iFlyQuiet Procedures Demonstration

Application of Fly Neighborly Procedures in East Hampton, NY

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13. ABSTRACT (Maximum 200 words)

In recent years significant effort has been expended to support and enhance the Helicopter Association International (HAI) Fly Neighborly Program, including focused FAA/NASA flight test programs and helicopter noise model development as well as application efforts conducted with university and industry support. Two of the challenges faced in implementing Fly Neighborly flight operations can be the lack of available noise abatement procedure information for specific helicopter models and/or difficulties in adapting existing noise abatement procedure information to a given heliport operation. This report documents a Fly Neighborly and iFlyQuiet demonstration conducted at East Hampton Airport, NY in September 2018. The objectives were to evaluate available resources and information for implementing noise abatement procedures, as well as to provide recommendations for modifying the existing procedures for improved Fly Neighborly effectiveness. It was found that: 1) Operators are generally aware of basic Fly Neighborly (e.g. fly higher) but tend not to tailor specific procedures for noise outside of the existing published voluntary low noise procedures. 2) Operators are open to guidance and suggestions and are willing to adapt with technical assistance. 3) Low noise procedures are needed for situations with low ceiling VFR flight or where low altitudes are necessary.

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APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
oz	ounces	28.35	grams	g
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
mL	milliliters	0.034	fluid ounces	fl oz
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
g	grams	0.035	ounces	oz
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	Kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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List of Abbreviations

Abbreviation	Term
AAM	Advanced Acoustic Model
ATC	Air Traffic Control
CHARM	Comprehensive Hierarchical Aeromechanics Rotorcraft Model (CDI Helicopter aerodynamics and dynamics computer code)
ERHC	Eastern Region Helicopter Council
FAA	Federal Aviation Administration
FN	Fly Neighborly
HAI	Helicopter Association International
HIGE	Hover in ground effect
HOGE	Hover out of ground effect
iFQ	iFlyQuiet FAA community outreach program
NASA	National Aeronautics and Space Administration
PSU	The Pennsylvania State University
PSU-WOPWOP	PSU Helicopter noise computer code
ROD	Rate-of-Descent
VFR	Visual Flight Rules

1. Introduction

In recent years significant effort has been expended to support and enhance the Helicopter Association International (HAI) Fly Neighborly Program (Reference 1) including focused Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA) flight test programs (References 2, 3), as well as helicopter noise model development and application efforts conducted with industry support (References 5, 6). As part of this effort, the FAA tasked the Volpe National Transportation Systems Center with finding the means for further implementing the growing body of noise abatement information and maneuvering flight noise data into the existing Fly Neighborly (FN) framework. The elements of the HAI Fly Neighborly Program include providing generic and model-specific guidance on low noise helicopter operation and pilot/operator training materials and courses. A complementary FAA initiative, iFlyQuiet, seeks to improve community relations by encouraging operators to apply the FN guidance and perform community outreach (Reference 7).

Two of the challenges often faced in implementing FN into flight operations can be the lack of available noise abatement flight procedures information for specific helicopters and/or difficulties in adapting existing noise abatement flight procedure information to a given heliport operation. The former can leave an operator guessing as to what flight procedure changes would prove effective for noise abatement, while the latter can prove problematic in achieving Fly Neighborly noise abatement within operational constraints, including prescribed arrival/departure routes and poor weather conditions.

This report documents a Fly Neighborly and iFlyQuiet demonstration conducted at East Hampton Airport, NY (KHTO) over the weekend of September 7-10, 2018[1]. An objective of this effort was to evaluate available resources and information for implementing noise abatement procedures in an existing operation. Another goal of this demonstration was to evaluate the noise abatement characteristics of the published KHTO November noise abatement procedure and potentially provide recommendations for modifying the existing procedure for improved Fly Neighborly effectiveness.

Additionally, the benefits of implementing the site-specific noise abatement procedures were to be verified through a limited amount of *in situ* acoustic measurements along with acoustic modeling and simulations. A rigorous acoustic measurement campaign was not the focus of this demonstration effort. Rather, the primary focus was to provide concrete evidence that noise abatement procedures can be tailored and implemented in a specific location through interaction with operators. To summarize, the primary objectives were to:

- Engage with operators on the implementation objectives – document these interactions
- Understand and document the impediments to operator implementation of noise abatement procedures

[1] This Demonstration is also detailed in a paper for the Vertical Flight Society (Reference 4) by the authors of this report.

- Design site-specific noise abatement procedures
- Ask the operators to fly these procedures and collect data for verification
- Provide recommendations for wider promulgation of FN techniques
- Obtain operator/pilot feedback and document examples of implementation into normal routines

In addition to understanding the practical application of noise abatement procedures, the demonstration was documented such that additional training and outreach materials may be produced for the iFlyQuiet initiative. Documentation in the form of the ‘raw’ materials needed to produce before and after noise abatement comparisons suitable for iFlyQuiet outreach and education included:

- Cockpit Video(s)
- Aircraft tracking and performance data
- Ground-based audio recordings and sound-level time-histories
- Narratives of results

The following sections detail the test methods (Section 2), the data acquired (Section 3) and results (Section 4).

2. Test Methods

2.1 Location Selection

The Fly Neighborly and iFlyQuiet Demonstration was best suited to an area with existing helicopter noise abatement requirements/procedures, as these areas can be the most challenging in terms of implementation and thus more likely to produce a wealth of ‘lessons learned’. These areas are also likely to gain the most benefit from any site-specific noise abatement procedures developed. Partner organizations and HAI members suggested the following potential demonstration locations: East Hampton, NY (airport operations, recommended by the Eastern Region Helicopter Council or ERHC), Los Angeles / Hollywood, CA (Hollywood sign tours, recommended by the Los Angeles Area Helicopter Operators Association or LAAHOA), and the Palm Beach, FL airport. Of these, East Hampton was considered to have the most beneficial balance of route, operations, and aircraft fleet, and was selected for the procedures demonstration.

East Hampton Airport (KHTO) has three established helicopter noise abatement arrival and departure procedures: November Arrival, Echo Departure and the Sierra Arrival/Departure. The November, light helicopter Echo Light (<6,000 lb.) and heavy helicopter Echo Heavy (>6,000 lb.) procedures in effect for 2018 flights (see Appendix A) are copied below and shown in Figure 1. These procedures are identified in terms of flight waypoints and altitudes for helicopter operations, and were subsequently revised in 2019 (Reference 9), effecting minimal changes to routing but some changes to the November altitude requirements. These changes to the November procedure are, however, accommodative to the alternative noise abatement descent procedures evaluated during the current effort.

The 2018 November Arrival route for KHTO is specified as follows:

> *Arrivals from the west proceed to "November 1" (N40*57.37 W072*27.16) at or above 3500 feet, continue to "November 2" (N40*58.41 W072*20.43) at or above 3000 feet, to "November 3" (N40*58.14 W072*17.60) at or above 2500 feet, then to the airfield.*

The 2018 Echo Light departure route for KHTO is specified as follows:

> *Depart heading northwest over the power lines to "Echo 1" (N40*58.03 W072*16.28). Turn right, remaining well east of Town Line Road and proceed to the East side of Barcelona Neck "Echo 2" (N41*00.76 W072*15.29). "Echo 2" is a mandatory flyover point. Please keep your tracks away from the village of Sag Harbor. Use max performance climb so as to cross Barcelona Neck at or above 3000 ft. MSL. Proceed then to "Echo 3" (N41*02.63 W072*18.31) and then to "Echo 4" (N41*01.26 W072*22.58). Please avoid any over flight of Shelter Island and North Haven.*

The 2018 Echo Heavy departure for helicopters exceeding 6,000 lb. proceeded to waypoints A1 and A2 from "Echo 2" as shown in Figure 1. Note that for 2019, the weight distinction has been eliminated and the two Echo procedures are now designated as the Echo Northwest and Echo Northeast procedures.

The region also has in place processes that document noise complaints and operations. Mapped complaint data (Figure 2) suggests that the November approach route and the Echo departure route produce the bulk of the noise complaints.

Figure 1. Published November, Echo Light and Echo Heavy Noise Abatement Routes for 2018

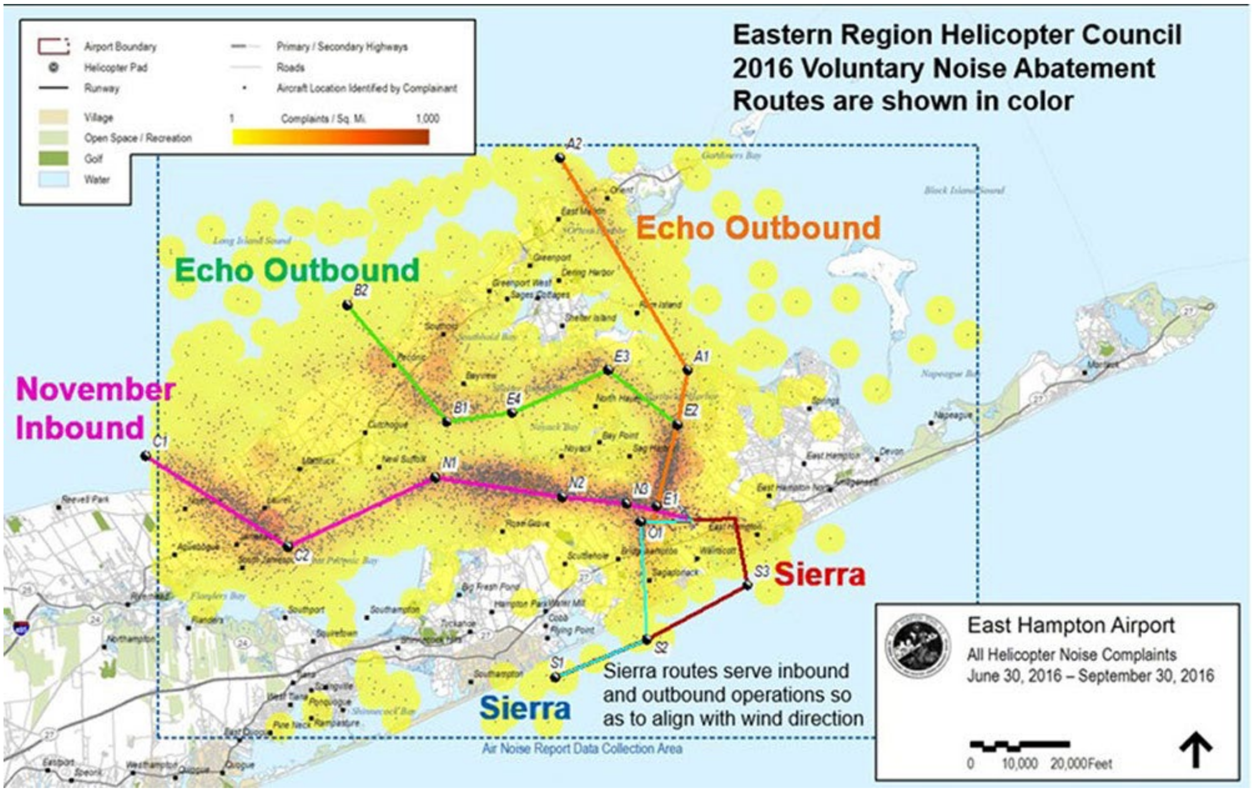

Figure 2. KHTO Helicopter Noise Complaint Map (2016)

2.2 Solicitation of and Discussion with Potential Operator Participants

At the recommendation of ERHC, five operators with significant operations in and out of East Hampton Airport were contacted regarding participation in the Demonstration test; responses were received from two of these operators. Discussion with these two operators was helpful to understand existing helicopter noise abatement procedures at KHTO.

The operators confirmed compliance with the November noise abatement route, flying the route as quickly as possible and descending into the airport as steeply as possible, noting some difficulties doing so depending on wind conditions or if put into a holding pattern by the airport control tower due to traffic. This provided some potential for evaluating the benefits of reduced cruise speeds in level flight and extended steep angle and or higher speed shallower angle descents into the airport.

Ultimately only one operator responded to outreach and agreed to participate in the demonstration. Discussions with this operator provided the following information relevant to test planning for the East Hampton Demonstration test:

Approaches:

- Weather permitting, S-76 helicopters fly the 'North Shore Route[2]' at 3600 – 3700 ft and further off shore than the smaller single engine helicopters to avoid congestion.
- Flight speed on the November route from Waypoint C1 through Waypoint N2 is typically 140 kt.
- Normal procedure is to descend to 3000 ft and decelerate to 120 kt between the N2 and N3 waypoints, using autopilot with a 500 fpm descent rate.
- After N3, pilots must execute a steep angle approach (12° – 14°+) to get down to the airport, decelerating to ~67 kt to provide some cushion above a 65 kt minimum airspeed. The typical descent rate into the airport is 2000 fpm and pilots typically fight "float" during this descent, indicating the aircraft is near autorotation for the final approach segment.
- In tailwind conditions, ground speeds are higher and descent angles are lower. On higher tailwind days a dog leg is sometimes needed during the approach to be able to get down to the airport, adding a left turn before the airport then a final right turn into Runway 16/22 the airport.
- Two main landing areas are the Runway 16/22 north ramp and the main ramp.
- Approaches are performed with minimal variation from the prescribed flight track when flying the November noise abatement route into the airport.
- With ceilings at 2000 ft or lower, VFR approaches are required by local Air Traffic Control and helicopters must execute approaches from lower altitudes, precluding use of the November Arrival procedure which requires altitudes at 2500 to 3500 ft. VFR is sometimes required for cloud decks higher than 2000 ft.

Takeoffs:

- Normal procedure is a horizontal Cat A takeoff.
- Difficult to get to specified 1500 ft altitude by Waypoint E1. Takeoff is quick as possible at a 270-280 heading at 98% torque, 1800 fpm and 60-70 kt. They must get above 60 kt to enable use of the Flight Management System (FMS).
- Passenger comfort (sensation of being pushed into the seat) can be an issue during takeoffs due to G levels, more so in turns.
- A 3000 ft altitude and cruise condition flight is typical by the E2 waypoint.
- During special VFR conditions, departure is directly north from airport, climbing to ceiling-limited altitude and proceeding to shoreline as directly as possible to minimize the exposed population.

The participating operator also agreed to carry GPS units and video cameras on two S-76 aircraft to record operations into and out of East Hampton Airport during the Demonstration test. Additionally, the operator also agreed to also perform two modified approach procedures, one maintaining altitude at 3500 ft then executing an extended steep angle approach to the airport and the second executing

[2] New York North Shore Helicopter Rule, Section 182 of the FAA Reauthorization Act of 2018. The Rule requires civil helicopter pilots operating under Visual Flight Rules (VFR), whose route of flight takes them over the north shore of Long Island between the Visual Point Lloyd Harbor (VPLYD) waypoint and Orient Point (VPOLT), to use the North Shore Helicopter Route.

reduced cruise speed (120 kt) followed by a longer 9° approach at a higher airspeed of 90 kt. Finally, the operator agreed to provide daily flight schedules to better coordinate test operations in East Hampton.

In addition to the flight profile/altitudes defined for the November noise abatement procedure, the information provided by both operators was instrumental in defining alternative noise abatement approach procedures for Bell 407 and S-76 helicopters at East Hampton Airport. The discussions also included the potential benefits of performing takeoffs at slightly slower speeds (up to 10 kt below best rate of climb airspeed) to increase climb angles, but it did not appear to be a significant change from current operations so the planned modified procedures concentrated on the November approach procedures.

2.3 **Noise Abatement Procedures Design**

Development of tailored procedures for the East Hampton area utilized existing noise data and toolsets capable of modeling the relevant aircraft types. The general Fly Neighborly guidance developed from the NASA/FAA joint 2018 flight tests was utilized as well as any available detailed noise data, including the noise spheres developed for the B407 or previous Department of Defense (DOD) or NASA datasets that already exist.

2.3.1 **Operational Analysis**

A preliminary analysis was conducted of existing published voluntary operational procedures to determine a noise baseline for the Bell 407 and Sikorsky S-76 aircraft. The Bell 407 and Sikorsky S-76 model helicopters are both commonly used for operations into and out of the East Hampton Airport, so operational analysis and noise modeling was also conducted in advance for both helicopters to understand the potential opportunities for noise reduction. The November and Echo routes were examined and alternate profiles were identified. Key constraints for alternate profiles included minimal or, if possible, no changes to the November route (latitude, longitude, and prescribed minimum altitudes), balancing source noise vs. duration tradeoffs, passenger comfort/acceptability and pilot workload. As a result, the recommended modifications focused on airspeed in cruise, and deceleration and descent rates on final approach. To accommodate changes in descent conditions, an additional waypoint was added to the current November procedure for each recommended procedure modification.

A total of four modified noise abatement routes were evaluated for the S-76 aircraft. Two modified routes, (November 1 (Nov 1) and November 2 (Nov 2)) were defined to follow the precise November route, *including* executing the course change at waypoint N3, but included two newly-defined waypoints N2A and N3A as intermediate points and to facilitate communication with operators. The routes are noted and described as follows (see Figure 3):

- Nov 0 - the current November procedure

- Nov 1 - Maintain 3500' to N3A, then steep angle approach into KHTO per current procedure, transitioning to approx. 2000 fpm descent, adjusted for wind conditions as needed. Continue approx. 2000 fpm descent until decel to the Landing Decision Point (LDP) near the airport.
- Nov 2 - Execute moderate decel after N1 to achieve 120 kt prior to reaching South Fork. Prior to reaching N2A, execute slow to moderate decel to achieve 100 kt at N2A. Prior to reaching N2A, execute slow to moderate decel to achieve 100 kt at N2A. Transition to approx. 1400 fpm descent, adjust for wind conditions as needed. Continue approx. 1400 fpm descent until decel to the LDP near the airport.

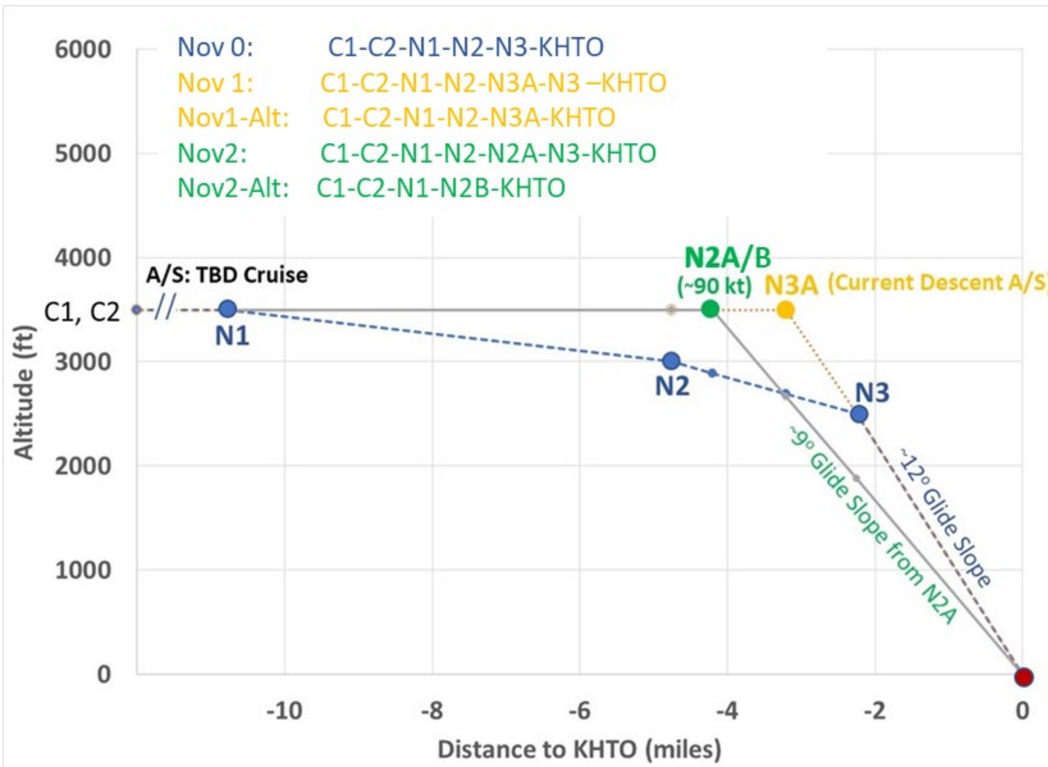

Figure 3. Current (blue) and Proposed (yellow and green) East Hampton Airport (KHTO) November Noise Abatement Descent Procedures

The Nov 1 procedure was intended to maintain the maximum altitude as long as possible prior to descent to the airport, while the Nov 2 procedure was intended to evaluate the relative effectiveness of a less steep, higher airspeed approach procedure potentially providing better fly-ability and passenger comfort.

