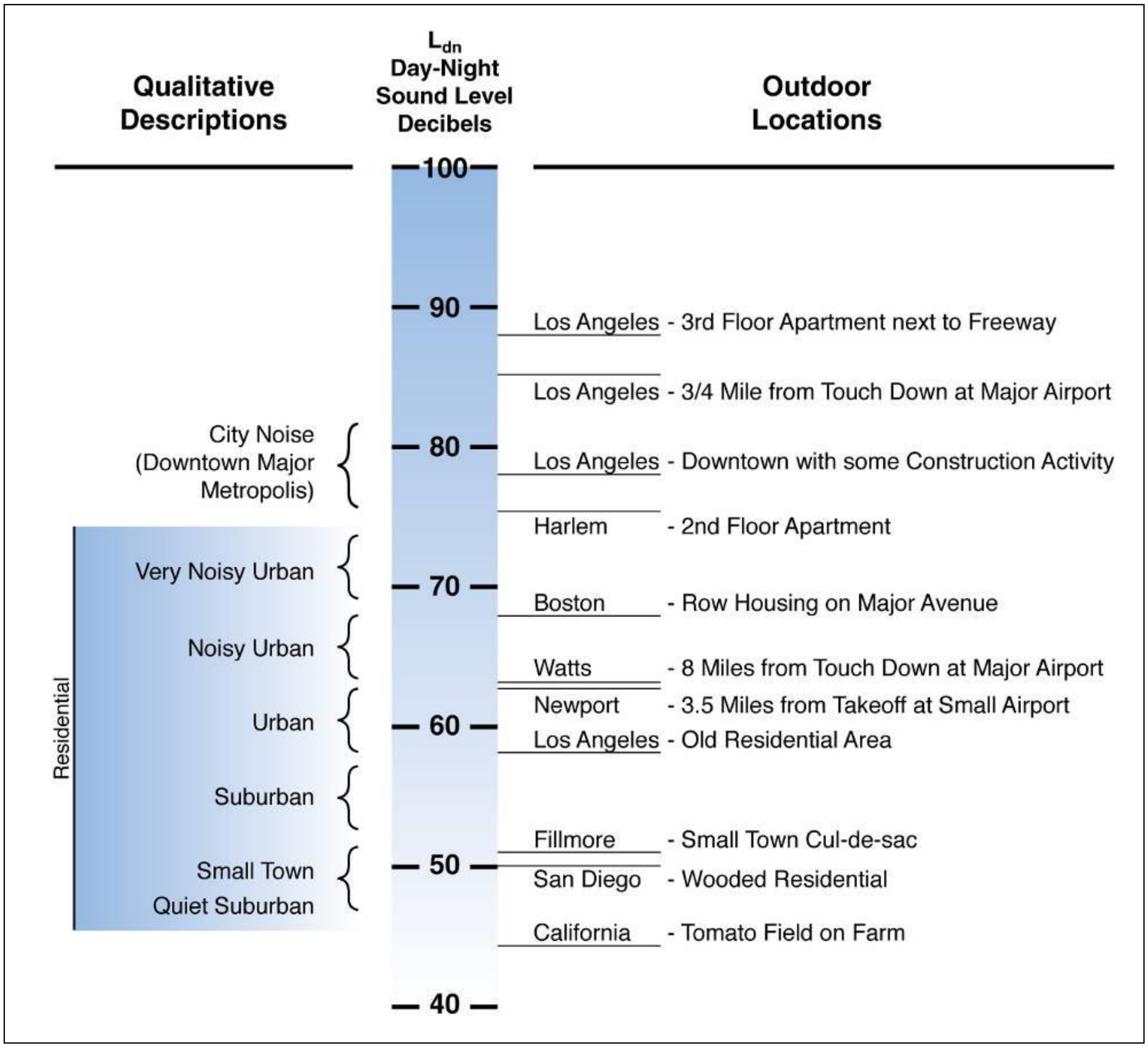

Figure A-7. Examples of Measured Day-Night Average Sound Levels, DNL

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

Aircraft Noise Effects on Human Activity

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

Speech Interference

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

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

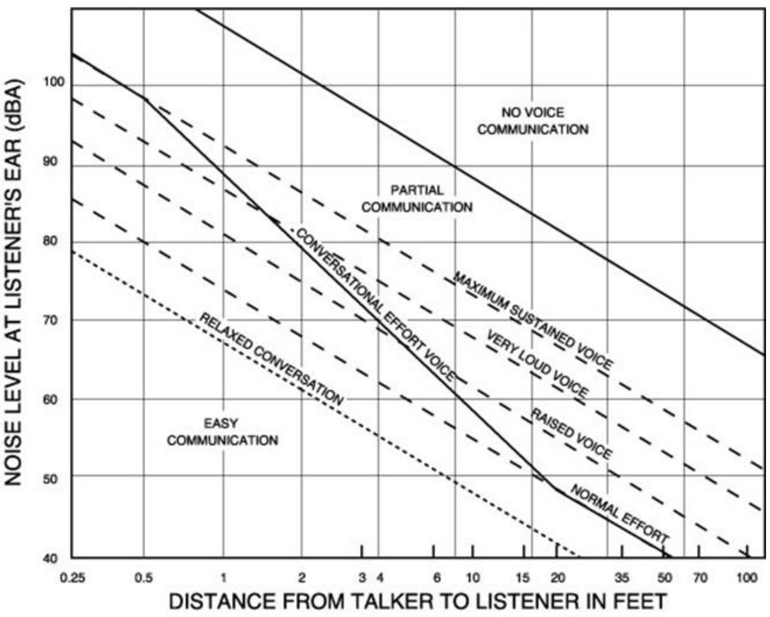

Figure A-8. Outdoor Speech Intelligibility

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

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

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

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

Sleep Interference

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

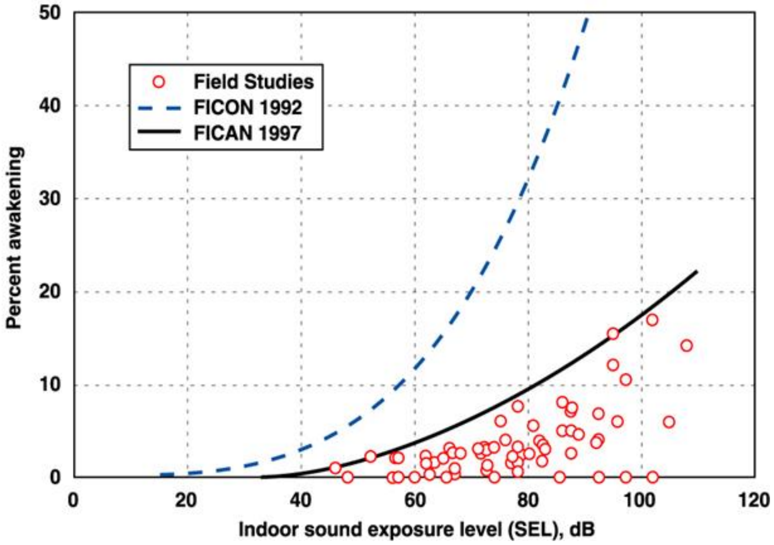

Figure A-9. Sleep Interference

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