Two additional routes that execute similar alternative descent conditions, but eliminate the course changes at waypoint N3 to proceed directly to the airport from waypoint N3A (Nov 1-alt) and waypoint N2B (Nov 2-alt) were similarly defined. These two additional routes each incurred some deviation from the precise November Arrival route (see Figure 4) that was deemed acceptable.

Figure 4. Flight Tracks for Current (Nov 0, solid line) and Proposed (dotted lines) KHTO November Noise Abatement Arrival Procedures

2.3.2 Noise Model Evaluation of S-76 Approach Procedures

The Advanced Acoustic Model (AAM) was used to predict and evaluate the potential noise benefits of the modified November noise abatement procedures for the Sikorsky S-76. Predicted noise spheres were first calculated by PSU (References 6, 7) over a broad range of airspeeds and descent rates using the comprehensive, physics-based, whole vehicle helicopter noise modeling framework under development at Penn State under FAA ASCENT Project 38. These noise spheres were then used in AAM to assess ground-level noise levels.

Predictions were made for the current November procedure (Nov 0), and the four modified procedures. An example of the AAM predicted flight track (Mid-0) and noise benefits at lateral points nominally 1000, 2000 and 3000 ft to the North (N) and South (S) of the ground track (see Figure 5) for the Nov 1, Nov 2, Nov 1-alt and Nov 2-alt alternative November noise abatement procedures are shown in Figure 6, which provides insight into how the modified procedures could address specific noise sensitive areas both beneath and lateral to the November noise abatement route. This analysis also included evaluations of the locations along the high speed and approach segments, as well as the noise exposure footprints (sound exposure level metric). A summary of this analysis data is included in Appendix B.

The analysis of predicted sound levels concluded that the November 1 and 2 procedures were quieter than the baseline (November 0); producing a reduction in maximum sound level (Lmax) of 1-2 dBA in most locations. The November 1-alt and 2-alt were even quieter, producing a reduction in Lmax of 2-3 dBA, especially in the 'middle' segment.

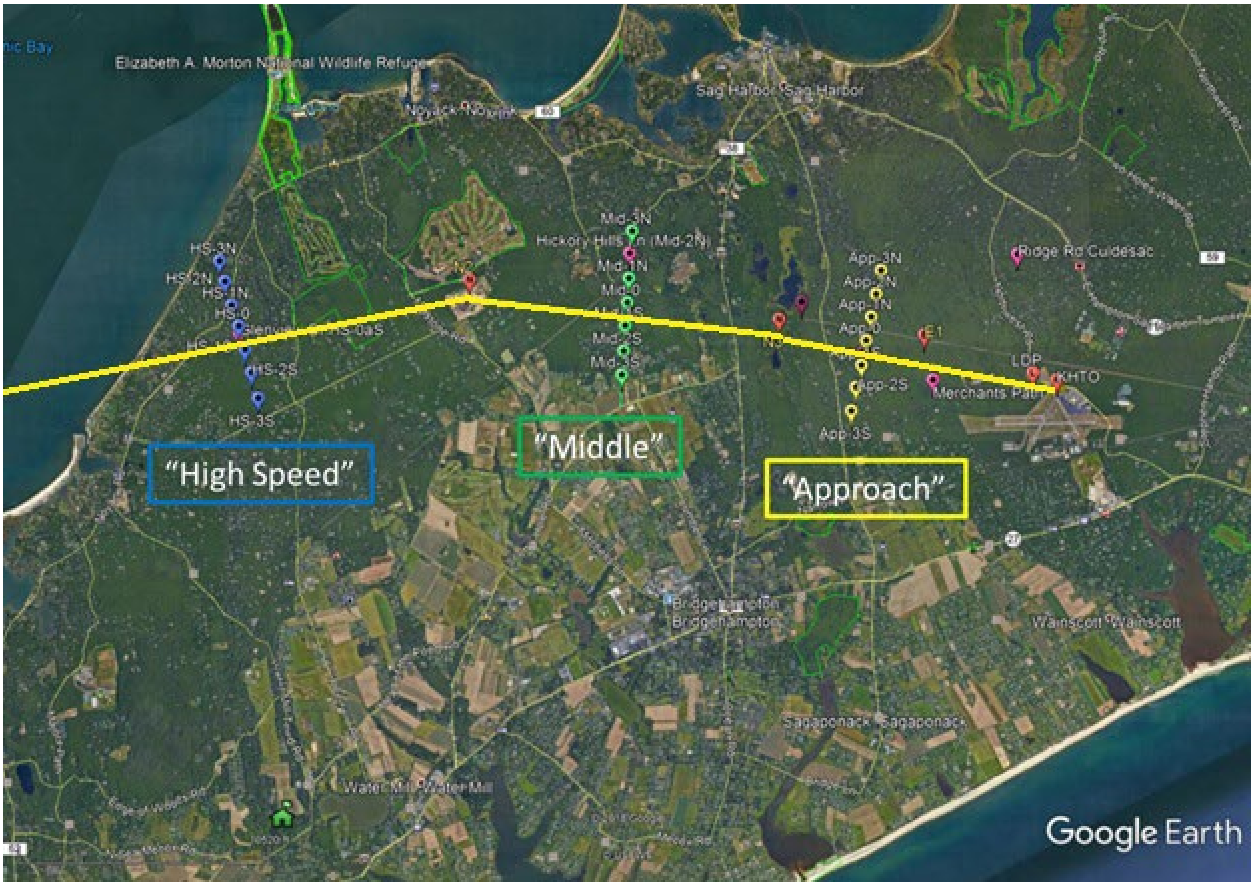

Figure 5. AAM Analysis locations (lateral points) 1000, 2000 and 3000 ft to the North (N) and South (S) of the ground track during 'high speed', 'middle' and 'approach' segments of November Noise Abatement Arrival Route

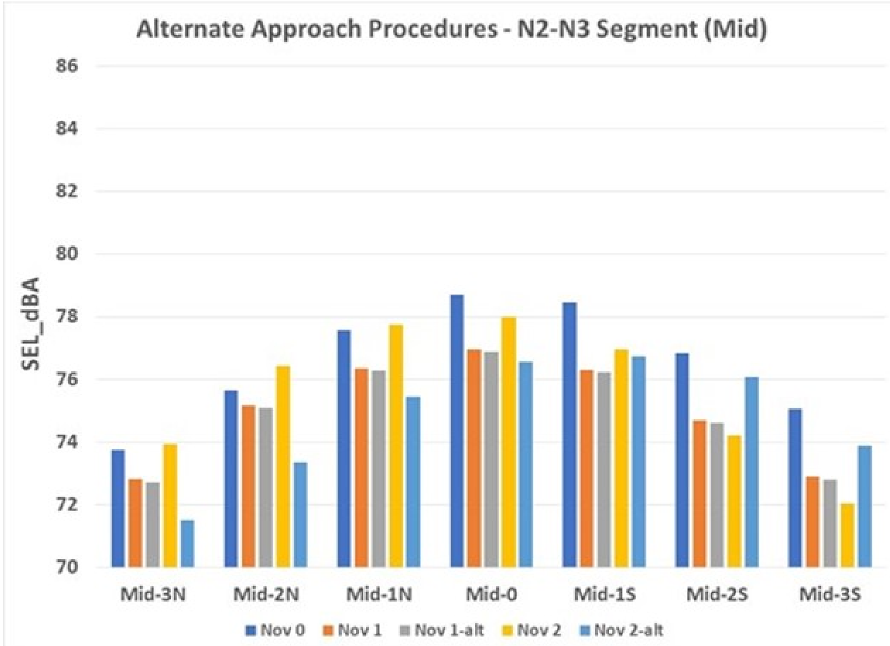

Figure 6. Advanced Acoustic Model (AAM) Predicted Flight-Track (Mid-0) Benefits and Lateral Noise Benefits at 1000, 2000 and 3000 ft to the North (N) and South (S) of the Flight Track (middle segment) for Alternative November Procedures

2.4 Selection of Noise Monitoring Locations

The benefits of implementing site-specific noise abatement procedures were to be verified through a limited amount of *in situ* acoustic measurements. Potential noise monitoring sites were assessed using Google Maps and Google Earth map and satellite images, as well as a site survey conducted by the test team in August 2018. Desired site characteristics included proximity to the noise abatement route segments, potentially sufficient open area to permit video recordings of the approaching/departing helicopters, relatively low ambient noise and site accessibility and security.

The eight sites shown in Table 1 and Figure 7 were selected as suitable for noise monitoring and video/observations during the demonstration test. Of these site, seven were designated for noise monitoring (Sites 0, 1, 2, 3, 4, 5, and 6 in Table 1), five of those were suitable for video recording (Sites 0, 1, 2, 5 and 6) and one was suitable for observation/video recording only due to security concerns (Site 4A).

Table 1. Noise Monitoring Locations

Site	Route Segment	Latitude N	Longitude W
0. Glenview Dr Cul-de-Sac	N1-N2	40°58’2.5”	72°22’32”
1. Hickory Hills Cul-de-Sac	N2-N3	40°58’35.5”	72°18’57.5”

Site	Route Segment	Latitude N	Longitude W
2. Sagg Rd – Power Line Site	N2-N3, N3-KHTO	40°58’15.5”	72°17’18”
3. Lillian Lane Cul-de-Sac	N3-KHTO	40°57’55.5”	72°16’49.5”
4. Merchants Path @ Town Line Rd	N3-KHTO	40°57’45”	72°16’10”
4A. Town Line Rd	N3-KHTO, KHTO-E1	40°57’57”	72°16’12”
5. Ridge Rd Cul-de-Sac	E1-E2	40°58’35”	72°15’25”
6. Northwest County Park	E1-E2	41°00’43”	72°15’2.5”

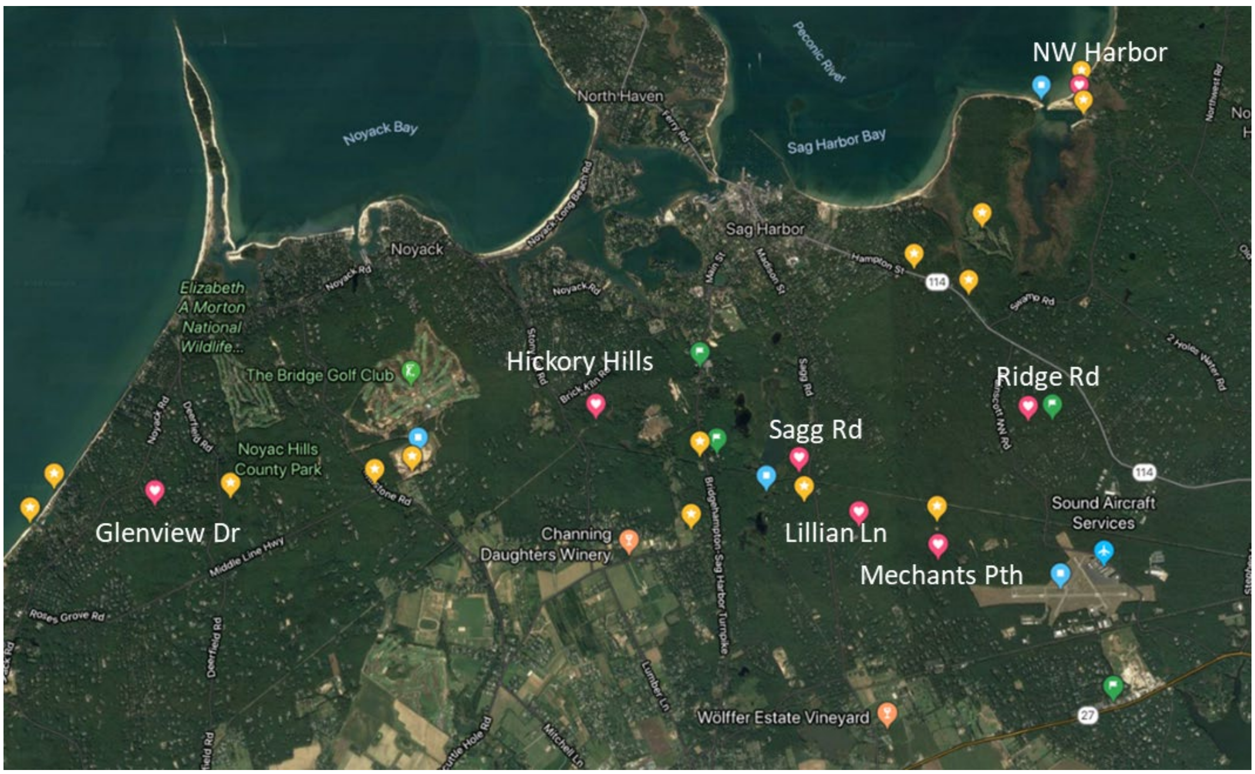

Figure 7. Noise monitoring Locations (red markers) and November and Echo flight waypoints (blue markers)

2.5 Data Collection

The noise abatement procedures demonstration was conducted September 7-10, 2018 (Friday-Monday). This time period occurred the weekend after Labor Day, while airport air traffic control (ATC) was still in operation. This 3 to 4 day measurement window was targeted such that the ‘before’ condition could be documented on days 1 and 2, while the after condition(s) could be documented on days 3 and 4.

One participating operator agreed to perform two of the modified approach procedures, one maintaining altitude at 3500 ft then executing an extended steep angle approach to the airport and the second executing reduced cruise speed (120 kt) followed by a longer 9^{o} approach at a higher airspeed of 90 kt. Before the start of testing, the operator provided daily flight schedules, allowing the test team to anticipate and note the flights of this operator. There was no real-time coordination between the test team and the operator.

The operator also agreed to carry GPS units and video cameras on two S-76 aircraft. These data were obtained at the conclusion of the test and utilized during analysis. The GPS data in particular, being recorded at 1-second intervals, provided numerous useful insights.

In the end, the weather during measurement window was less than optimal. Conditions were cloudy with a low ceiling on September 7, 8 and 9. During this time period, acoustic data were collected, although operators were unable to execute the agreed-upon alternative November procedures. It was observed that some aircraft used November waypoints, but many did not – using instead the power-line visual (VFR) route. In addition, a significant number of arrivals/departures used the Sierra noise abatement routes – a route which follows the southern shore of Long Island and had been previously closed. The weather on Sept 10 was rainy; curtailing flights and precluding acoustic data collection.

During the demonstration, publicly-available phone applications (FlightAware and Flightradar24) were used to identify, as much as possible, the individual helicopters observed arriving and/or departing from East Hampton Airport. These apps provided useful real-time information, but for many flights there were significant data gaps near to and sometimes well before/after landing and/or takeoff from the airport. As a result, while several of the helicopters were identified by the test team as they approached the airport, much of the helicopter identification effort had to be conducted post-test.

3. Data Acquired

Overall, 46 individual helicopter arrival/departure events were observed during the demonstration; 26 on September 7, 2018, seven on September 8, 2018, 11 on September 9, 2018 and two on September 10, 2018. The model type of the identified helicopters, posted/estimated arrival and departure times and routes were added to the flight log shown in Table 3. Table 3 includes several helicopters for which only tracking data are available. These helicopters were included for completeness and to provide additional operational data. Of these 46 flights, five were identified as flights of the participating operator: Flights 5, 16, 24, 29 and 33.

Table 2. Flight log for East Hampton Procedures Demonstration

Flight ID	Date	Arrival Time	Departure Time	Aircraft Type	Arrival Route N=November O=Other PL=Power Line SE=Sierra East SW=Sierra West	Departure Route EL=Echo Light EH=Echo Heavy O=Other SE=Sierra East SW=Sierra West
1	9/7/2018	1159	~1205	AS355F	N	SE
3	9/7/2018	1220	~1305	S-76B	O	EH
4	9/7/2018	1228	1336	B407	N-PL	EL
5	9/7/2018	1340	1358	S-76B	N	EH
6	9/7/2018	1303	?	S-76C	N	EH
7	9/7/2018	1343	1413	B407	N-PL?	EL
8	9/7/2018	1558	1601	B407	N	EL
9	9/7/2018	1627	1705	B407	N	EL
10	9/7/2018	1653	1714	B407	N	EL
11	9/7/2018	1653	?	AB139	N	
12	9/7/2018	1654?	~1700	S-76		EH
13	*9/7/2018*	*1722*	*1749*	*S-76B*	*SW*	*SW*
14	9/7/2018	1740	1759	B407	SE	SW
15	9/7/2018	1752	1815	B430	O-PL	SW
16	9/7/2018	1753	1803	S-76C	N	O
17	9/7/2018	1757	1936	B407	N	
18	9/7/2018	1757	?	S-76C+		
19	9/7/2018	1807	?	A109e	N (?)	
20	9/7/2018	1818	1834	B407	N	SW
21	9/7/2018	1837	1850	AB139	N-PL	SW
22	9/7/2018	1845	~1930	S-76C	N	EH
23	9/7/2018	1856	1936	B407	N	EL
24	9/7/2018	1857	1926	S-76B	N	O
25	9/7/2018	1936	1946	AS350	N	EL
26	9/7/2018	2010	2036	EC130T2	N	SW
27	9/8/2018	1117	1348	AS350	O-PL	O
28	9/8/2018	1214				
29	9/8/2018	1252	2149	S-76B	N	O
30	9/8/2018	1533	1619	B407	N-PL	EL
31	9/8/2018	~1541	~1549	Vought SA-366	N	SW
33	9/8/2018	1648		S-76C	N	
34	9/9/2018	938	~1020	S-76C	N	EH(?)
35	9/9/2018	957	~1020	S-76C	N	O
36	9/9/2018	1257	1308	S-76C	SW	SW
37	9/9/2018	1324	?	B430	O-PL	
38	9/9/2018	1356	1404	B407	N	SW
39	9/9/2018	1412	1600	S-76C	N	EH(?)
40	9/9/2018	1444	?	S-76C	SW	

Flight ID	Date	Arrival Time	Departure Time	Aircraft Type	**Arrival Route** N=November O=Other PL=Power Line SE=Sierra East SW=Sierra West	**Departure Route** EL=Echo Light EH=Echo Heavy O=Other SE=Sierra East SW=Sierra West
41	9/9/2018	1538	1600	S-76C	SW	SW
42	9/9/2018	1611	?	S-76C	SW	SW(?)
43	9/9/2018	1708	1848	S-76C	N	EH
44	9/9/2018	1914	1953	S-76C	N	SW
45	9/10/2018	1121	1217	S-76C	O	O
46	9/10/2018	1315	1328	Vought SA-366	SW	SW

3.1 Acoustic Data

Data and observations were collected for 6-9 hours per day during the monitoring period; the exact timeframes were adjusted according to the anticipated schedule of operations. Table 3 summarizes the noise monitoring schedule. Based on the anticipated passenger loads into and out of East Hampton Airport, and in particular zero/low passenger loads anticipated for Friday through Saturday departures and higher passenger loads anticipated for Sunday and Monday departures, a plan was made to deploy the sixth noise monitoring station at Northwest County Park on Thursday/Friday and Monday to get lighter and heavier departures, respectively, and at Glenview Drive on Saturday and Sunday to measure typical and reduced cruise airspeeds. Weather conditions, including low cloud ceilings and some rain, made this recommendation somewhat moot. The Northwest Harbor monitoring station was deployed both on Friday during a good number of Echo departures and on Saturday when helicopter activities were very light and Echo departures were few. An onsite recommendation was made to go ahead and redeploy the sixth monitoring station to the Glenview Drive site on Sunday and rearrange site coverage by test personnel appropriately. This turned out to be a good decision as departure tracks were more routinely performed to the west and south of the airport (including several Sierra departures) and the opportunities for data acquisition at Northwest County Park on Sunday were limited.

Table 3. Noise Monitoring Summary

Location	Friday, Sept 7	Saturday, Sept 8	Sunday, Sept 9
0 – Glenview Drive			X
1 – Hickory Hills	X	X	X
2 – Powerline @ Sagg Rd.	X	X	X
3 – Lillian Lane	X	X	X
4 – Merchant Path	X	X	X
5 – Ridge Rd.	X	X	X
6 – Northwest Harbor	X	X	

Acoustic and photo/video data collected at these locations include the following:

- One-third octave-band sound level time history at 100 ms intervals (10 Hz to 20 kHz)
- Continuous audio recordings (wav)

- Photos and ground-based videos

Table 4 correlates the availability of the acoustic data during the observed events; a 'Y' indicates acoustic data are available. Unfortunately, not all events were coincidental with acoustic data collection, as information on flight schedules was not made available to the team; monitoring was limited to daylight hours and occurred only during the time periods that were anticipated to contain the majority of flights. In total, 34 of the 46 flights had both acoustic and at least one form of tracking data. Five of these flights had both precision tracking data obtained by the participating operator and acoustic data collected at least one monitoring location. It is these five flights with precision tracking and acoustic monitoring data which have been selected for further analysis (shaded rows in Table 4).

Table 4. Availability of acoustic data by flight (shaded rows indicate flights of participating operator)

Flight ID	0- Glenview	1- Hickory Hills	2- Power At Sag	3- Lillian Lane	4- Merchant	5- Ridge Rd	6- NW Harbor
1	N	N	N	N	N	N	N
3	N	N	N	N	N	N	N
4	N	N	N	N	N	N	N
5	N	Y	N	Y	N	y	y
6	N	N	N	N	N	N	Y
7	N	Y	N	N	N	Y	Y
8	N	Y	Y	Y	Y	Y	Y
9	N	Y	Y	Y	Y	Y	Y
10	N	Y	Y	Y	Y	Y	Y
11	N	Y	Y	Y	Y	Y	Y
12	N	Y	Y	Y	Y	Y	Y
13	*N*	Y	Y	*Y*	*Y*	*Y*	*Y*
14	N	Y	Y	Y	Y	Y	Y
15	N	Y	Y	Y	Y	Y	Y
16	N	Y	Y	Y	Y	Y	Y
17	N	Y	Y	Y	Y	Y	Y
18	N	Y	Y	Y	Y	Y	Y
19	N	Y	Y	Y	Y	Y	Y
20	N	Y	Y	Y	Y	Y	Y
21	N	Y	Y	Y	Y	Y	Y
22	N	Y	Y	Y	Y	Y	Y
23	N	Y	Y	Y	N	Y	Y
24	N	N	**Y**	**Y**	N	**Y**	**Y**
25	N	N	N	N	N	Y	N
26	N	N	N	N	N	N	N
27	N	Y	Y	Y	Y	Y	Y
28	N	Y	Y	Y	N	N	Y
29	N	Y	Y	Y	Y	Y	Y
30	N	N	N	Y	N	N	N
31	N	N	N	Y	N	N	N
33	N	N	N	N	N	N	N
34	N	N	N	N	N	N	N
35	N	N	N	N	N	N	N

Flight ID	0- Glenview	1- Hickory Hills	2- Power At Sag	3- Lillian Lane	4- Merchant	5- Ridge Rd	6- NW Harbor
36	Y	Y	Y	Y	Y	N	N
37	Y	Y	Y	Y	Y	Y	N
38	Y	Y	Y	Y	Y	Y	N
39	N	Y	Y	Y	Y	Y	Y
40	Y	Y	Y	Y	Y	Y	N
41	Y	Y	Y	Y	Y	Y	N
42	Y	Y	Y	Y	Y	Y	N
43	Y	Y	Y	Y	Y	Y	N
44	Y	Y	Y	Y	Y	Y	N
45	N	N	N	N	N	N	N
46	N	N	N	N	N	N	N

3.2 Aircraft Tracking

FlightAware.com and PlaneFinder.net were the primary tools used to identify and obtain information (latitude, longitude, and altitude) on aircraft flight tracks during a post-test investigation of the publicly available tracking data. These data are generally available with 1-minute resolution. The flight tracking plots and tracking logs on FlightAware.com were used to determine arrival and departure times at East Hampton Airport (KHTO); these plots and logs were also downloaded and stored for additional analysis if needed. An example of this data from FlightAware.com is shown in Figure 8. In some cases, arrival/departure times were given in the FlightAware tracking data, but in many cases a recorded landing and/or takeoff time were not available, either because the filed flight plan had KHTO as an intermediate stop and not as the final destination or, as often was the case, there was a significant gap in the tracking data near the airport. In these cases, arrival and departure times were estimated from the distance to/from to the airport for data gaps, field observer notes and, in one case, a phone video recording. Additional tracking data sources such as the FAA-NASA PDARS (Performance Data Analysis and Reporting System), were evaluated but did not provide adequate coverage for low-altitude helicopter operations to be a useful source of information for the approaches to KHTO.

Figure 8. Example of publically-available tracking data (image courtesy of Flightaware.com)

In addition, GPS data (latitude, longitude, altitude, airspeed) with 1-second resolution were obtained from the participating operator for Flights 5, 16, 24, 29 and 33. An example of this data is shown in Figure 9.

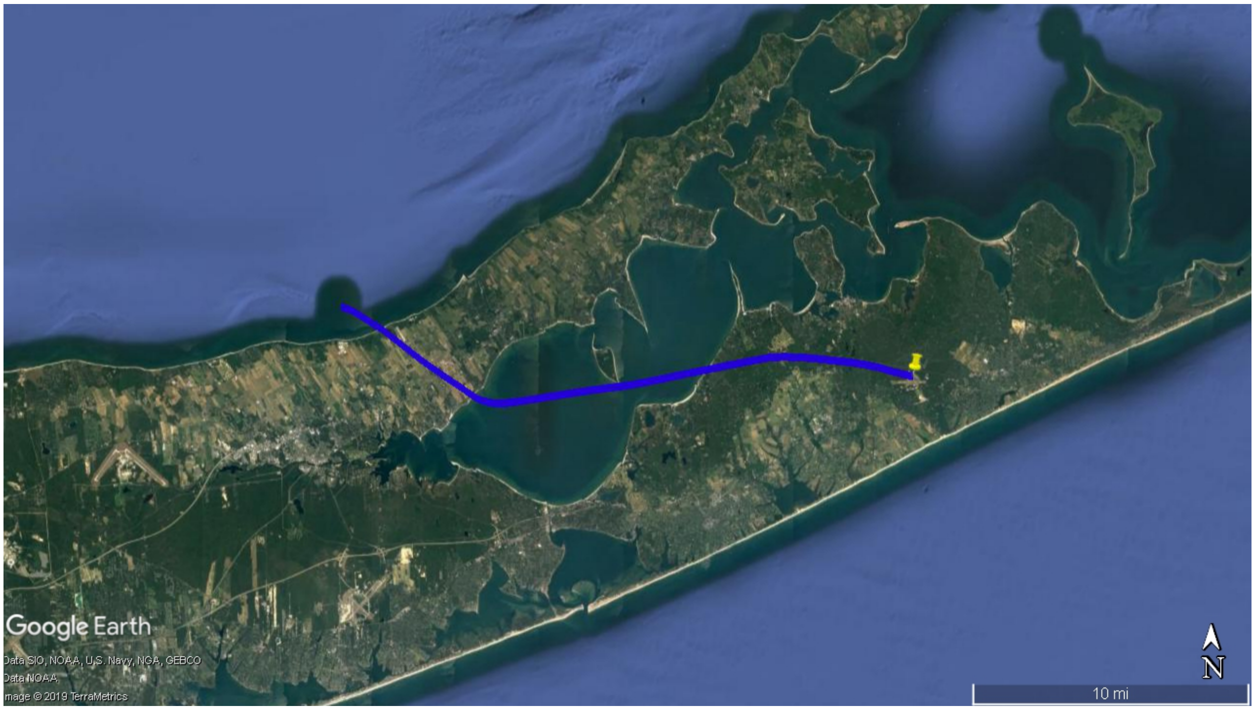

Figure 9. Example of operator-provided GPS data (satellite imagery courtesy of Google Earth)

3.3 Cockpit Video

Cockpit video footage were filmed at the operator's discretion for Flights 16 and 29. A snapshot of this footage is shown in Figure 10. Additional video footage of flights in/out of the Manhattan Heliport (JRA) were also obtained and archived.

Figure 10. Example of operator-provided cockpit video footage

4. Results

Poor weekend weather conditions (including rain) curtailed and constrained helicopter operations at East Hampton Airport during the demonstration. The vast majority of operations utilized VFR approach procedures, defaulting to a route known as the 'power line' route. These conditions precluded use and 'testing' of both the current and alternate November arrivals. Shows these VFR routes (dotted blue line) along with the prescribed November route.

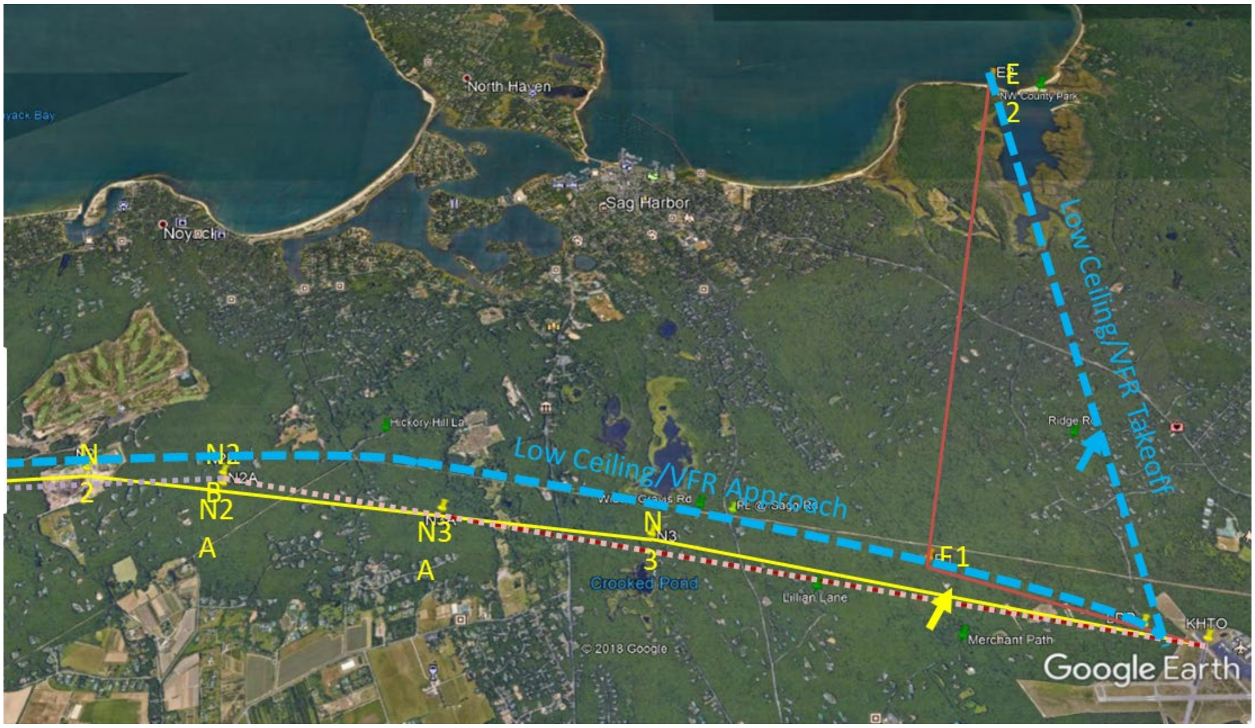

Figure 11. VFR routes (dotted blue line) along with the prescribed November route

The as-flown VFR procedures for the five flights with precision GPS tracking and acoustic data were evaluated nonetheless, to determine what, if any, information could be gleaned and to provide further evidence that procedural differences can affect and mitigate noise on the ground.

For each of the five flights, the following information was evaluated:

- Tracking data (1-second samples) – latitude/ longitude, altitude, and airspeed; from these glide slope, rate-of-descent (ROD), and deceleration rate were computed (Section 4.1)
- Sound-level time history data and basic summary metrics (maximum sound level, sound exposure level) at each monitor location (Section 4.2)
- Recorded audio files at each monitor location

The tracking data in particular proved useful for evaluating the noise abatement qualities of each flight. Data plots were generated for each of the five flights and four operational parameters of interest (altitude, ROD, glideslope and deceleration rate). The recorded audio clips, where available, were then used to confirm/deny the assessments made using tracking data alone. In the vast majority of cases, it was clear from the audio clips that BVI was produced as expected/predicted based on the tracking data.

4.1 Flight Profiles

Analyses of the GPS tracking data acquired for five Sikorsky S-76 helicopter flights with GPS tracking data (Flights 5, 16, 24, 29 and 33) were conducted to evaluate potential blade vortex interaction (BVI) noise issues and compare approach flight profiles with potential noise abatement procedures. Flights 5, 24 and 29 were flown using S-76B model helicopter while Flights 16 and 33 were flown using an S-76C model helicopter. Two of the five flights exhibited flight profiles fairly consistent with noise abatement techniques for the S-76, with one flight in particular using descent and airspeed/deceleration profiles conducive to noise abatement that was used to help further define potential noise abatement procedures for VFR flight conditions into East Hampton Airport.

4.1.1 Discussion

In the late 1990's, Sikorsky Aircraft, McDonnell Douglas Helicopters (now Boeing Helicopters), NASA and FAA/Volpe conducted extensive noise abatement testing using Sikorsky S-76B helicopters (References 9, 10, 11, and 12). A summary of the S-76 noise levels measured as a function of airspeed and ROD is shown in Figure 12. Also denoted in Figure 12 are the airspeed and ROD for the reference S-76 noise certification approach condition and the two original HAI Fly Neighborly Program-recommended approach conditions for the S-76. All three of these conditions are in the high BVI source noise region for the S-76. This high BVI source noise region presents a challenge in achieving noise abatement while reducing airspeed for landing at typical descent rates/glide slopes.

One method for reducing BVI source noise generation utilizes aircraft deceleration to increase the effective aerodynamic ROD/glide slope. Additional noise testing of an S-76B helicopter was conducted in 2000 as part of the development of a decelerating helicopter instrument landing system using differential GPS for aircraft guidance and control (Reference 13). Differential GPS was fully coupled to the aircraft FADEC, allowing hands-off, autopilot-control decelerating approaches to landing. Noise measurements were made with 6^{o} and 9^{o} approach angles, initial airspeeds from 120 to 70 kt and deceleration rates from 0.8 to 2.0 kt/sec. During this test, a best noise abatement approach condition was identified, consisting of a 9^{o} approach with 1.2 kt/sec deceleration from an entry airspeed of approximately 90 kt. As can be seen in Figure 13 this approach procedure uses ROD and airspeed combinations that occur in the heart of the high BVI noise region for the S-76. Aerodynamically, however, this approach condition is close to a 12^{o} approach below the high BVI noise region, and acoustic recordings for this approach condition exhibit no auditory evidence of BVI noise.

Based on the test results discussed above, a primary objective for achieving noise abatement for the S-76 is conducting decelerating approaches at high ROD's/glide slopes. Approaches performed at low ROD's/glide slopes can potentially exhibit high BVI noise emissions that could be exacerbated rather than ameliorated by deceleration of the aircraft. Hence in evaluating the GPS tracking data acquired for indications of potential high BVI noise for Flights 5, 16, 24, 29 and 33, periods of low ROD/glide slope and/or low deceleration rate are of concern, particularly during the more BVI-critical airspeeds between approximately 80 to 40 kt.

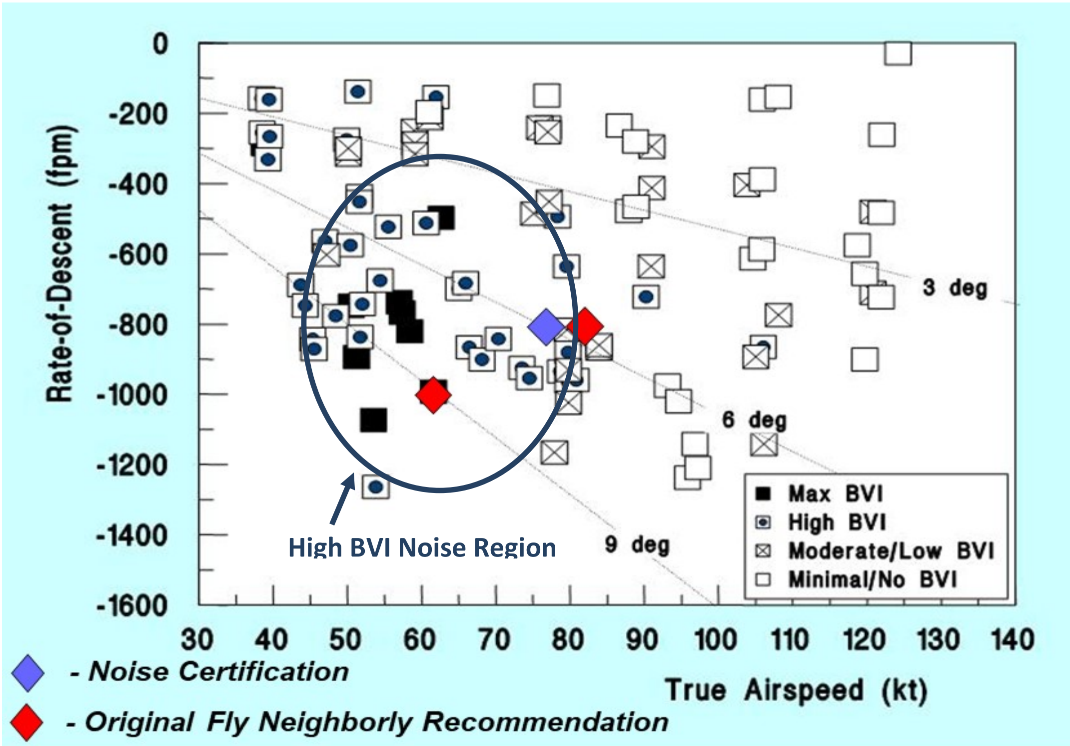

Figure 12. S-76 BVI Noise Levels vs. Airspeed and ROD Showing FAA Noise Certification and Original HAI Fly Neighborly Program Recommendations (References 10, 11, and 12)

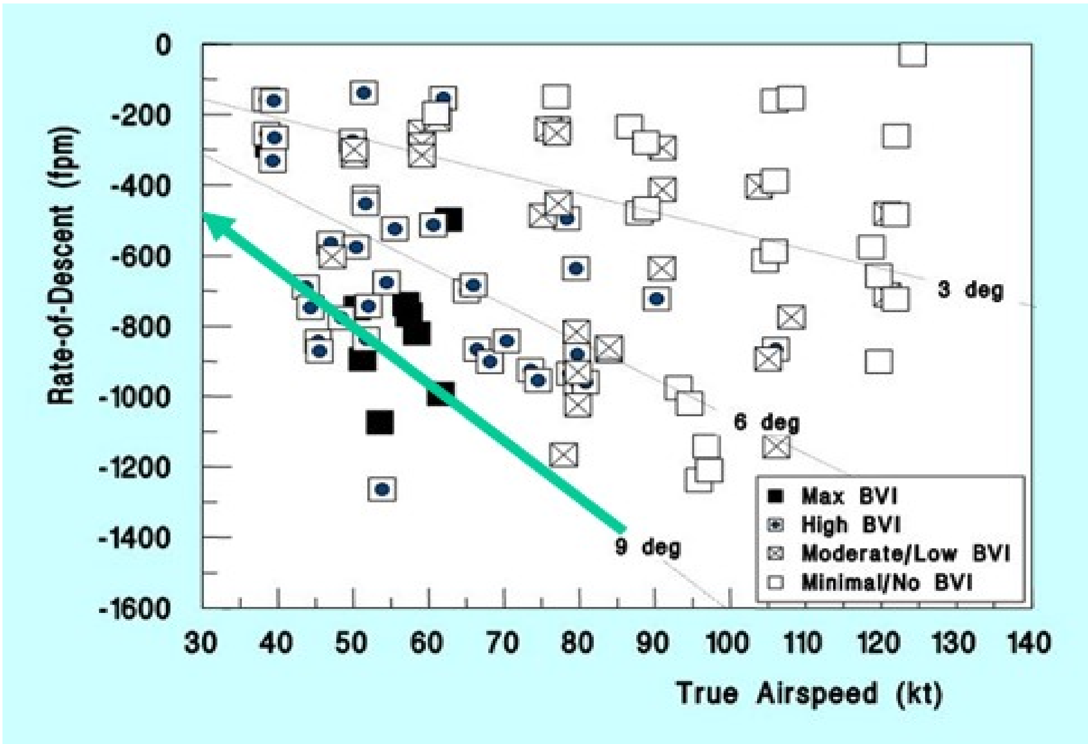

Figure 13. S-76 BVI Noise Levels vs. Airspeed and ROD Showing Best Identified Noise Abatement Procedure, a 1.2 kt/sec Decel at a 9° Glide Slope (Reference 12). Aerodynamically, this approach condition is close to a 12 degree approach, below the high BVI noise region.