Figure A-9 uses indoor SEL as the measure of noise exposure; current research supports the use of this metric in assessing sleep disruption. An indoor SEL of 80 dBA results in a maximum of 10% awakening.[14]

Community Annoyance

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

As noted above in the discussion of DNL, the full report on the FAA's recent research, polling communities surrounding 20 airports nationwide, was released in January 2021. At the time of this reporting (on the HVN Master Plan) that research is in the public review and comment period.

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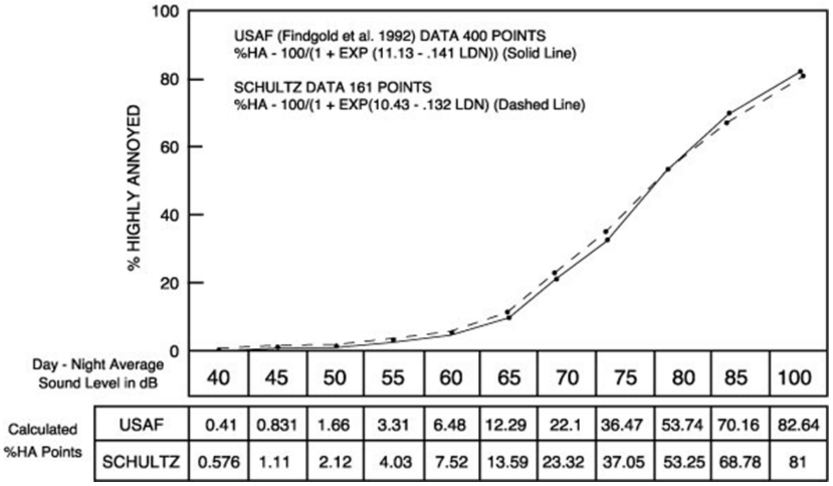
[14] The awakening data presented in Figure A-9 apply only to individual noise events. The American National Standards Institute (ANSI) has published a standard that provides a method for estimating the number of people awakened at least once from a full night of noise events: ANSI/ASA S12.9-2008 / Part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



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

Figure A-10. Percentage of People Highly Annoyed

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

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

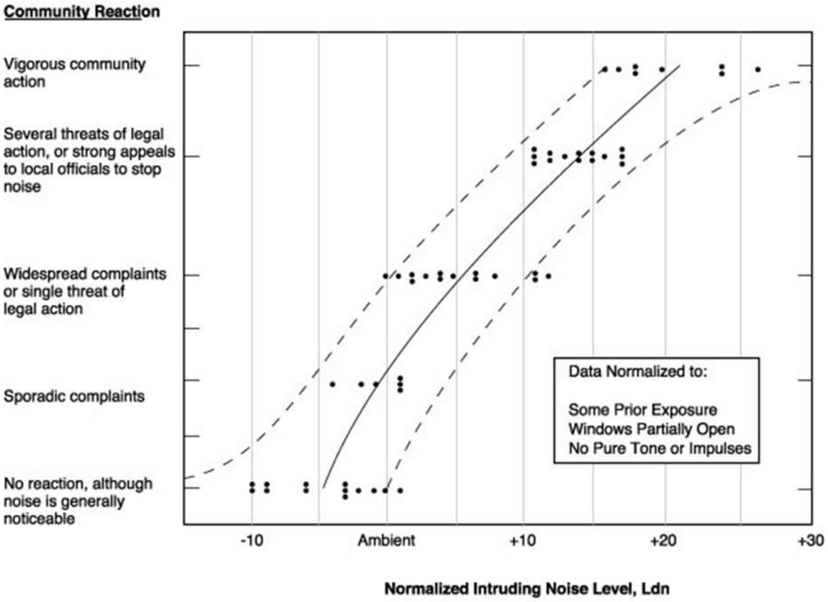


Figure A-11. Community Reaction as a Function of Outdoor DNL

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

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

Noise Propagation

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

Weather-Related Effects

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

Influence of Humidity and Precipitation

Humidity and precipitation rarely effect sound propagation in a significant manner. Humidity can reduce propagation of high-frequency noise under calm-wind conditions. This is called “Atmospheric absorption.” In very cold conditions, listeners often observe that aircraft sound “tinny,” because the dry air increases the propagation of high-frequency sound. Rain, snow, and fog also have little, if any noticeable effect on sound propagation. A substantial body of empirical data supports these conclusions.[15]

Influence of Temperature

The velocity of sound in the atmosphere is dependent on the air temperature. [16] As a result, if the temperature varies at different heights above the ground, sound will travel in curved paths rather than straight lines. During the day, temperature normally decreases with increasing height. Under such “temperature lapse" conditions, the atmosphere refracts ("bends") sound waves upwards and an acoustical shadow zone may exist at some distance from the noise source.

Under some weather conditions, an upper level of warmer air may trap a lower layer of cool air. Such a “temperature inversion” is most common in the evening, at night, and early in the morning when heat absorbed by the ground during the day radiates into the atmosphere. [17] The effect of an inversion is just the opposite of lapse conditions. It causes sound propagating through the atmosphere to refract downward.

The downward refraction caused by temperature inversions often allows sound rays with originally upward-sloping paths to bypass obstructions and ground effects, increasing noise levels at greater distances. This type of effect is most prevalent at night, when temperature inversions are most common and when wind levels often are very low, limiting any confounding factors. [18] Under extreme conditions, one study found that noise from ground-borne aircraft might be amplified 15 to 20 dB by a temperature inversion. In a similar study, noise caused by an aircraft on the ground registered a higher level at an observer location 1.8 miles away than at a second observer location only 0.2 miles from the aircraft. [19]

Influence of Wind

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[15] Ingard, Uno. “A Review of the Influence of Meteorological Conditions on Sound Propagation,” *Journal of the Acoustical Society of America*, Vol. 25, No. 3, May 1953, p. 407.