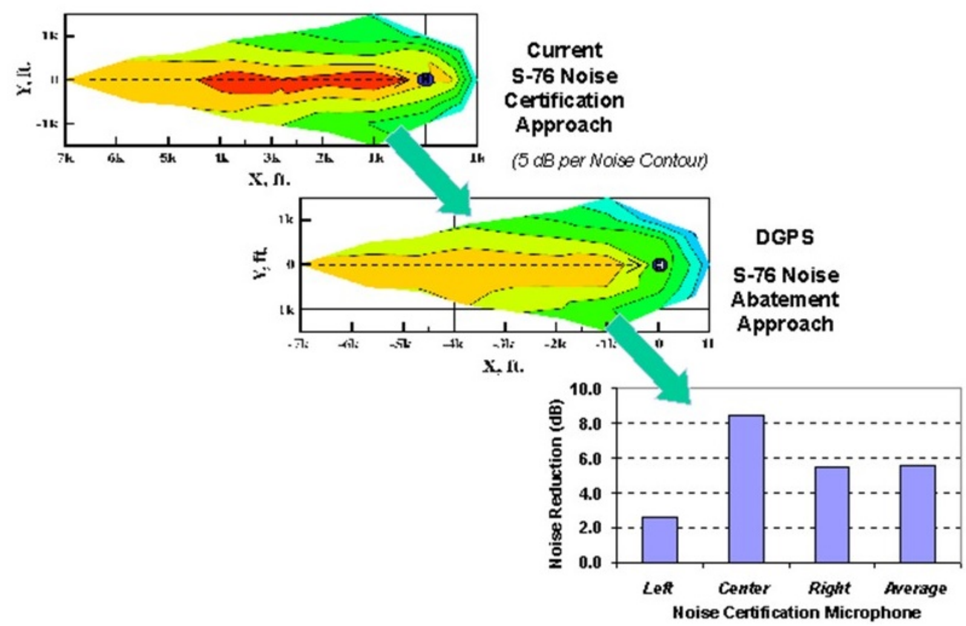

Figure 14. S-76 Noise Benefits of a Decelerating 9^o Approach (Reference 13)

To analyze the approach flight profile (altitude, airspeed, ROD, glide slope and deceleration rate) for each of these flights as functions of distance to arrival/landing at KHTO, an individual arrival/landing point was defined for each flight as shown in Table 5. Direct distance to the airport was then calculated from the recorded GPS tracking data. Although some small course changes as well as variations between the individual flight tracks into the airport likely occurred, both are typically small within the "corridor" used to fly the general noise abatement route into the airport and the resulting errors vs. actual flight distance to the airport are expected to be small. Similarly, ROD, glide slope and deceleration rate were calculated as deltas between the GPS data points recorded at one second intervals which introduced some errors/increased fluctuations into the results. Although some data points were removed from the analyses as physically impossible variations over a one second time frame, in general the errors appeared sufficiently random and small such that conclusions on potential BVI noise issues and noise abatement effectiveness could be reached for the data. Finally, ground speeds provided by the GPS tracking data were assumed to be representative of true airspeeds for the analyses. Wind speeds at altitude were unknown but ground level winds were very low during testing and weather conditions were indicative of lower winds at altitude, indicating that this assumption did not introduce excessive errors into the analyses.

Table 5. Latitudes and Longitudes for Arrival/Landing Points of GPS-tracked Flights

	Latitude	Longitude
Flight 5	40.9599	-72.2495
Flight 16	40.9599	-72.2497
Flight 24	40.9621	-72.2512
Flight 29	40.9599	-72.2492
Flight 33	40.95983	-72.2488

Results of the analyses of altitude, airspeed, ROD, glide slope and deceleration rate for Flights 5, 16, 24, 29 and 33 are summarized in Figures 15 through 39. These results are discussed in further detail below for each flight. Further recommendations for noise abatement procedures are discussed for Flight 24.

4.1.2 **Flight 5**

Results of the analyses of Flight 5 are shown in Figure 15 through Figure 20. This approach was initiated from a cruise condition of approximately 135 kt at an altitude of 1600 to 1700 ft. Figure 15 shows the altitude and airspeed profiles performed during the approach while the ROD's, glide slopes and deceleration rates derived from these tracking data are shown in Figure 16, Figure 17 and Figure 18 respectively. Figure 19 and Figure 20 show the measured altitudes and airspeeds versus recommendations for potentially quieter profiles for the entry altitude and airspeed of this flight.

In general, this flight was performed at sufficiently high ROD's and deceleration rates to potentially mitigate BVI source noise during much of the approach. One concern in regards to effective noise abatement was the relatively early initiation of the descent and the deceleration of the aircraft which in turn limited the ability to utilize higher ROD's and deceleration rates later in the approach. The first recommendation for modifying this approach would be to maintain altitude and cruise speed until nearer to the N3 waypoint adjacent to Long Pond as defined in the published noise abatement procedures for East Hampton Airport, with initiation using Sag Harbor-Bridgehampton Turnpike shortly before reaching Long Pond as a visual cue.

An examination of the data indicates two segments of the approach from approximately 11,000 to 7,500 ft and 4,000 to 2,500 ft from landing at the airport that are of concern for increased noise levels. These segments were flown at lower glide slopes and/or lower deceleration rates, possibly incurring increased BVI. Of these two segments, the second is likely of greater concern as it occurred well within the airspeed range for high BVI noise levels with relatively low deceleration rates despite a fairly good glide slope as indicated in Figures 17 and 18. This second segment did occur relatively close to the airport, however, and may therefore not be an issue for increased annoyance/complaint levels.

Adjustments to the Flight 5 approach to provide potentially more consistent noise abatement effectiveness are shown in Figures 19 and 20. These adjustments were made to the approach as flown rather than a generic noise abatement recommendation. A more generic recommendation is discussed below for Flight 24.

The primary recommendations for adjusting the approach profile performed for Flight 5 consist of establishing either a stable 7.5^{o} or 1000 fpm descent combined with stabilizing airspeed at 100 kt for a period while descending until initiating a more consistent deceleration segment closer to the airport at a minimum of 1 kt/sec. The airspeed recommendation also includes a stable 45 kt segment at the airport consistent with performing a Category A (Cat A) approach prior to landing at the airport. The deceleration for this recommended procedure could, however, continue to the airport similar to the measured tracking data. As noted above, additional adjustments to potentially further reduce BVI noise emissions could be to maintain cruise speed and altitude until nearer to the airport to permit higher descent rates and deceleration rates during the descent.

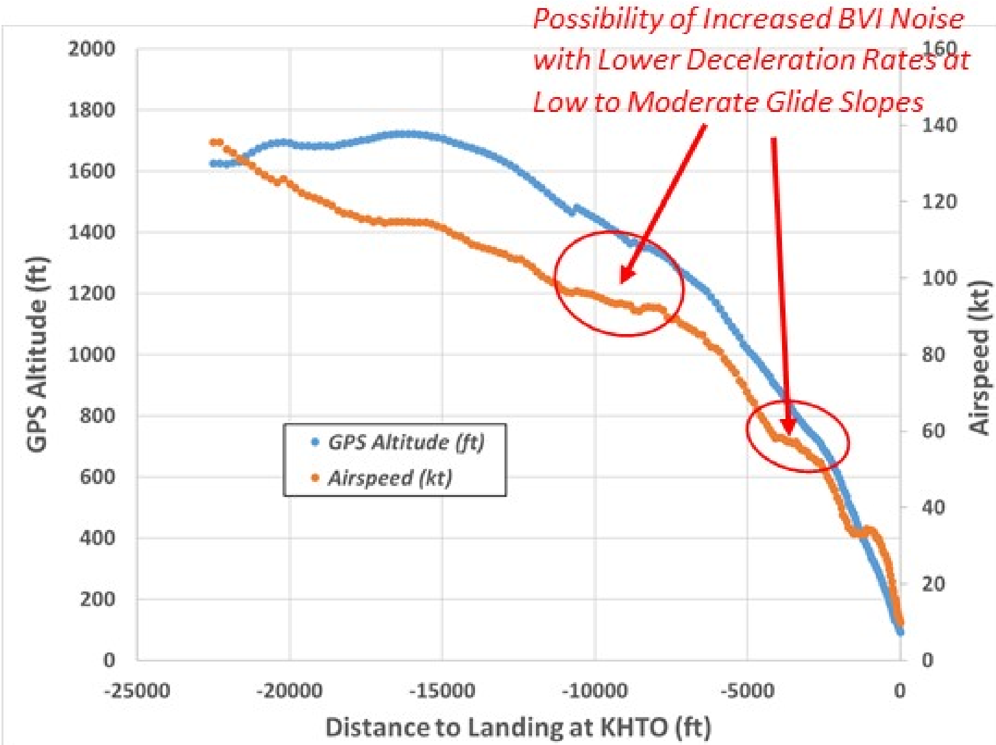

Figure 15. Flight 5 Altitude and Airspeed During Approach to East Hampton Airport

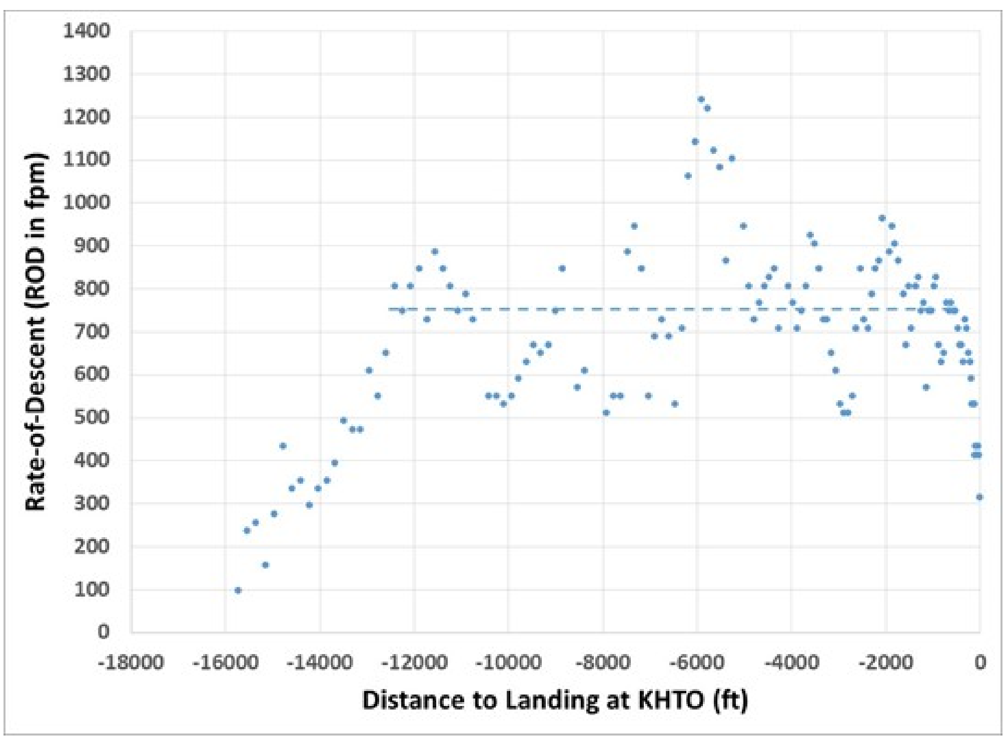

Figure 16. Flight 5 Rate of Descent (ROD) During Approach to East Hampton Airport

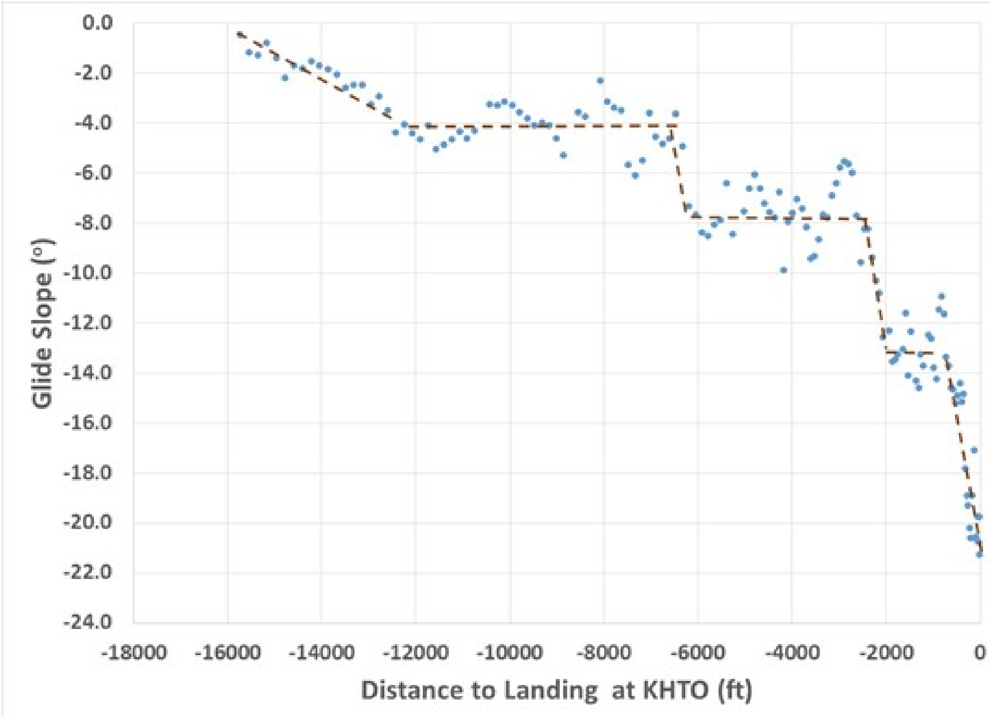

Figure 17. Flight 5 Glide Slope During Approach to East Hampton Airport

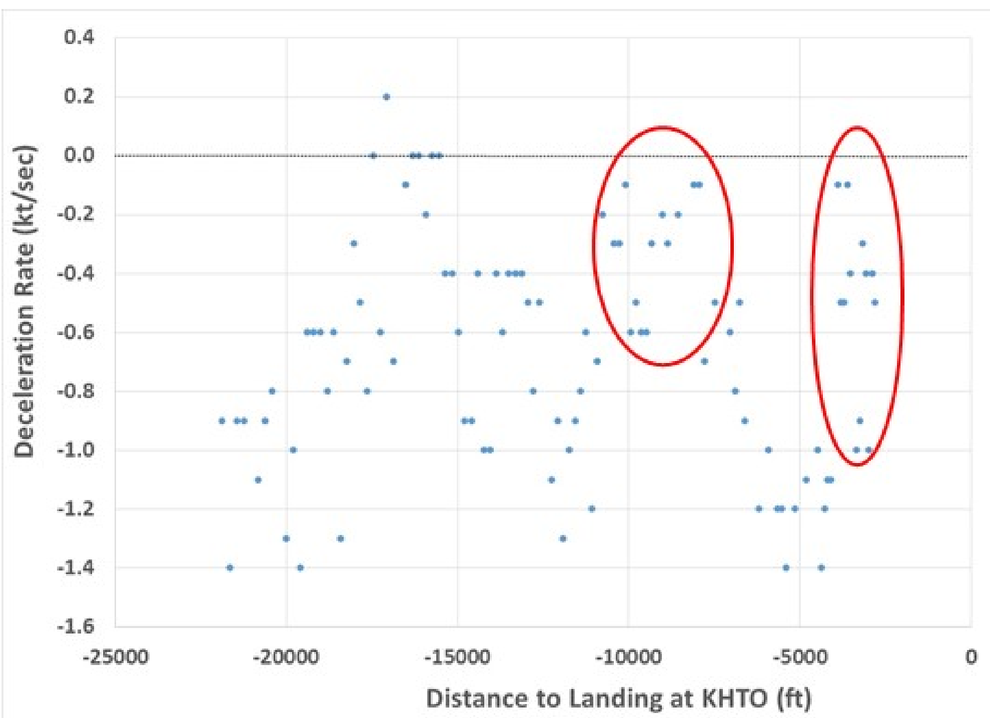

Figure 18. Flight 5 Deceleration Rate During Approach to East Hampton Airport

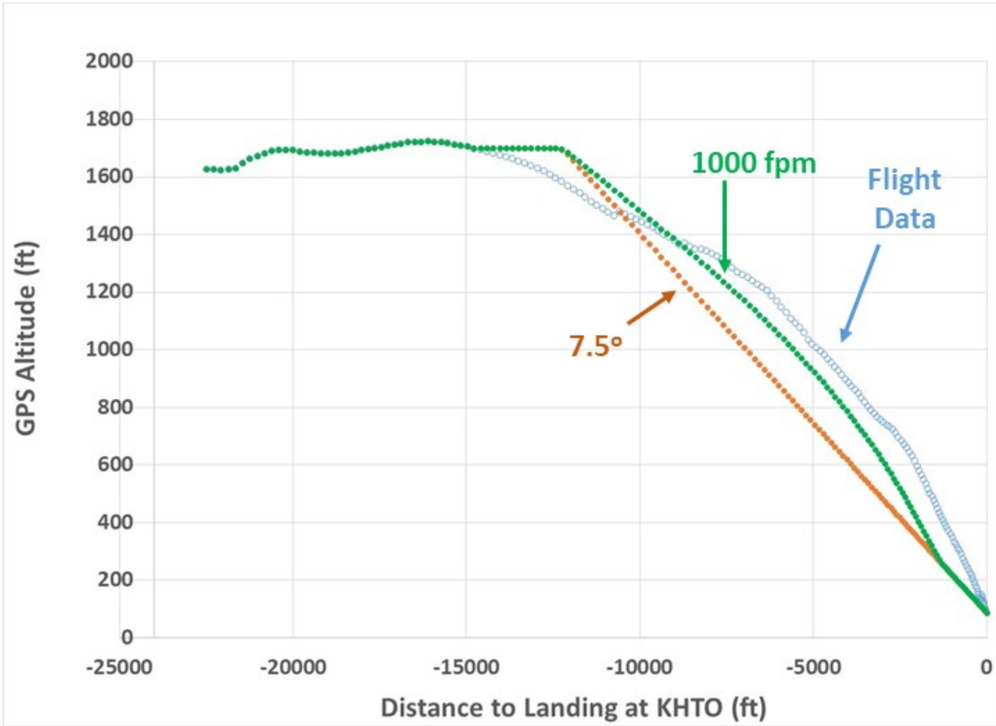

Figure 19. Flight 5 Measured & Recommended Altitude Profiles During Approach to East Hampton Airport

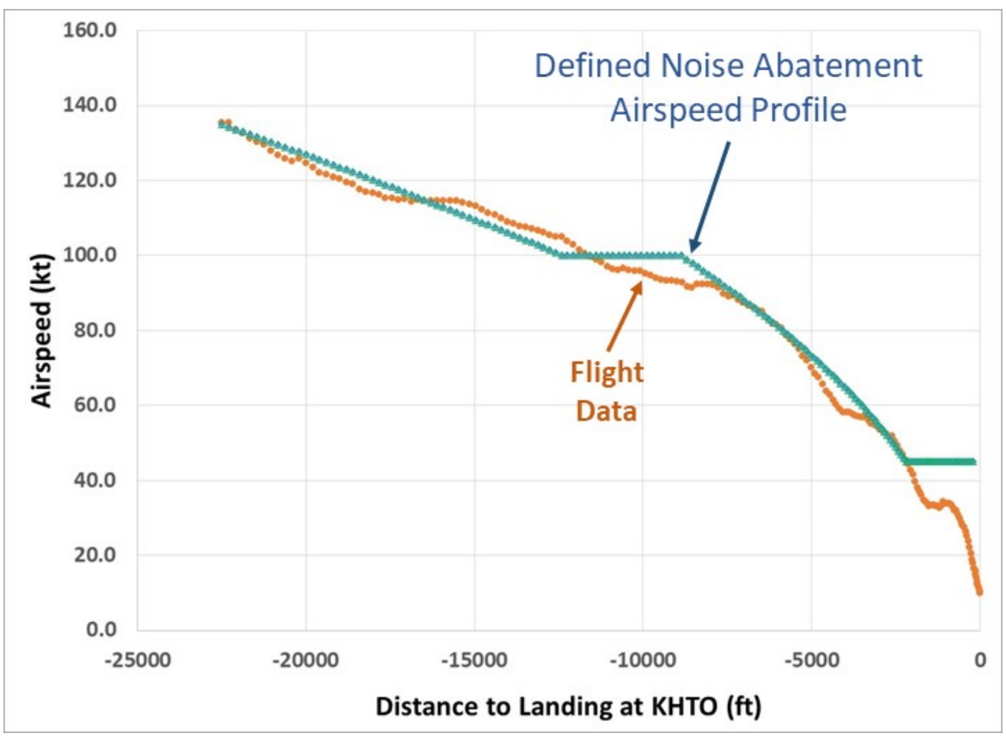

Figure 20. Flight 5 Measured & Recommended Airspeed Profiles During Approach to East Hampton Airport

4.1.3 **Flight 16**

Results of the analyses of Flight 16 are shown in Figure 21 through Figure 24. This approach was initiated from a cruise condition of approximately 110 kt at an altitude of 1700 ft. Figure 21 shows the altitude and airspeed profiles performed during the approach while the ROD's, glide slopes and deceleration rates derived from these tracking data are shown in Figure 22, Figure 23, and Figure 24 respectively.