[16] In dry air, the approximate velocity of sound can be obtained from the relationship:

$c = 331 + 0.6T_c$ (c in meters per second, T_c in degrees Celsius). Pierce, Allan D., *Acoustics: An Introduction to its Physical Principles and Applications.* McGraw-Hill. 1981. p. 29.

[17] Embleton, T.F.W., G.J. Thiessen, and J.E. Piercy, “Propagation in an inversion and reflections at the ground,” *Journal of the Acoustical Society of America*, Vol. 59, No. 2, February 1976, p. 278.

[18] Ingard, p. 407.

[19] Dickinson, P.J., “Temperature Inversion Effects on Aircraft Noise Propagation,” (Letters to the Editor) *Journal of Sound and Vibration.* Vol. 47, No. 3, 1976, p. 442.

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

The refraction caused by wind direction and temperature gradients is additive. [20] One study suggests that for frequencies greater than 500 Hz, the combined effects of these two factors tends towards two extreme values: approximately 0 dB in conditions of downward refraction (temperature inversion or downwind propagation) and -20 dB in upward refraction conditions (temperature lapse or upwind propagation). At lower frequencies, the effects of refraction due to wind and temperature gradients are less pronounced. [21]

Wind turbulence (or "gustiness") can also affect sound propagation. Sound levels heard at remote receiver locations will fluctuate with gustiness. In addition, gustiness can cause considerable attenuation of sound due to effects of eddies traveling with the wind. Attenuation due to eddies is essentially the same in all directions, with or against the flow of the wind, and can mask the refractive effects discussed above. [22]

Distance-Related Effects

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

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

Vegetation-Related Effects

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

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

The International Standard ISO 9613-2[23] provides a useful example of the types of calculations employed in these methods. Originally developed for industrial noise sources, ISO 9613-2 is well-suited for the evaluation of ground-based aircraft noise sources under favorable meteorological conditions for sound propagation. ISO 9613-2's methodology for calculating sound propagation includes geometric dispersion from acoustical point sources, atmospheric absorption, the effects of areas of hard and soft ground, screening due to barriers, and reflections. The attenuation provided by dense foliage varies by octave band and by distance as shown in **Table A-1**.

For propagation through less than 10 m of dense foliage, no attenuation is assumed. For propagation through 10 m to 20 m of dense foliage, the total attenuation is shown in the first row of **Table A-1**. For distances between 20 m and 200 m, the total attenuation is computed by multiplying the distance of propagation through dense foliage by the dB/m values shown in the second row of **Table A-1**.

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[20] Piercy and Embleton, p. 1412. Note, in addition, that as a result of the scalar nature of temperature and the vector nature of wind, the following is true: under lapse conditions, the refractive effects of wind and temperature add in the upwind direction and cancel each other in the downwind direction. Under inversion conditions, the opposite is true.

[21] Piercy and Embleton, p. 1413.

[22] Ingard, pp. 409-410.

[23] International Organization for Standardization, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General Method of calculation, International Standard ISO9613-2, Geneva, Switzerland (15 December 1996).

Table A-1. Dense Foliage Noise Attenuation

Source: ISO 9613-2, Table A.1

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

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

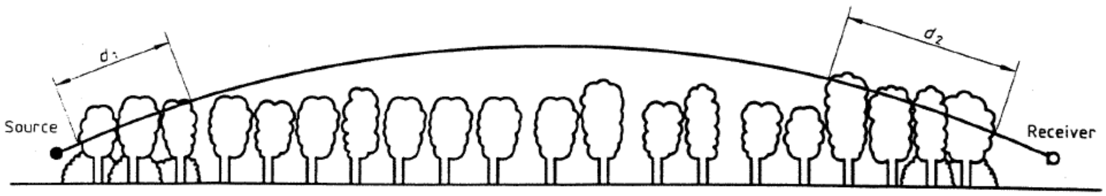

Figure A-12. Downward Refracting Sound Path (source: ISO 9613-2)

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

Appendix B. High 2040 Forecast Scenario Noise Analysis

An additional forecast case has been prepared using the "Unconstrained High" level of 2040 air carrier operations from the Master Plan forecast. As this analysis is just supplemental information, it is only presented in this appendix. The High Forecast 2040 scenario differs from the Approved Forecast 2040 scenario in just the number of modeled flights; the High Forecast model inputs add an additional 7,301 annual (20 daily) air carrier operations.

As modeled for the Approved Forecast 2040 scenario, the improvements and extensions to Runway 2/20 are included in the High Forecast 2040 scenario.

Table B-1 lists the annual and average day totals by category modeled for the High Forecast 2040 scenario in comparison to the Existing Conditions and Approved Forecast 2040 scenarios. The air carrier operations included for each of the 2040 cases represent the "Unconstrained High" and the "Constrained Low" air carrier forecasts from the Master Plan.

Table B-1. Modeled Aircraft Operations for High Forecast 2040 Scenario, compared to Existing Conditions and Approved Forecast

Source: MJ Airport Master Plan Forecast, 2020

Annual Operations

Scenario	Air Carrier /Air Taxi	GA Itinerant	GA Local	Military	Total Annual Operations
Existing Conditions	5,267	10,084	9,411	457	25,219
Approved Forecast 2040	6,351	10,771	10,052	457	27,631
High Forecast 2040	13,652	10,771	10,052	457	34,932

Annual Average Day Operations

Scenario	Air Carrier /Air Taxi	GA Itinerant	GA Local	Military	Total Average Daily Operations
Existing Conditions	14.4	27.6	25.8	1.3	69.1
Approved Forecast 2040	17.4	29.5	27.5	1.3	75.7
High Forecast 2040	37.4	29.5	27.5	1.3	95.7

Table B-2 presents the detailed air carrier and air taxi operations modeled for the High Forecast 2040 scenario. GA and Military operations modeled for the High Forecast 2040 scenario are the same as for the Approved Forecast 2040 scenario; those itinerant and local operations are shown in **Table 10** and **Table 11**, respectively, in the main body of this memorandum.

As described in Section 1.3.1, the day/night split percentages and stage length split percentages that were applied in both the Existing Conditions and Approved Forecast 2040 modeling were derived from the analysis of a full year's (2019) radar flight track data. For the High Forecast 2040 scenario, it was assumed that 10.7 percent of the air carrier size jet operations would occur at night. The day/night split for all other aircraft were not changed from the Approved Forecast 2040 model input data.

All other noise model inputs for the High Forecast 2040 scenario, such as runway utilization, flight track geometry, and flight track utilization were the same as those developed for the Approved Forecast 2040 scenario.

Table B-2. Air Carrier & Air Taxi Annual Operations, High Forecast 2040 Scenario

Sources: 2019 HVN radar flight track data, MJ and HMMH 2021

AEDT Aircraft Type	Aircraft Category	Arrivals		Departures				Total Annual Operations
		Day	Night	Day		Night		
				SL 1	SL 2	SL 1	SL 2	
EC130	Helicopter	11.8	3.0	12.1	0.0	2.7	0.0	**29.6**
A319-131	Air Carrier Size Jet	1,236.2	148.1	1,177.0	59.2	141.0	7.1	**2,768.7**
A320-271N	Air Carrier Size Jet	1,236.2	148.1	1,177.0	59.2	141.0	7.1	**2,768.7**
737MAX8	Air Carrier Size Jet	1,236.2	148.1	1,177.0	59.2	141.0	7.1	**2,768.7**
737700	Air Carrier Size Jet	1,085.0	130.0	1,033.0	52.0	123.8	6.2	**2,430.0**
CNA510	Small Jet	21.8	5.6	22.5	0.0	5.0	0.0	**54.9**
CNA525C	Small Jet	127.6	33.0	131.3	0.0	29.3	0.0	**321.2**
CNA55B	Small Jet	120.9	31.2	124.4	0.0	27.8	0.0	**304.3**
CNA560U	Small Jet	102.4	26.5	105.4	0.0	23.5	0.0	**257.8**
CNA560XL	Small Jet	18.5	4.8	19.0	0.0	4.2	0.0	**46.5**
CNA680	Small Jet	115.9	29.9	119.2	0.0	26.6	0.0	**291.6**
CNA750	Small Jet	65.5	16.9	67.4	0.0	15.0	0.0	**164.8**
G650ER	Small Jet	13.4	3.5	11.2	2.6	2.5	0.6	**33.8**
GIV	Small Jet	25.2	6.5	25.9	0.0	5.8	0.0	**63.4**
LEAR35	Small Jet	122.6	31.7	126.1	0.0	28.2	0.0	**308.5**
MU3001	Small Jet	50.4	13.0	51.8	0.0	11.6	0.0	**126.8**
CNA208	Turboprop	214.9	55.5	221.1	0.0	49.4	0.0	**540.9**
DHC6	Turboprop	70.5	18.2	72.5	0.0	16.2	0.0	**177.5**
BEC58P	Piston	62.1	16.1	63.9	0.0	14.3	0.0	**156.4**
CNA182	Piston	10.1	2.6	10.4	0.0	2.3	0.0	**25.4**
GASEPV	Piston	5.0	1.3	5.2	0.0	1.2	0.0	**12.7**
Air Carrier and Air Taxi Operations Totals		**5,952.2**	**873.8**	**5,753.3**	**232.1**	**812.5**	**28.1**	**13,652.0**