Descent appears to have been initiated too early for effective noise abatement for Flight 16. Although relatively high rates of descent were achieved prior to initiating deceleration, higher descent was broken off at approximately 9,000 ft from the airport, with low descent rates/glide slopes at only low to moderate deceleration rates performed until arriving at the N-S runway at approximately 400 ft altitude prior to a near vertical descent to landing. Note that this 400 ft altitude point was defined as the arrival point for determining distance to the airport.

Because of the low descent and deceleration rates, increased BVI noise generation is of concern from 9,000 ft (~1.5 nautical miles) from the airport until arrival with the segment from 9,000 to nearly 2,500 ft from the airport of primary concern as shown in Figure 21 to Figure 23. No recommended adjustments to potentially enhance noise abatement were specifically defined for Flight 16, although a recommendation defined in Section 4.1.4 for the Flight 24 analyses would potentially be effective.

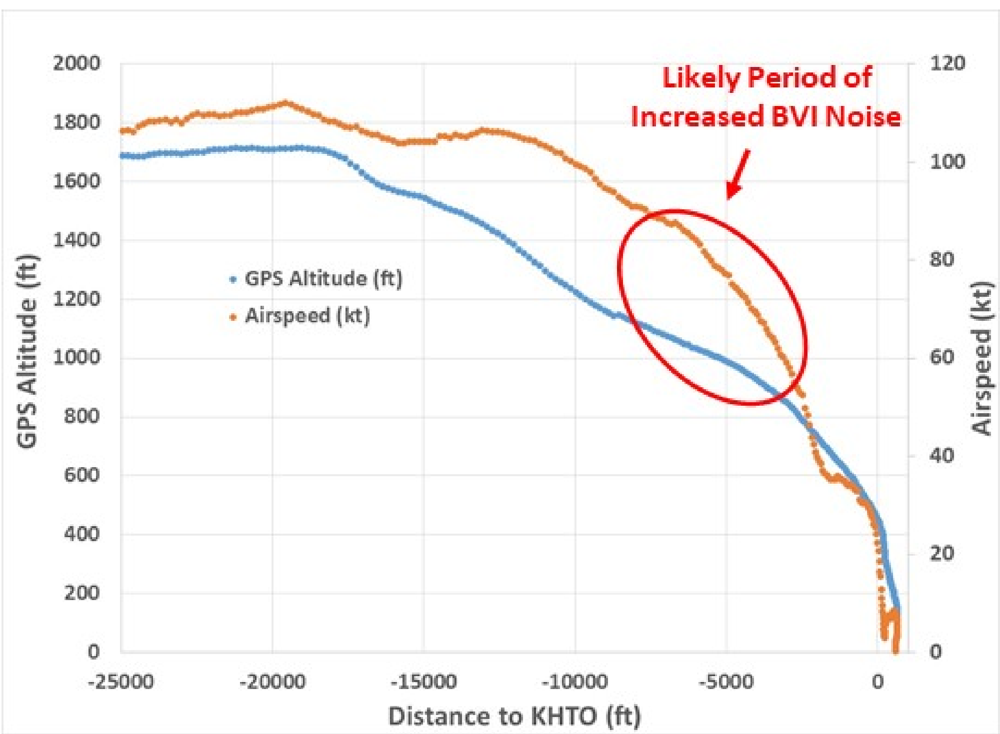

Figure 21. Flight 16 Altitude and Airspeed During Approach to East Hampton Airport

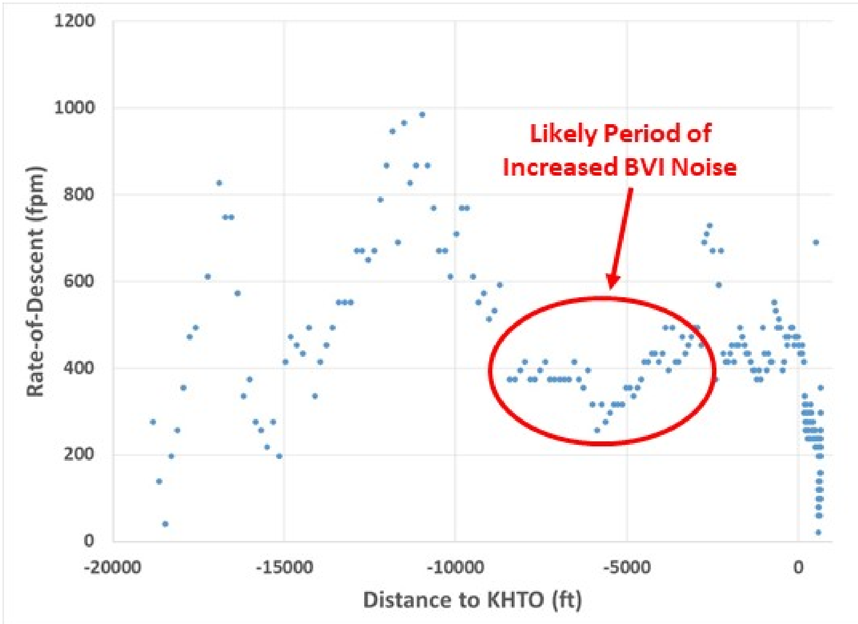

Figure 22. Flight 16 Rate of Descent (ROD) During Approach to East Hampton Airport

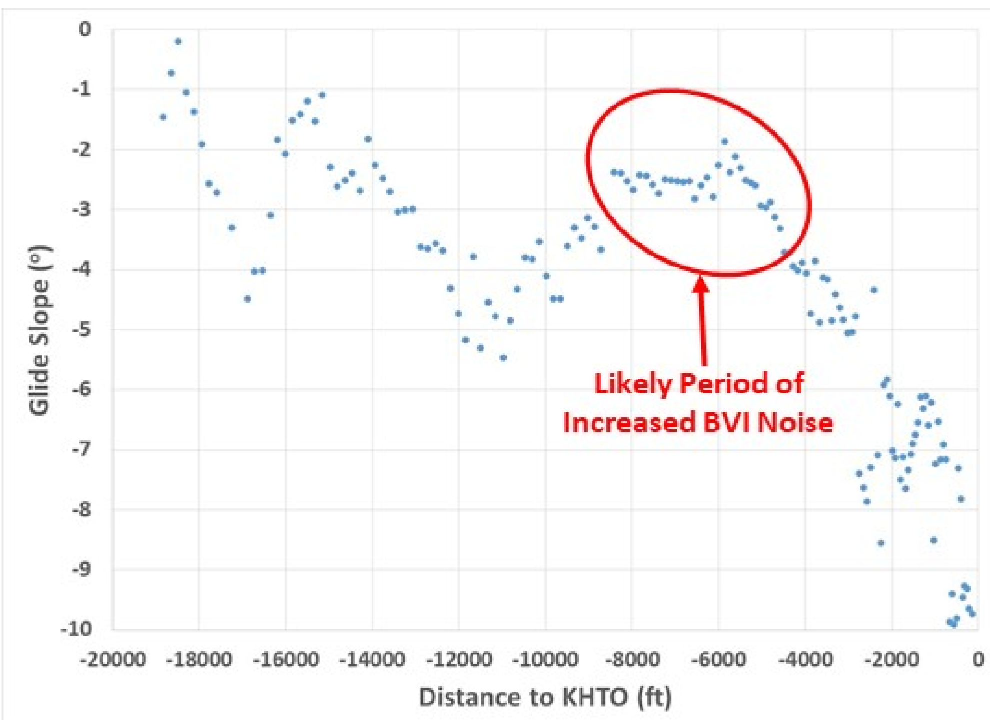

Figure 23. Flight 16 Glide Slope During Approach to East Hampton Airport

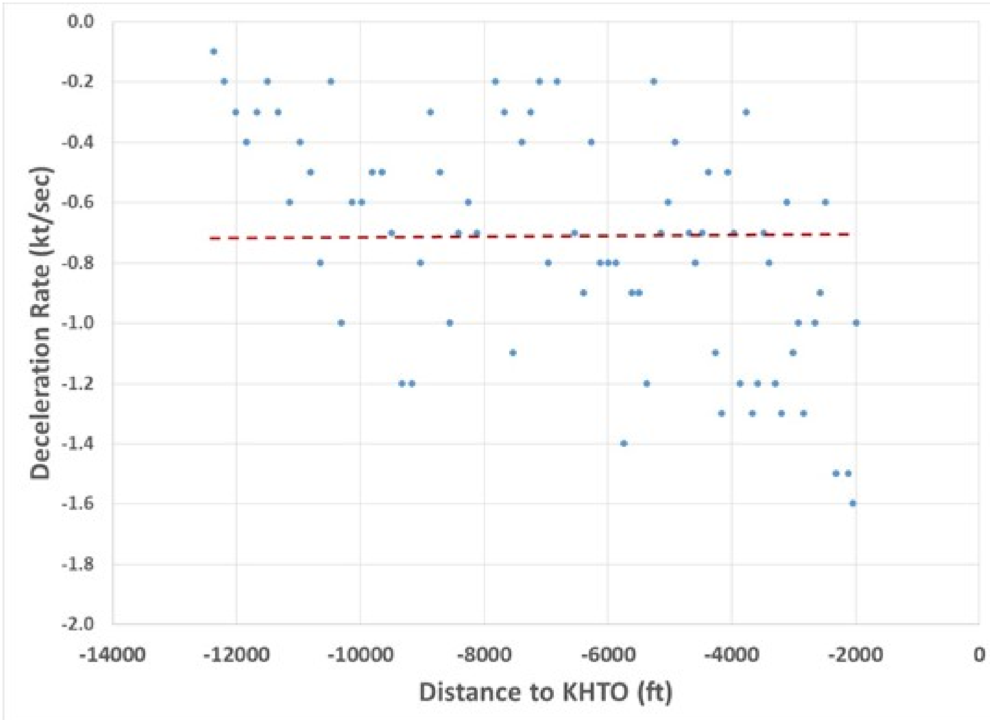

Figure 24. Flight 16 Deceleration Rate During Approach to East Hampton Airport

4.1.4 Flight 24

Results of the analyses for Flight 24 are shown in Figure 25 through Figure 31. Figure 25 shows the altitude and airspeed profiles performed during the approach while the ROD's, glide slopes and deceleration rates derived from these tracking data are shown in Figure 26, Figure 27, and Figure 28 respectively. The more critical airspeed range for S-76 BVI noise generation is shown by the vertical lines overlaid on each plot in Figure 25 through Figure 28. Figure 29 shows an overlay of the Flight 24 altitude and descent rate data on the S-76 test data provided in Figure 12 and Figure 13. Figure 30 and Figure 31 show the measured altitudes and airspeeds versus recommendations for potentially quieter profiles for the entry altitude and airspeed of this flight.

As noted previously, Flight 24 was deemed the best of the tracked flights for potential noise abatement. This approach was initiated near the Sag Harbor-Bridgehampton Turnpike from a cruise condition of approximately 132 kt at an altitude of 1300 to 1400 ft. Only one segment of the Flight 24 approach might be of any concern for increased BVI noise generation. A short segment near 4,000 ft from the airport exhibited lower descent rates/glide slopes which may have induced some increased BVI noise, but deceleration rates remained relatively high during this segment which may have precluded it. The overlay in Figure 29 of the Flight 24 descent rate and airspeed data on the S-76 test data shown in indicates that descent rates were not as high as the best tested S-76 noise abatement procedure discussed previously. Figure 28 shows, however, that the deceleration was performed at rates exceeding 1.2 kt/sec during the critical airspeed range for BVI noise, indicating that the Flight 24 approach profile may be nearly if not as effective as the best tested S-76 noise abatement procedure.

Initial descent and airspeed profile recommendations for potentially improving noise abatement similar to those defined for Flight 5 are provided in Figure 30 and Figure 31. These recommendations again incorporate initiating a stable 5.8^{o} or 650 fpm descent with a minimum 1 kt/sec decel from cruise using Sag Harbor-Bridgehampton Turnpike as a visual cue. To potentially reduce noise annoyance levels during cruise over the North and South Forks of Long Island, cruise airspeed can be lowered from the typical 130 - 140 kt to 120 kt. A recommended airspeed profile based on a 120 kt cruise speed using Long Pond as the visual cue is also shown in Figure 31. This Sag Harbor-Bridgehampton Turnpike cue for initiating descent with the Long Pond cue for initiating deceleration would be recommended for adjusting the lower cruise speed Flight 16 approach profile for improved noise abatement.

In addition to the noise abatement recommendation provided in Figure 30 and Figure 31, an additional recommendation replicative of the approach profile flown for Flight 24 could also be effective and provide an option more closely aligned to current operations. Specifically, the recommendation would consist of initiating a descent for higher cruise speeds at Sag Harbor-Bridgehampton Turnpike (at Long Pond for lower cruise speed) that gradually increases ROD to a target 800 to 900 fpm while rapidly decelerating the aircraft at 1.5 to 2 kt/sec, maintaining the 800 to 900 fpm ROD and deceleration rate into the airport.

In making the additional noise abatement recommendation applicable for cruise altitudes higher or lower than the 1300 to 1400 feet performed for Flight 24, at least one performance variable needs to change. The candidates include descent initiation point, deceleration rate and the stabilized descent rate. As the initiation point is based on the existing limited visual cues and a consistent deceleration rate would be preferable for repeatability, the final stabilized ROD appears to be the preferred choice. For VFR flights at cruise altitudes above 1300 to 1400 ft, an increased ROD would be needed while for VFR flights at cruise altitudes lower than 1300 to 1400 ft, a decreased ROD would be needed. These adjustments to the ROD might require several flights to establish values that provide the desired descent profile to properly target completion at the airport.

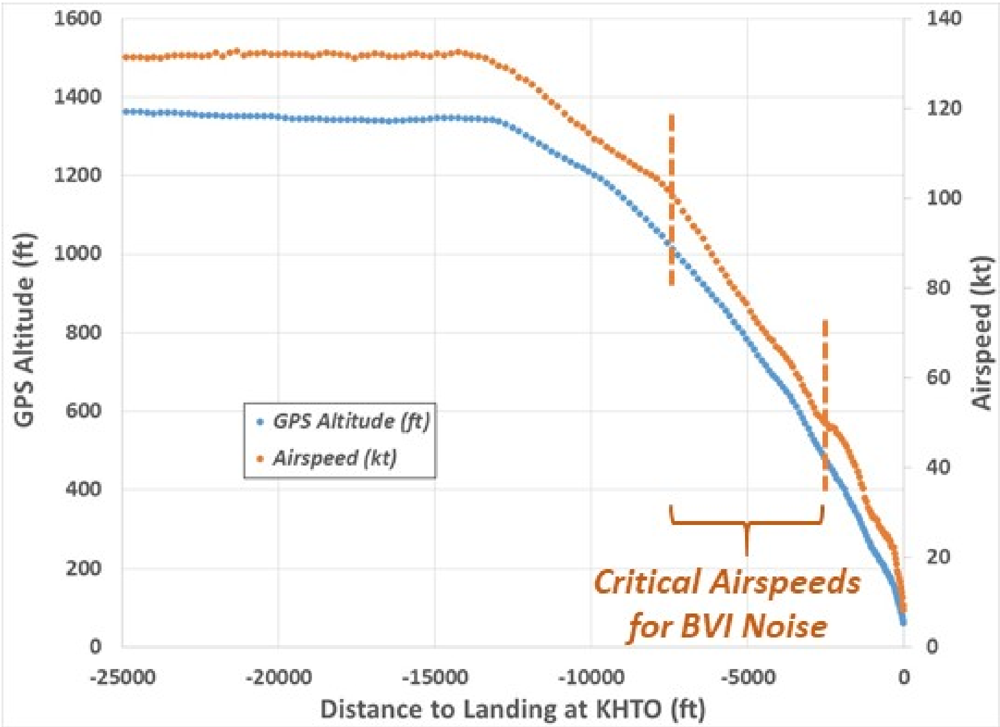

Figure 25. Flight 24 Altitude and Airspeed During Approach to East Hampton Airport

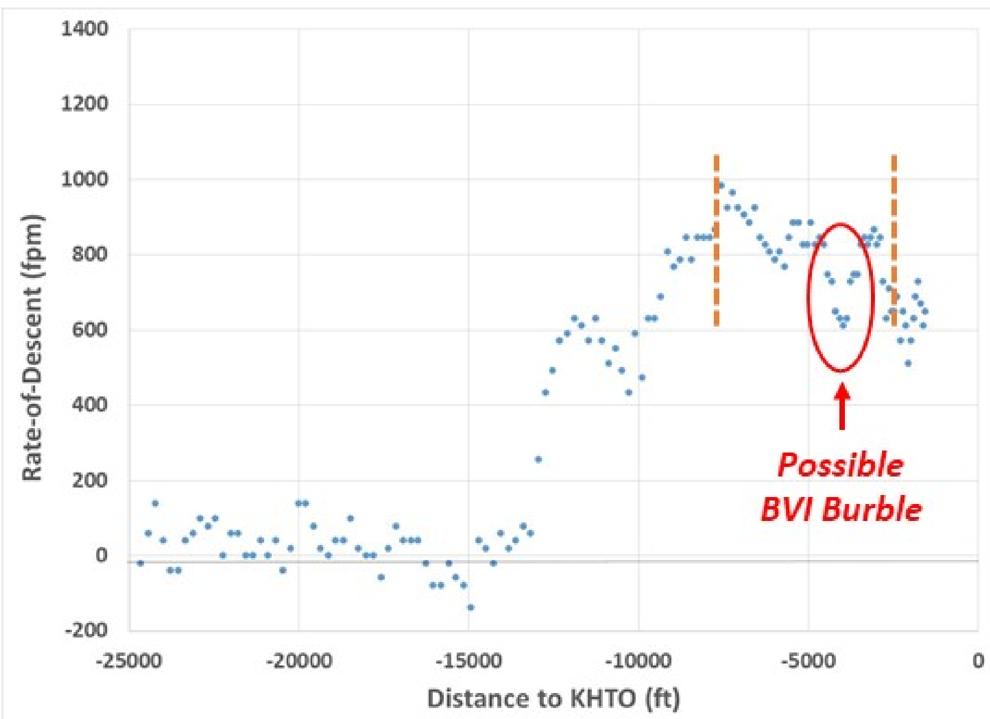

Figure 26. Flight 24 Rate of Descent (ROD) During Approach to East Hampton Airport