Figure B-1 shows the annual average day DNL contours for the High Forecast 2040 scenario. **Figure B-2** shows a comparison of the two sets of forecast 2040 contours. Compared to the Approved Forecast, the High Forecast 2040 65 DNL contour encompasses a larger area, due to the expected increase in air carrier passenger operations.

Table B-5 presents the calculated land area within each contour interval for both 2040 analysis scenarios. As indicated by the comparison of contours, the noise is expected to increase uniformly in areas that are exposed to noise from flight operations (at the runway ends and long the runway sidelines). The net increase in land within DNL 65 is about 21 acres, or 12 percent as compared to the Approved Forecast. The increase in off-airport land area is estimated to be 2.5 acres. For both the Approved Forecast 2040 and the High Forecast 2040 scenarios, no off-airport land is exposed to DNL 70 or higher.

Table B-6 presents the estimated population, housing units, and other noise-sensitive parcels for the High Forecast scenario as compared to the Approved Forecast scenario. The data indicate an increase of 35 people in 15 housing units between the Approved Forecast and High Forecast 2040 scenarios. With this increase the High Forecast counts are still less than the existing counts. There are no people or housing units within the 70 DNL contour in either of the forecast cases. There was a school[24] location that was identified as the only non-residential noise sensitive property within the 65 DNL contour in the most recent HVN official Noise Exposure Map. The 65 DNL contour line is closer to that property for the High Forecast 2040 scenario than for either the Existing Conditions or the Approved Forecast 2040 scenario in this analysis, but still does not appear to include the parcel.

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[24] The FAR Part 150 Noise Compatibility Study for Tweed New Haven Regional Airport, dated November 2012, documents one non-residential noise sensitive land use within the DNL 65 contour, where two schools, the Shoreline Clinical Day School and East Haven Adult Education both rented out the same facility in a commercial/industrial center at 290 Dodge Ave in East Haven. A Google search in 2021 yields no results for the Shoreline Clinical Day School, but the East Haven Adult Education appears to be still operating at that location.

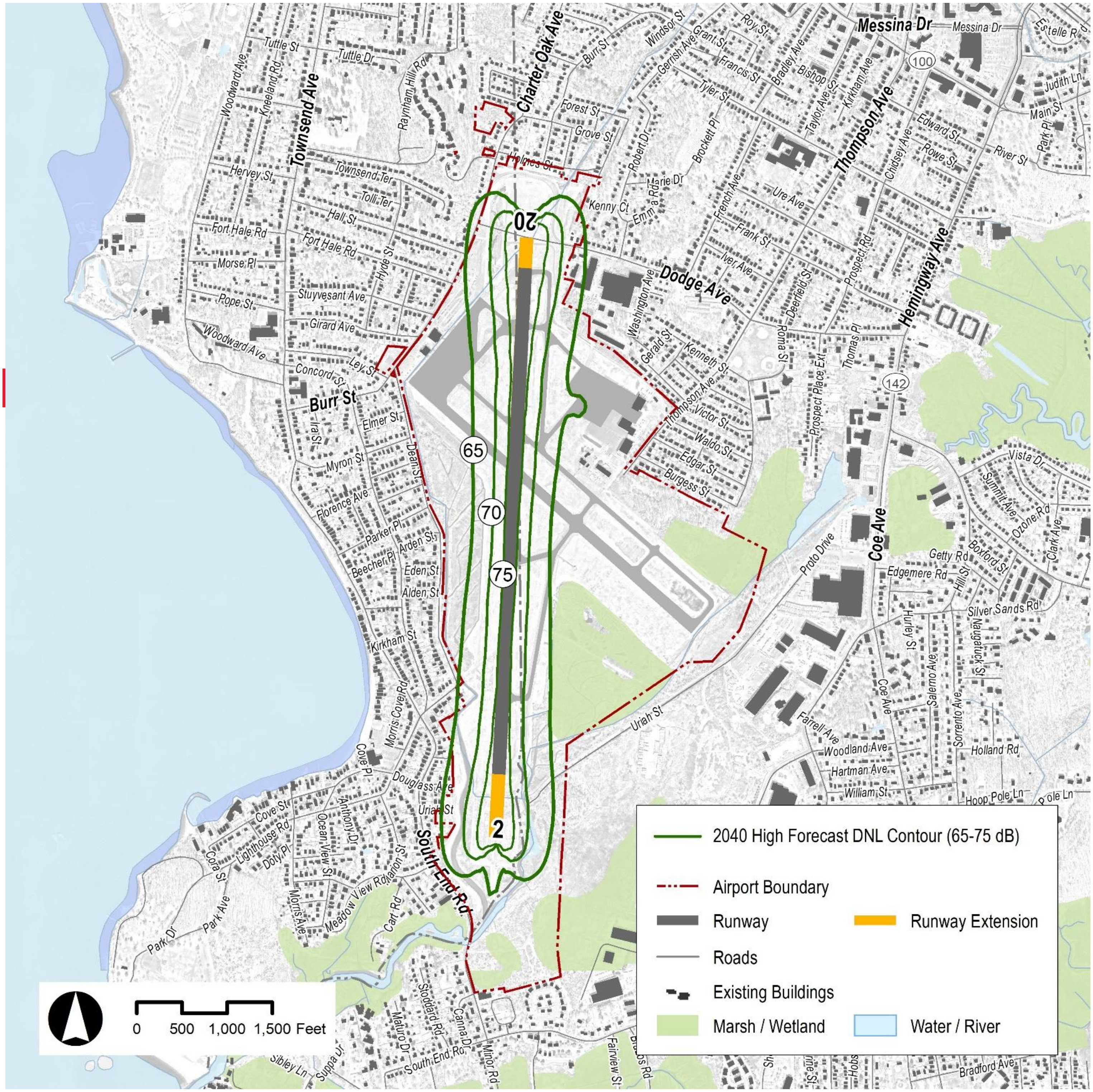

Figure B-1. High Forecast 2040 DNL Contours

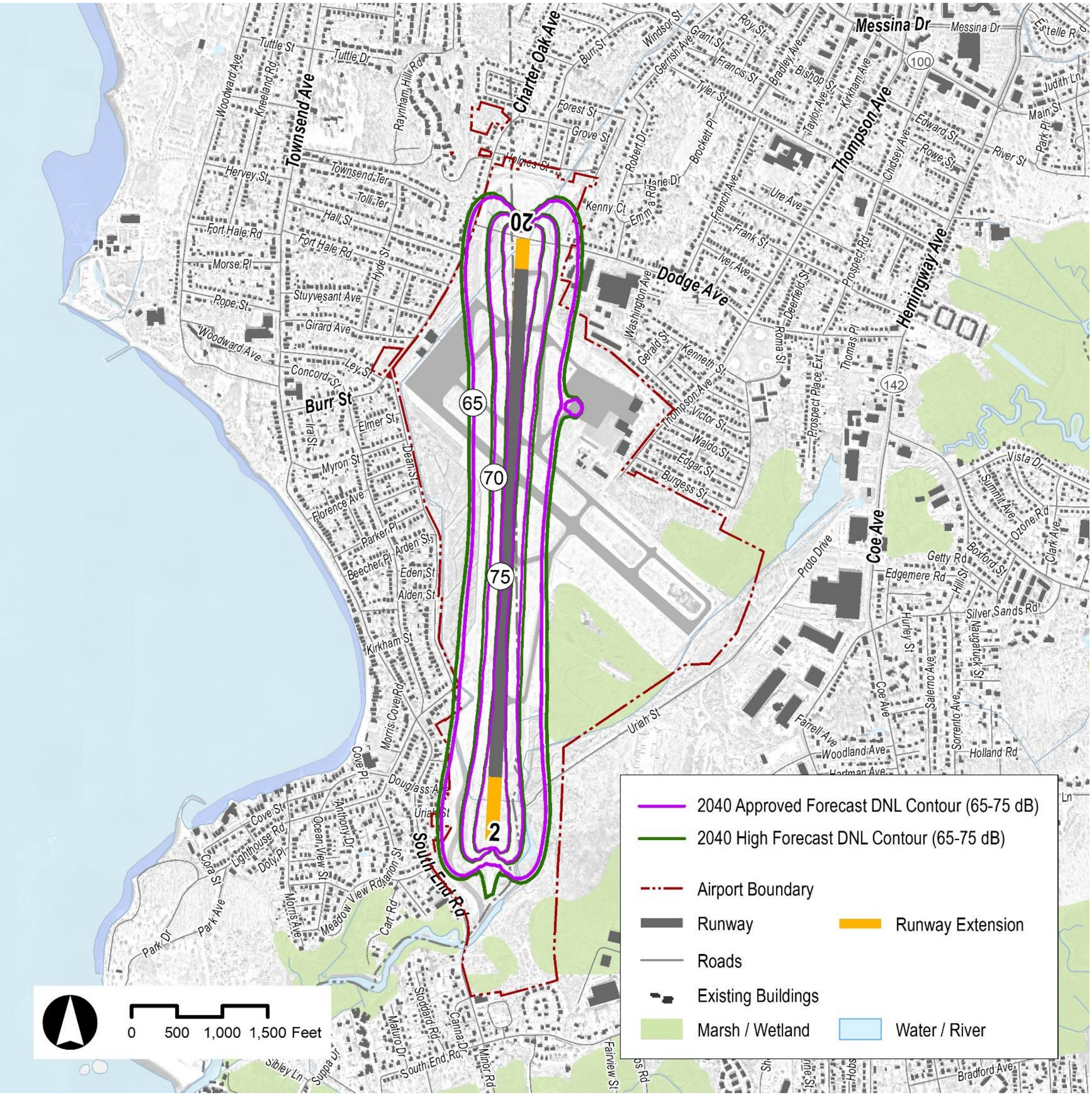

Figure B-2. Comparison of 2040 DNL Contours: Approved Forecast vs. High Forecast

Table B-3. Land Area Enclosed by the Approved Forecast 2040 and High Forecast 2040 DNL Contours

Source: HMMH, 2021

Analysis Scenario	**Aircraft Noise Exposure**			
	DNL 65-70	**DNL 70-75**	**DNL 75+**	**Total within DNL 65**
Approved Forecast 2040				
On-Airport	83.7 acres	46.3 acres	30.8 acres	160.8 acres
Off-Airport	3.0 acres	0.0 acres	0.0 acres	3.0 acres
land area within contour interval	86.7 acres	46.3 acres	30.8 acres	163.8 acres
High Forecast 2040				
On-Airport	91.2 acres	51.6 acres	35.8 acres	178.6 acres
Off-Airport	5.5 acres	0.0 acres	0.0 acres	5.5 acres
land area within contour interval	96.7 acres	51.6 acres	35.8 acres	184.1 acres
difference				
On-Airport	7.5 acres	5.3 acres	5.0 acres	17.8 acres
Off-Airport	2.5 acres	0.0 acres	0.0 acres	2.5 acres
within contour interval	10.0 acres	5.3 acres	5.0 acres	20.3 acres

Table B-4. Noise Sensitive Parcels and Estimated Population within 65 DNL contour for the Approved Forecast 2040 and High Forecast 2040 Analyses

Source: HMMH

DNL (dB)	**Approved Forecast 2040**			**High Forecast 2040**		
	Estimated Population	Housing Units$^{\text{Note 1}}$	Other Noise Sensitive Parcels$^{\text{Note 2}}$	Estimated Population	Housing Units$^{\text{Note 1}}$	Other Noise Sensitive Parcels$^{\text{Note 2}}$
65-70	28	12	0	63	27	0
70-75	0	0	0	0	0	0
75+	0	0	0	0	0	0
Total within 65 DNL	28	12	0	63	27	0

Notes:

1. HVN has undertaken noise mitigation based on the most recent FAR Part 150 Noise Exposure Map but the housing units listed here have not been compared against mitigation records.

2. Noise Sensitive Parcels include schools, places of worship, hospitals, nursing homes, and designated historical sites.