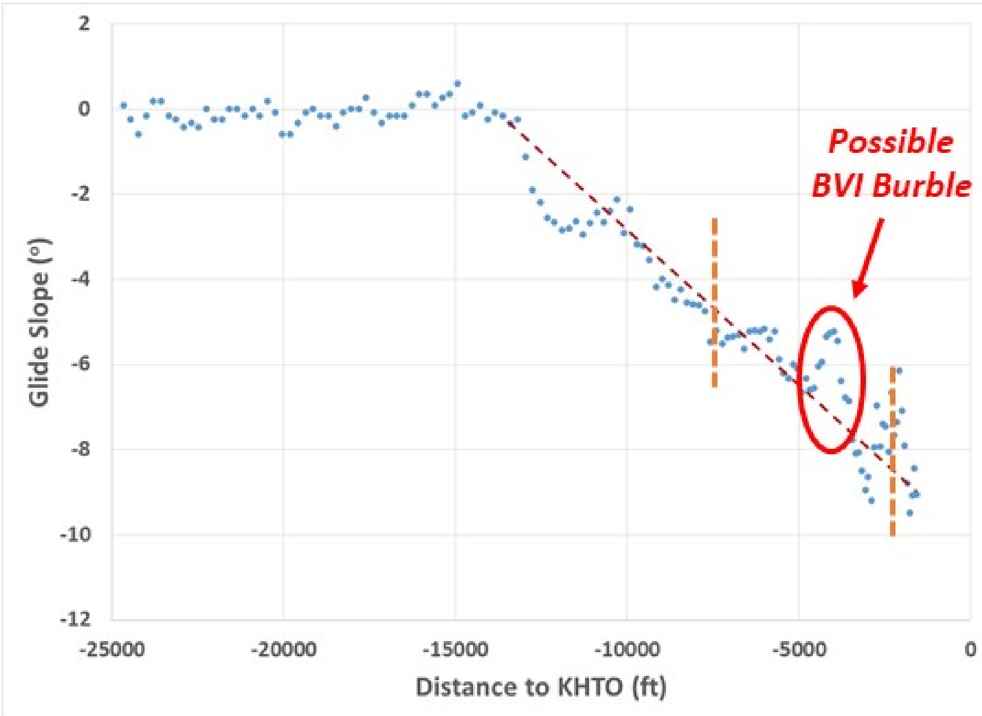

Figure 27. Flight 24 Glide Slope During Approach to East Hampton Airport

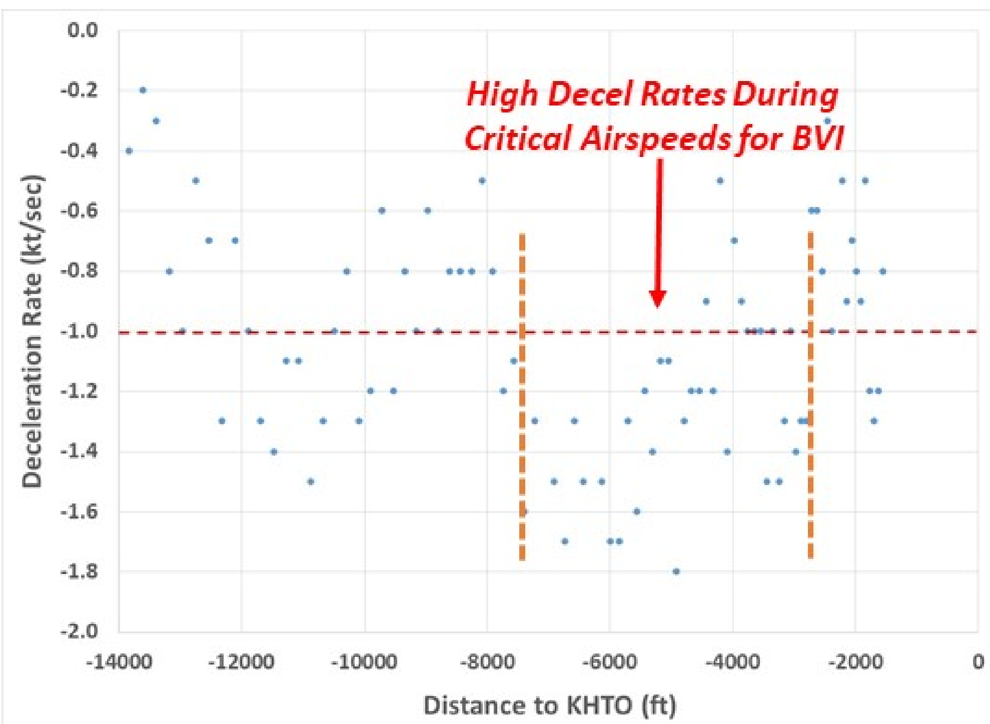

Figure 28. Flight 24 Deceleration Rate During Approach to East Hampton Airport

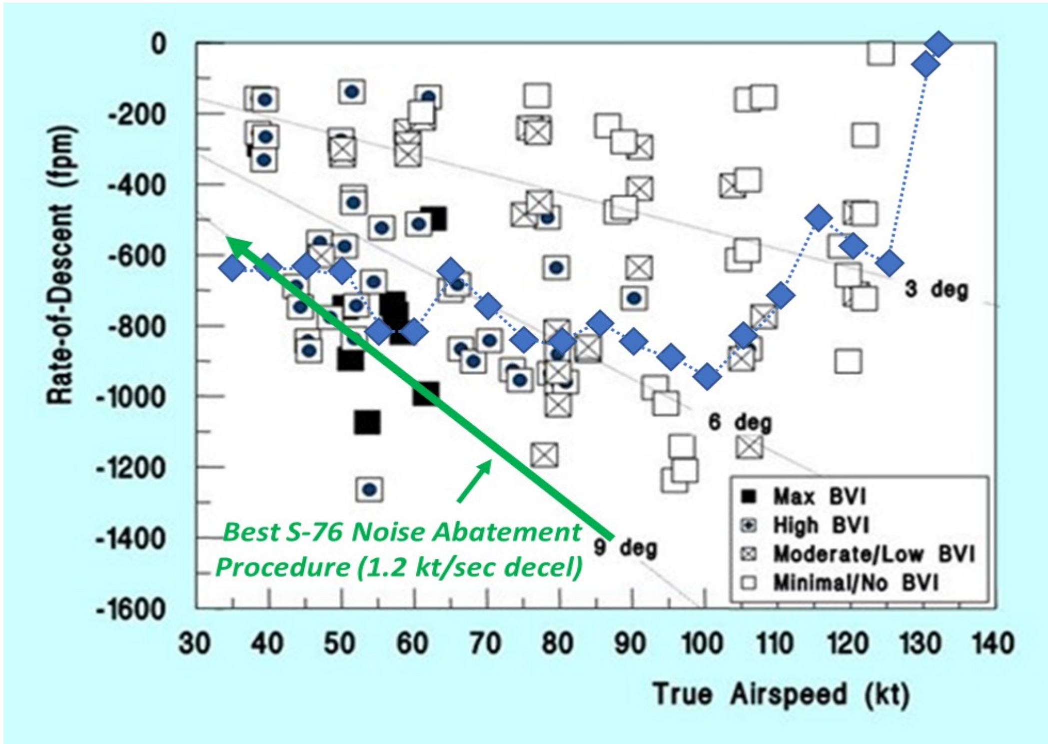

Figure 29. Overlay of Flight 24 Airspeed and ROD Data on Figure 13

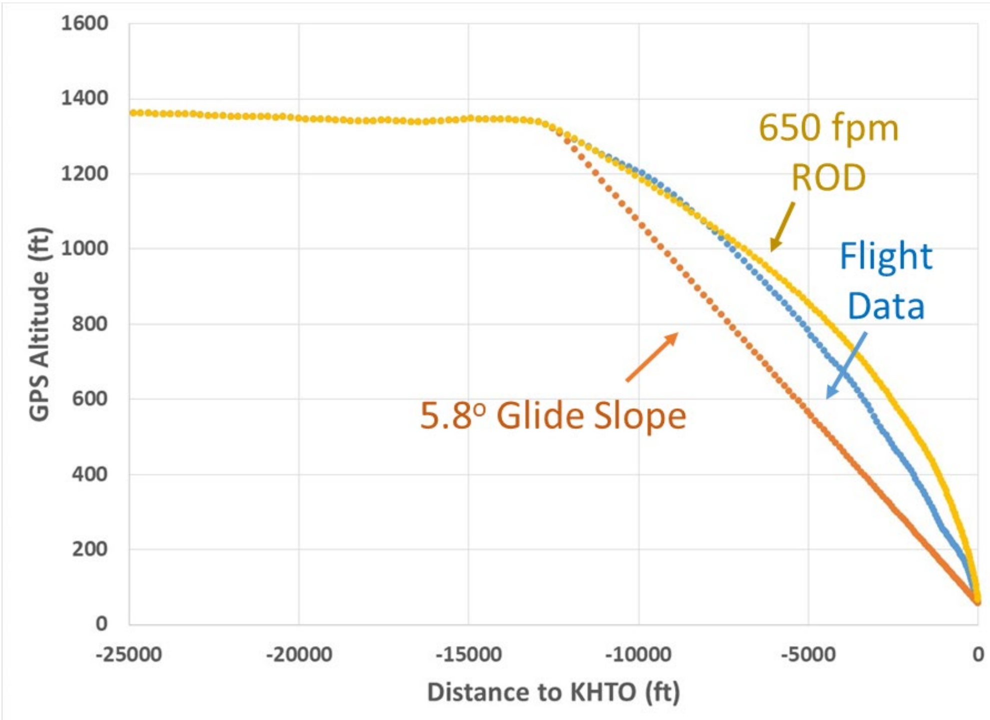

Figure 30. Flight 24 Measured and Recommended Altitude Profiles During Approach to East Hampton Airport

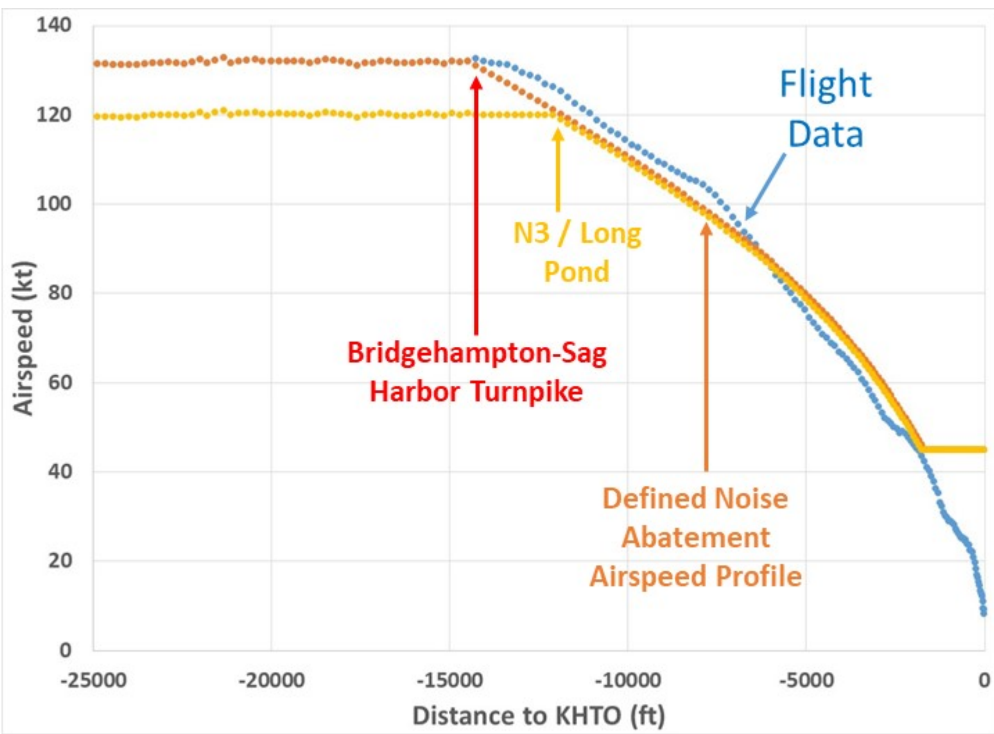

Figure 31. Flight 24 Measured and Recommended Airspeed Profiles During Approach to East Hampton Airport

4.1.5 Flight 29

Results of the analyses of Flight 29 are shown in Figure 32 through Figure 35. This approach was initiated a cruise condition of approximately 130 kt and an altitude of approximately 2100 ft more than 3 nautical miles from the airport. Figure 32 shows the altitude and airspeed profiles performed during the approach while the ROD's, glide slopes and deceleration rates derived from these tracking data are shown in Figure 33, Figure 34 and Figure 35 respectively.

After an initial deceleration, airspeed was nearly stabilized at 110 kt for a period from approximately 16,000 to 9,000 ft from the airport. During this period, the ROD was increased up to 1800 fpm, a high ROD, but was subsequently rapidly reduced to approximately 400 fpm by 7,000 ft from the airport. Despite an increase in deceleration rate by 7,000 ft, the low descent rates/glide slopes in the BVI-critical airspeed range utilized from 7,000 ft to 2,000 ft before arriving at the airport are of primary concern for potentially high and possibly intensive BVI noise as indicated in Figure 32 through Figure 34.

No recommended adjustments for increased noise abatement specific to the Flight 29 profile were made. The primary recommendation would be to delay descent and deceleration initiation until Sag Harbor-Bridgehampton Turnpike and then execute an approach similar to Flight 24 (or the recommended noise abatement procedures for Flight 24.)

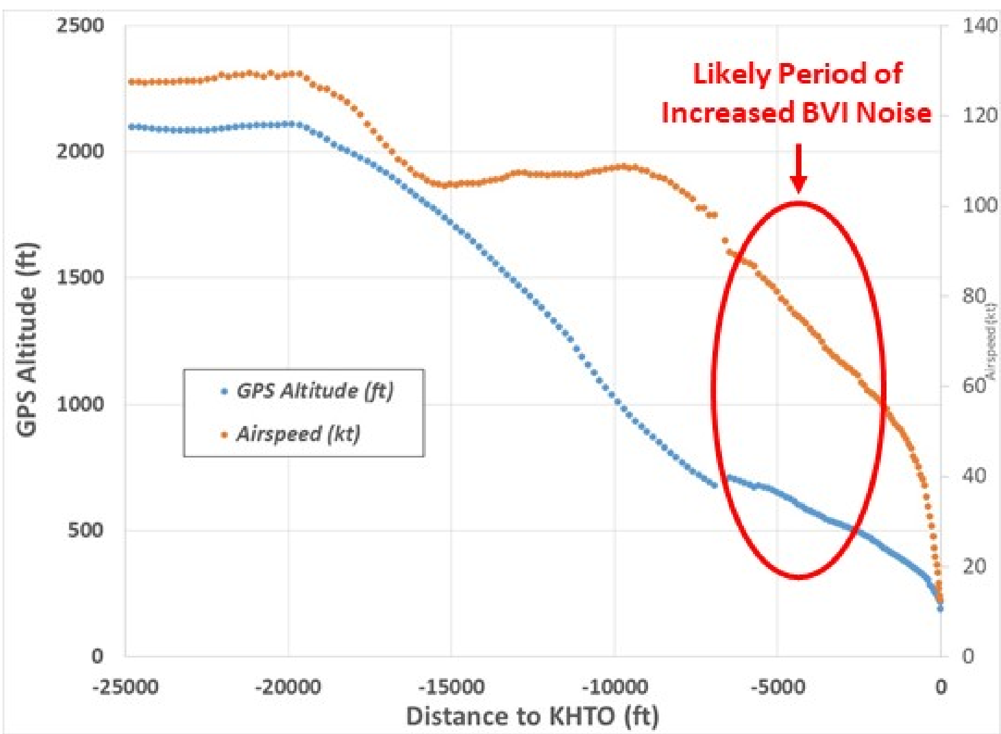

Figure 32. Flight 29 Altitude and Airspeed During Approach to East Hampton Airport

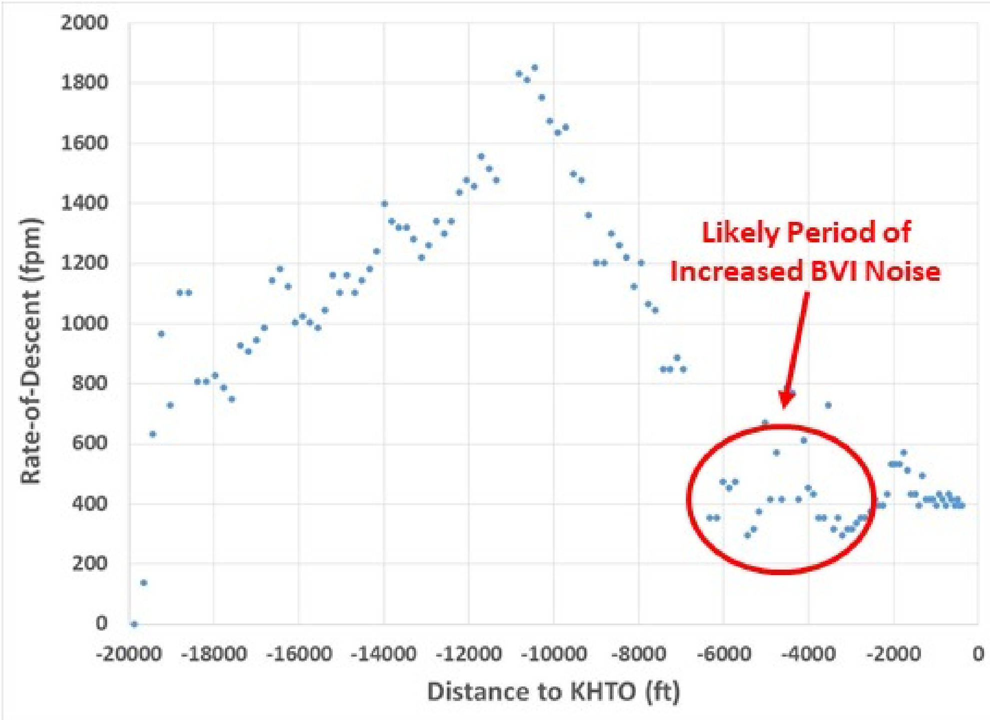

Figure 33. Flight 29 Rate of Descent (ROD) During Approach to East Hampton Airport

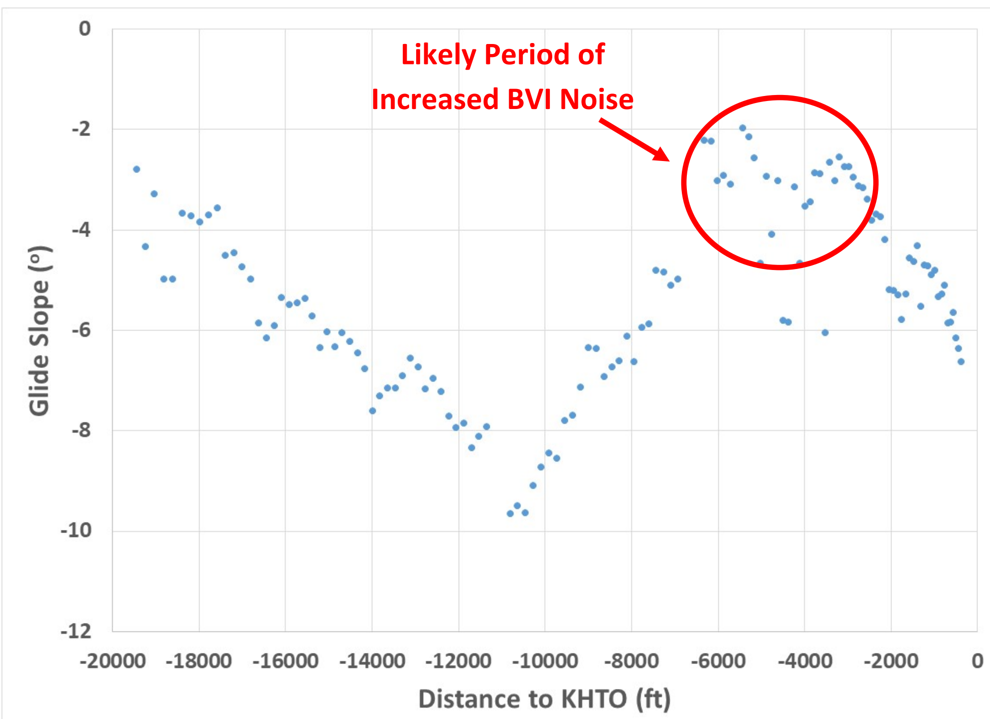

Figure 34. Flight 29 Glide Slope During Approach to East Hampton Airport

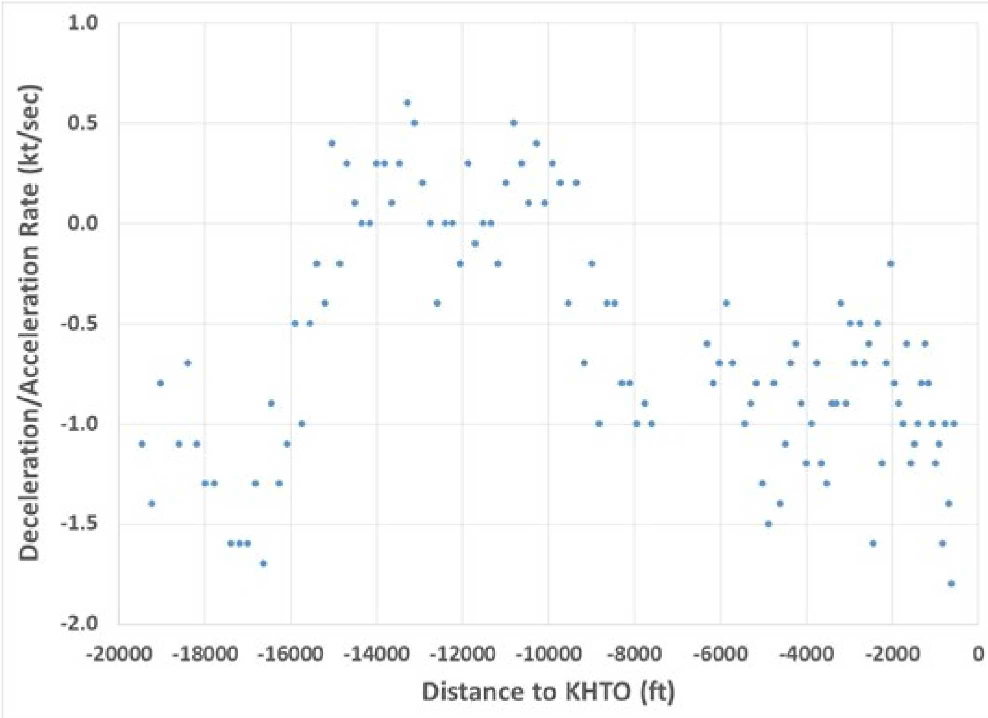

Figure 35. Flight 29 Deceleration Rate During Approach to East Hampton Airport

4.1.6 **Flight 33**

Results of the analyses of Flight 33 are shown in Figure 36 through Figure 39. This approach was initiated from a cruise condition of approximately 135 kt at an altitude of 2100 ft. Figure 36 shows the altitude and airspeed profiles performed during the approach while the ROD's, glide slopes and deceleration rates derived from these tracking data are shown in Figure 37, Figure 38 and Figure 39 respectively.

Although initially descent appears to have been initiated to achieve descent rates (glide slopes) and deceleration rates conducive to BVI noise abatement, these higher descent and deceleration rates were broken off at approximately 11,000 ft from the airport, with low descent rates/glide slopes at only low to moderate deceleration rates performed until establishing a short 600 ft hover at the N-S runway prior to a near vertical descent to landing. Note that this 600 ft altitude point was defined as the arrival point for determining distance to the airport. The reason for the descent breakoff is unknown, although potential reasons include too early initiation of the descent requiring an ROD adjustment to achieve the desired arrival point or possibly an adjustment for airport traffic using the N-S runway during the Flight 33 approach.

Because of the low descent and deceleration rates, increased BVI noise generation is of concern for distances recommended approximately 2 nautical miles from the airport until arrival with the segment from 11,000 to nearly 4,000 ft from the airport as shown in Figure 36 to Figure 39. No recommended adjustments for increased noise abatement specific to the Flight 33 profile were made. The primary recommendation would again be to delay descent and deceleration initiation until Sag Harbor-Bridgehampton Turnpike and then execute an approach similar to Flight 24 (or the recommended noise abatement procedures for Flight 24.)

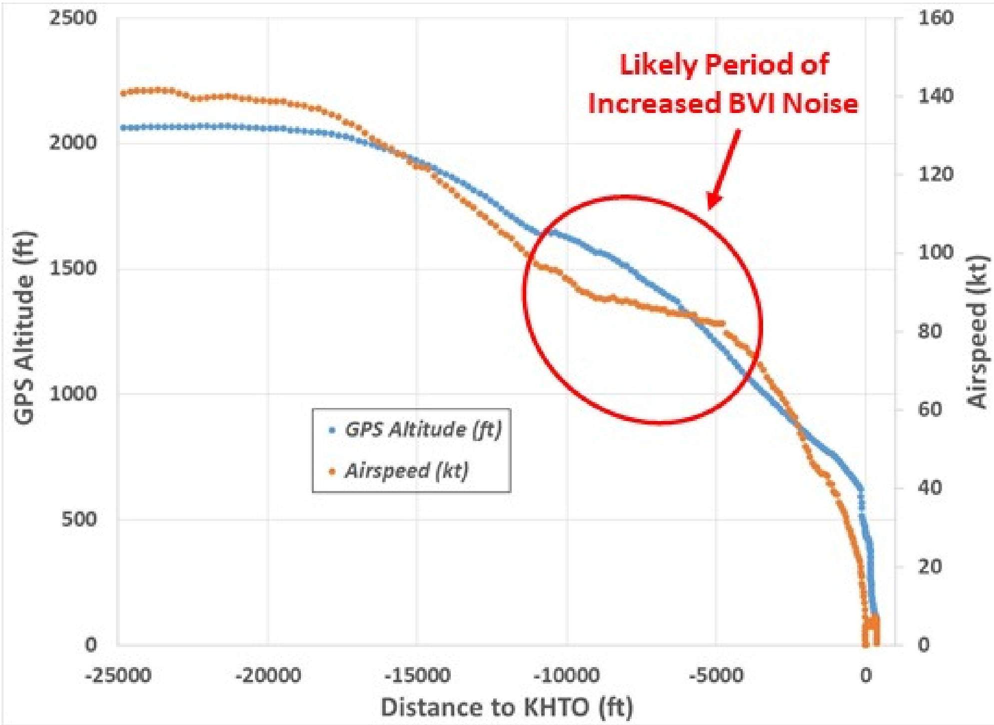

Figure 36. Flight 33 Altitude and Airspeed During Approach to East Hampton Airport

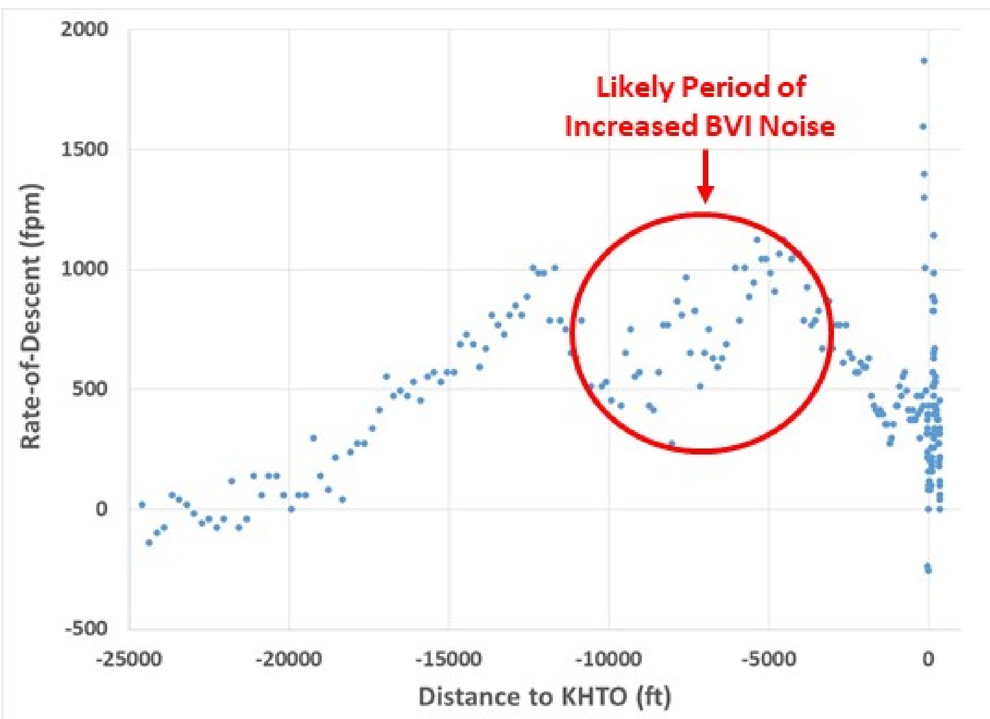

Figure 37. Flight 33 Rate of Descent (ROD) During Approach to East Hampton Airport

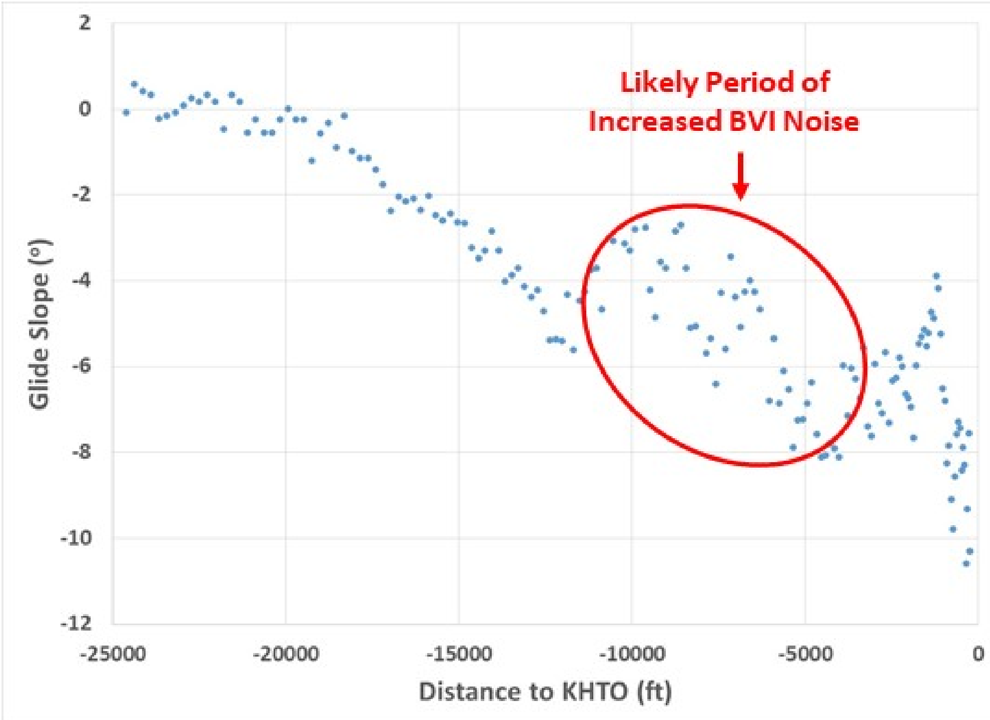

Figure 38. Flight 33 Glide Slope During Approach to East Hampton Airport

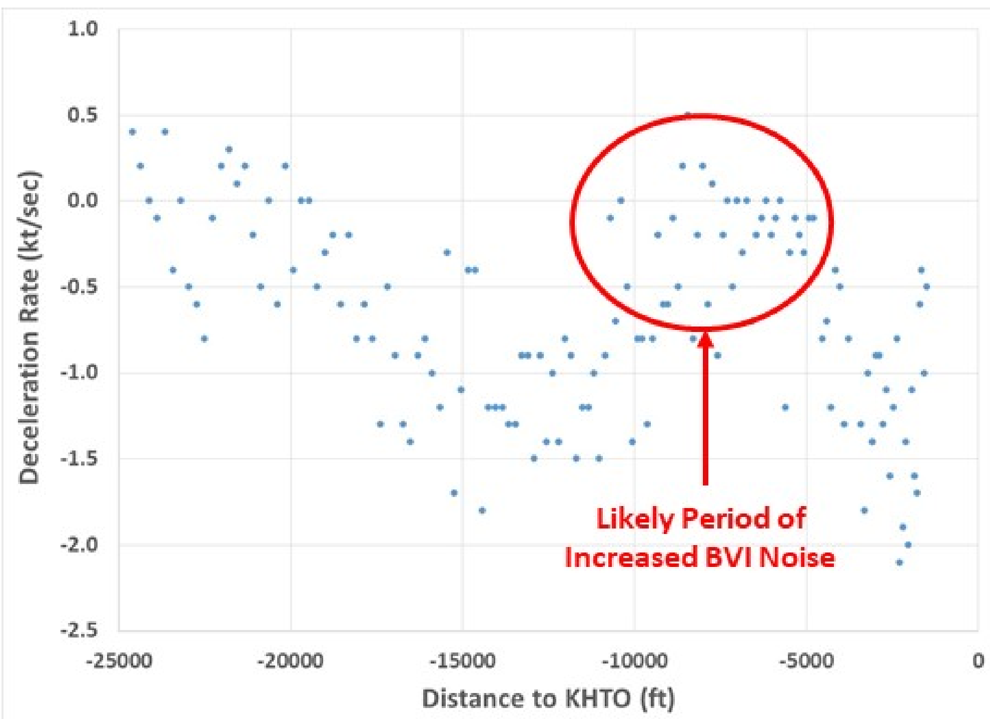

Figure 39. Flight 33 Deceleration Rate During Approach to East Hampton Airport

4.2 Noise Exposure

The as-flown VFR procedures for the five flights with precision tracking and acoustic data were evaluated, to determine what, if any, information could be gleaned and to provide further evidence that procedural differences can affect and mitigate noise on the ground. Two types of acoustic data were evaluated: 1) the *in situ* sound level and audio recordings, and 2) noise exposure footprints predicted based on AAM modeling of the as-flown profiles.

4.2.1 Sound Level Meter and Audio Clip data summary

Analyses of the sound level meter time history data acquired for five Sikorsky S-76 helicopter flights with GPS tracking data (Flights 5, 16, 24, 29 and 33) were conducted to compare and 'ground-truth' the as-flown approach flight profiles. For each flight, data from each monitor location along with the aircraft tracking data were used to derive the maximum sound level, sound exposure level, aircraft altitude, slant range between aircraft and monitor location, emission angle, and aircraft airspeed at closest point of approach (CPA). These data were tabulated (Table 6) and graphed (Figure 40 and Figure 41) to determine if any visible trends or outliers would exist, potentially indicating quieter or louder flights. There is some indication in Figure 40 that Flight 29 exhibited higher-than-average maximum sound levels (but not sound exposure level) at larger slant distances. However, these data are not corrected for airspeed, or emission angle, nor have instances of line-of-sight blockage been accounted for (the Lillian Lane location, for instance, may have been shielded by hilly terrain at times). Thus, definitive conclusions cannot be made. Helicopter directivity may also play a role in the measured sound level comparisons between sites. Locations 1 was typically under the flight path or slightly to the left of flight path. Location 2 was under the flight path. Location 3 was typically under the flight path or slightly to the right of the flight path. Location 4 was to the right of the flight path, and location 5 was to the left of the flight path.

Table 6. Summary of maximum sound level, sound exposure level, aircraft altitude, slant range, and air speed for each of the five selected S-76 flights

	Flight	1- Hickory Hills	2- Power At Sagg Rd.	3- Lillian Lane	4- Merchant Path	5- Ridge Rd
Maximum Sound Level (dBA)	Flight 5	76.2	No data	80.5	No data	No data
	Flight 16	73.3	83.8	73.5	73.6	60
	Flight 24	No data	76.4	80.7	No data	51.1
	Flight 29	78.5	80.2	83.6	87.6	62.9
	Flight 33	No acoustic data for this flight				
Sound Exposure Level (dBA)	Flight 5	80.9	No data	88.4	No data	No data
	Flight 16	80.3	85.1	75.1	80.1	65.6
	Flight 24	No data	84.1	87.1	No data	63.5
	Flight 29	79.1	76.7	87.0	91.9	54.7
	Flight 33	No acoustic data for this flight				
Altitude (ft)	Flight 5	1,680	1,514	1,368	1,108	897

	Flight 16	1,710	1,326	1,161	1,031	916
	Flight 24	1,342	1,235	1,088	785	515
	Flight 29	2,078	1,281	871	672	557
	Flight 33	2,052	1,680	1,566	1,298	1,061
Slant Range (ft)	Flight 5	1,699	1,538	1,567	1,482	5,245
	Flight 16	2,361	1,349	1,889	2,449	3,631
	Flight 24	2,355	1,475	1,366	3,373	4,736
	Flight 29	2,678	1,391	1,176	1,060	5,324
	Flight 33	2,522	1,793	1,909	1,927	4,804
Emission Angle (deg)	Flight 5	88	87	81	74	58
	Flight 16	73	87	68	62	59
	Flight 24	67	79	76	59	58
	Flight 29	75	83	74	69	58
	Flight 33	77	84	78	71	59
Airspeed (knots)	Flight 5	121.0	99.0	92.0	78.0	58.0
	Flight 16	110.1	104.2	94.6	83.9	67.5
	Flight 24	132.0	117.5	105.6	76.4	52.0
	Flight 29	127.0	107.0	107.0	87.0	70.0
	Flight 33	138.0	101.0	89.0	84.0	75.0

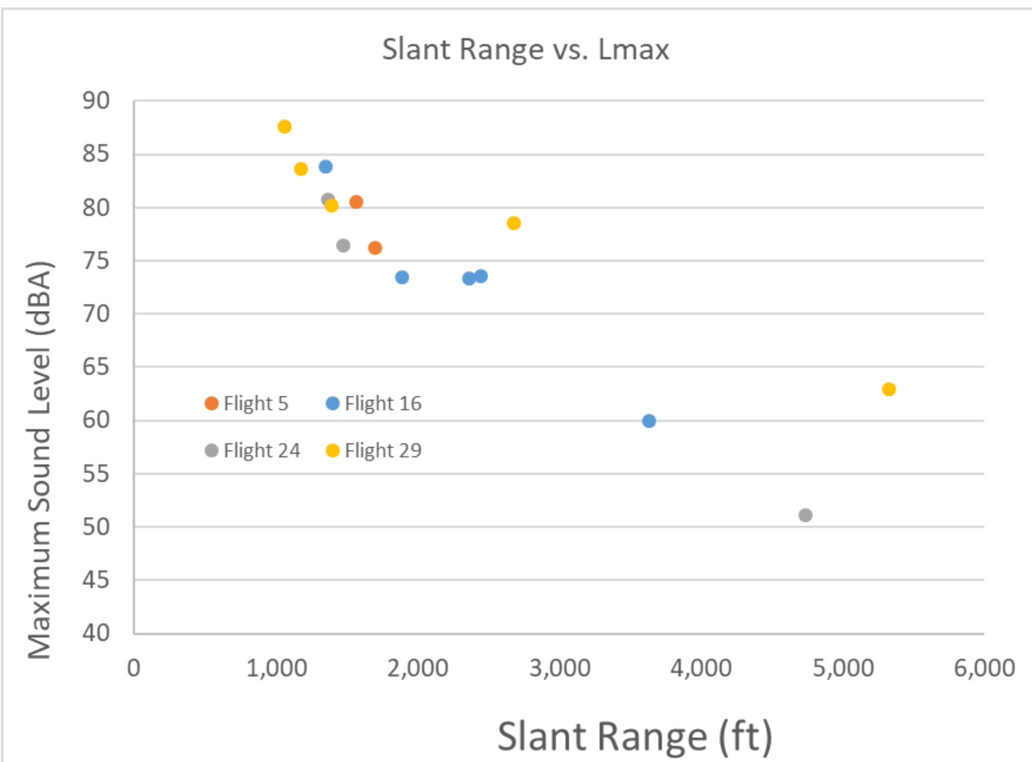

Figure 40. Maximum sound level vs slant distance to each monitoring location for the five selected flights.

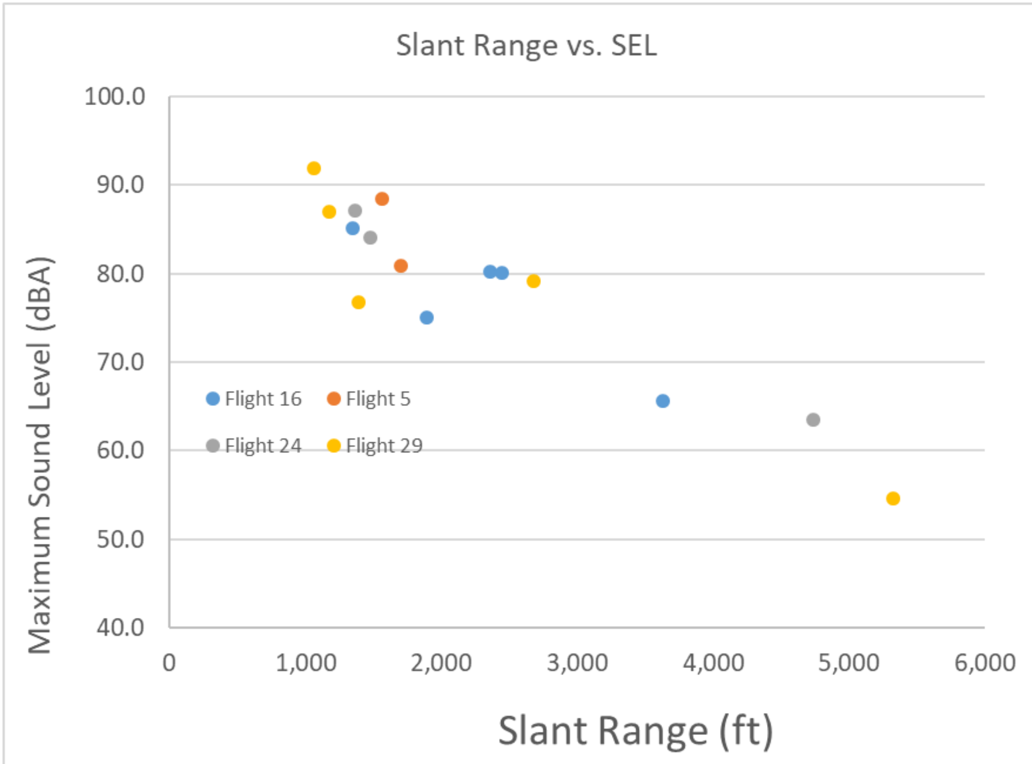

Figure 41. Sound Exposure Level vs slant distance to each monitoring location for the five selected flights.

4.2.2 Noise Exposure Modeling

The Advanced Acoustic Model (AAM) was used in conjunction with the 1-second tracking data to predict noise exposure from the as-flown arrivals for the Sikorsky S-76 to compare and 'ground-truth' the as-flown approach flight profiles. Modeling again utilized the noise source data (spheres) calculated by PSU. The noise exposure 'footprints' were generated using AAM for approach segments from the N2 waypoint to KHTO and sound exposure level metric. These are shown in Figure 42 through Figure 46.

A few notable differences can be extracted from these plots:

- The extent of the Flight 24 footprint is smaller, in agreement with the conclusion that this was most likely the best flight profile of the five, from a noise abatement perspective.
- The sound levels directly under the track of Flight 29 are somewhat lower, although the extent of the footprint is relatively large compared to the other flights

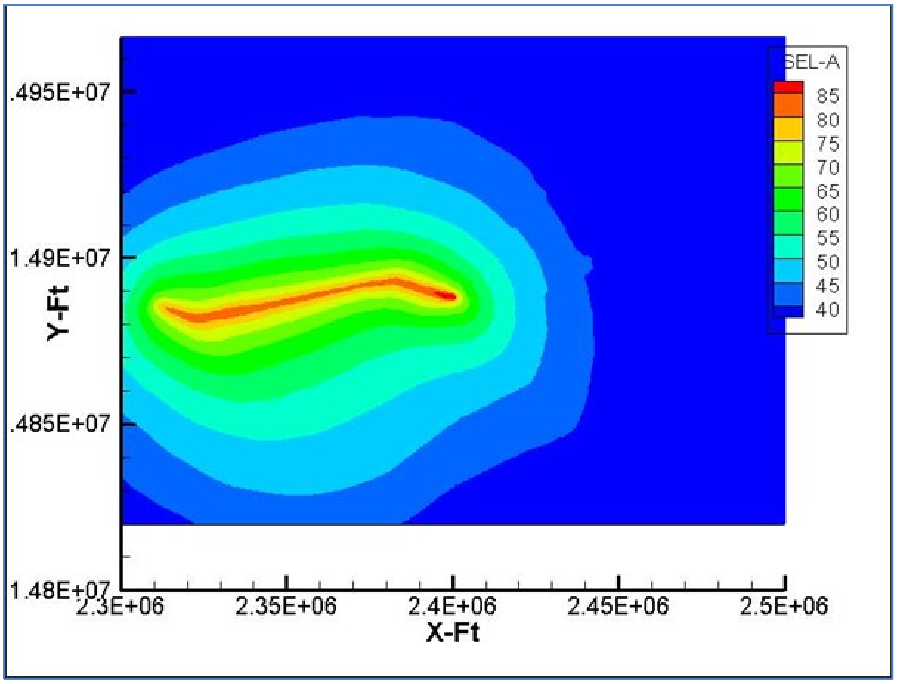

Figure 42. Flight 5 sound exposure level footprint

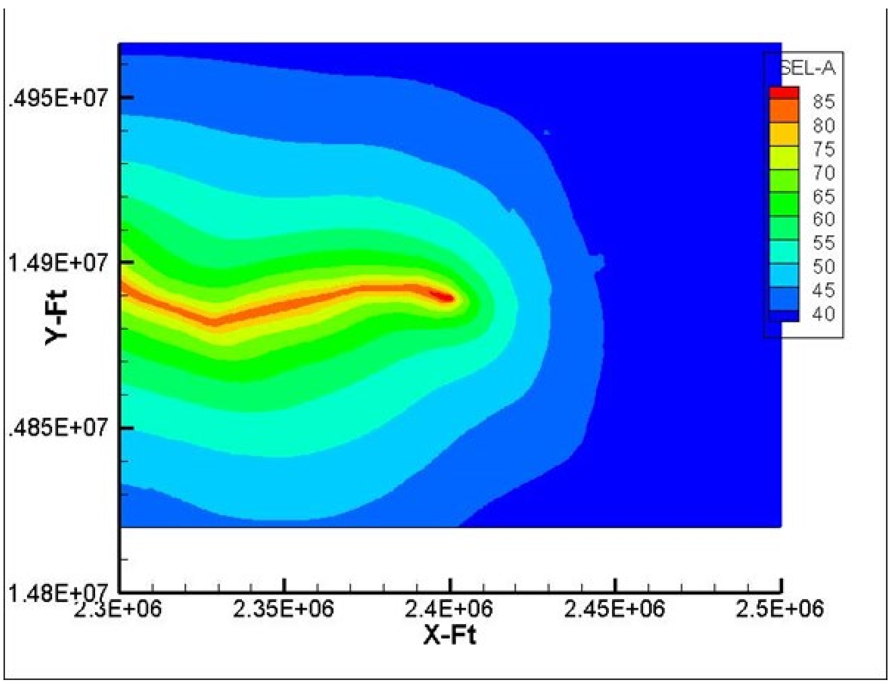

Figure 43. Flight 16 sound exposure level footprint

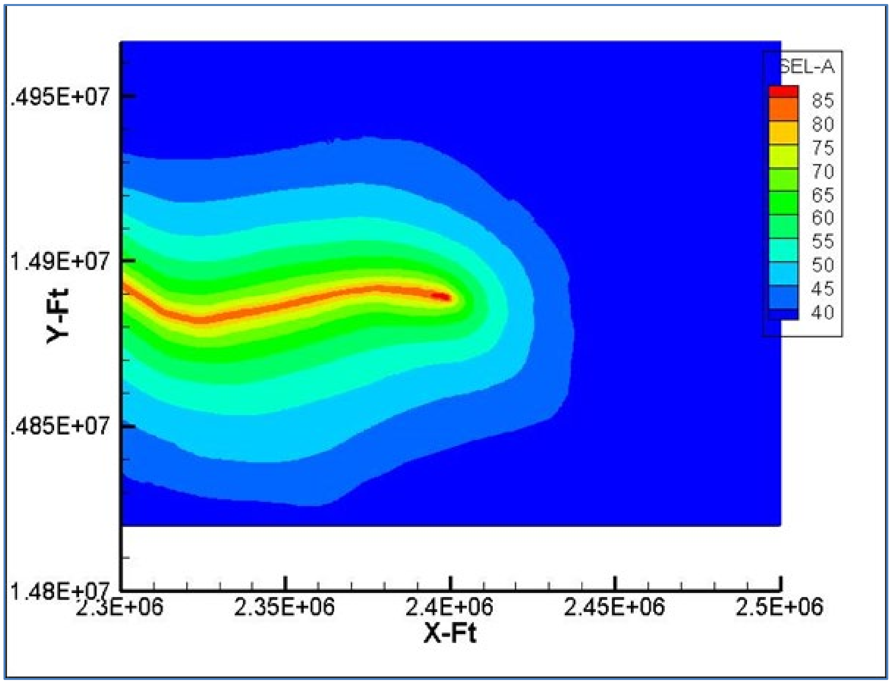

Figure 44. Flight 24 sound exposure level footprint

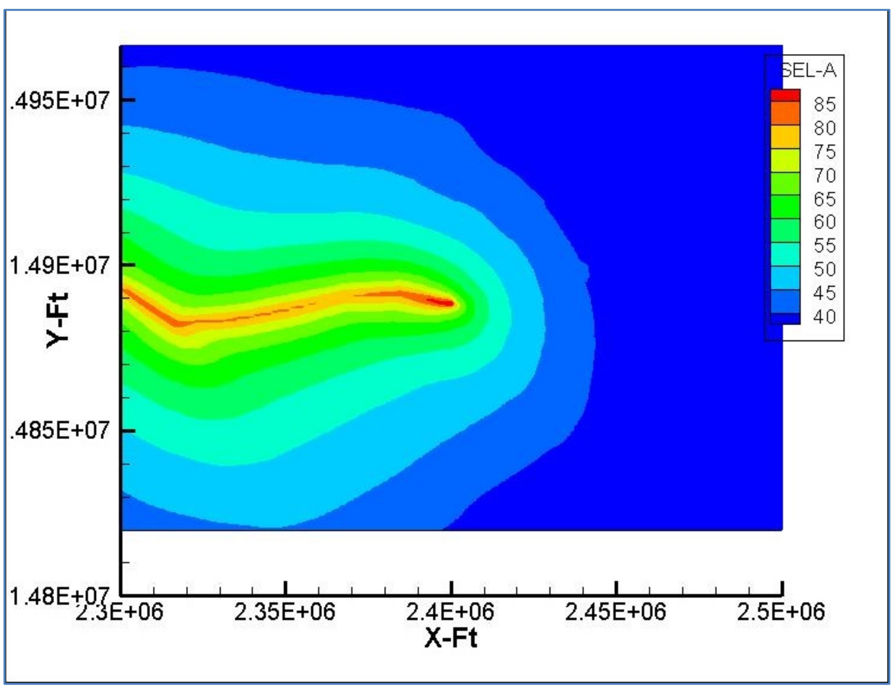

Figure 45. Flight 29 sound exposure level footprint

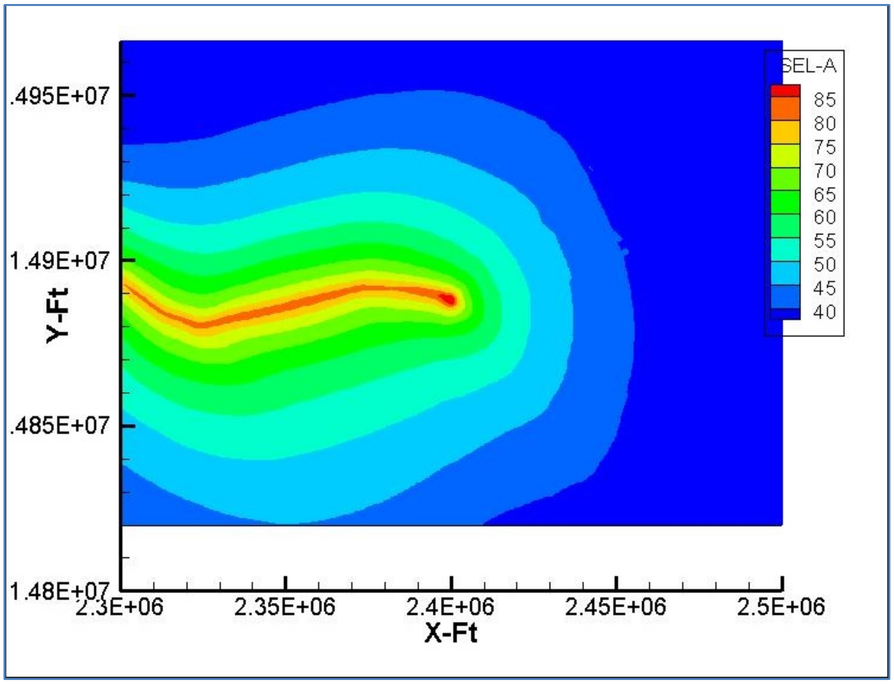

Figure 46. Flight 33 sound exposure level footprint

4.3 Development of Training and Outreach Materials

Based on the results and outcomes of the demonstration, it was agreed that a number of training and outreach materials would be developed from the experiences and documentation obtained. In particular, a cockpit noise overlay video with ground-based audio recordings was developed. This video demonstrates the noise generated on the ground (as a 'heatmap') for a particular flight as seen from the pilot's perspective. Figure 47 shows an example screenshot.

For development of items 1 and 2 (the cockpit overlay video and the acoustic animations), the AAM was used in conjunction with the 1-second tracking data to predict noise exposure from the as-flown arrivals for the Sikorsky S-76.

Figure 47. Example screenshot of cockpit noise overlay video. This video depicts an S-76 approach to KHTO.

For the cockpit overlay video, noise exposure footprints were generated at ½ second intervals and overlaid on the cockpit video footage, using knowledge of aircraft altitude, airspeed, pitch, and bank angle. The final video also makes use of the ground-based audio recordings, which form the basis of a video soundtrack, allowing viewers to both see the noise generated from the cockpit vantage and hear the noise generated as it is received on the ground. Markers were overlaid on the video footage to depict the location of the recording stations. The final video can be accessed on YouTube at https://youtu.be/GyMHk85MPYE.

5. Summary

Overall, the Fly Neighborly and iFlyQuiet Flight Procedures Demonstration went fairly well, particularly given the cloud ceiling constraints and VFR operational conditions. Although the recommended alternative approach procedures for the November noise abatement arrival route could not be performed because of the weather-restricted approach altitudes, field observations and aircraft tracking data were informative.

One conclusion of this test effort does stand out for developing and implementing noise abatement flight procedures for Fly Neighborly operations. The development of helicopter noise abatement procedures is typically focused on getting good-weather data measuring good-weather operational conditions. This is beneficial for establishing low noise flight conditions applicable only for good weather conditions, when in fact defining and testing low noise operations for bad weather conditions, including low cloud ceilings, may be equally if not more impactful in reducing noise complaints.

Broadly-applicable findings include:

- Flight operations are very dynamic and not nearly as prescribed or regular as they are for fixed wing operations.

- Operators are generally aware of basic Fly Neighborly (e.g. fly higher) but tend not to tailor specific procedures for noise outside of the existing published voluntary low noise procedures.
- Operators are open to guidance and suggestions and are willing to adapt with technical assistance. This may be able to be accomplished through additional outreach, training and guidance, which would need to be developed.
- Low Noise procedures are needed for situations with low ceiling VFR flight or where low altitudes are necessary (e.g., news-gathering, search-rescue).

KHTO-Specific Findings:

- Voluntary low noise flight procedures are followed when possible, but often weather conditions and/or ATC direction preclude their use.
- Poor weekend weather conditions (including rain) curtailed helicopter operations during demonstration, mitigating overall noise exposure. Worst case scenario, however, is low ceiling, no rain conditions that restrict altitudes during flight operations but do not significantly impact the number of operations.
- The voluntary November procedure is already a very steep angle final approach that requires high pilot workload to execute, especially under tailwind conditions. Alternative descent profiles could result in equal or lower noise and be easier to fly, improving both pilot workload and passenger comfort.

6. References

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Appendix A: 2018 East Hampton Airport Helicopter Arrival and Departure Routes

The following document is available from the Town of East Hampton at ehamptonny.gov.

Town of East Hampton Airport
P.O. Box 836
East Hampton, NY 11937
631.537.1130

May 10, 2018

Helicopter Noise Abatement

The following Helicopter Noise Abatement Procedures have been developed in collaboration with the East Hampton Control Tower, the Eastern Region Helicopter Council (ERHC), and East Hampton Airport Operations. These routes are strongly recommended in order to mitigate the noise associated with helicopter operations at HTO.

This plan has been selected to best relieve communities surrounding East Hampton Airport from the noise produced from Arriving and Departing helicopter traffic. While noise mitigation is extremely important, these procedures should in no way supersede the safe operation of aircraft. These procedures will be monitored for compliance at all checkpoints for accuracy of the route and recommended altitudes. The ERHC will receive weekly compliance reports.

November Arrival: (figure 2)

Arrivals from the west proceed to "November 1" (N40*57.37 W072*27.16) at or above 3500 feet, continue to "November 2" (N40*58.41 W072*20.43) at or above 3000 feet, to "November 3" (N40*58.14 W072*17.60) at or above 2500 feet, then to the airfield.

Sierra Route Arrivals and Departures for RWY 28 (figure 2)

Arrivals from the southwest fly along the south shore approximately half a mile offshore, via S2 (N40*52.30 W072*19.91) at 2,000 ft which is a point of converging traffic departing East Hampton Airport (HTO) on the Sierra Route.

Proceed past the mouth Georgica Pond to S3 (N40*55.32 W072*12.33) which is a flyover fix and enter a left base for Runway 28 or the parallel taxiway depending on the traffic at the airport and the direction of the air traffic controller.

Please hold your altitude as high as possible. Please look for fixed wing traffic in the traffic pattern or on approach to the airport. Overhead Georgica arrivals with spiraling descents on the north side of the airport are no longer expected and impede the safe flow of traffic on the north side of the airport.

Depart the airport via runway heading until passing 1,500 feet in the vicinity of S1 (N40.56.94 W072.19.64) then turn left to S2 (N40*52.30 W072*19.91) climbing to 3,000 feet BROC. After reaching S2, proceed westbound approximately a half mile off shore.

Sierra Route Arrivals and Departures for RWY 10 (figure 3)

When the winds are out of the East and the airport is utilizing RWY 10, the Sierra Route will be reversed.

Inbound aircraft will fly to S2 (40*52.30 W072*19.91) at 2,000ft then enter a right base for Runway 10. Remaining South of RWY 10 aiming for the approach of RWY 4 and listen for specific ATC instructions before crossing the runway to the north side of the runway.

Out bound traffic will depart into the wind to the East BROC to 1,500ft and when cleared by the tower, turn a right crosswind towards S3 (40*55.32 W072*12.33). After proceed west bound climbing to 3,000ft looking for inbound traffic to S2.

Echo Departure: (figure 4)

Depart heading northwest over the power lines to "Echo 1" (N40*58.03 W072*16.28). Turn right, remaining well east of Town Line Road and proceed to the East side of Barcelona Neck "Echo 2" (N41*00.76 W072*15.29). "Echo 2" is a mandatory flyover point. Please keep your tracks away from the village of Sag Harbor. Use max performance climb so as to cross Barcelona Neck at or above 3000 ft. MSL. Proceed then to "Echo 3" (N41*02.63 W072*18.31) and then to "Echo 4" (N41*01.26 W072*22.58). Please avoid any over flight of Shelter Island and North Haven.

PLEASE NOTE:

The success of noise abatement depends on the requested routes and altitudes being observed with precision to the greatest extent possible.

Pathways depicted on the map are for illustration only and may not conform precisely to coordinates.

The Control Tower will advise pilots of traffic conflicts on each of the voluntary helicopter routes and will retain the option of issuing arrival and departure instructions as traffic permits.

East Hampton Airport Curfews *(Emergency Ops Exempt)*:

Please adhere to the voluntary curfew: 2300 – 0700

Ramp Operations

All arrivals and departures to HTO should be to and from active runways or parallel taxiways so as not to interfere with fixed wing traffic. Approaches and departures directly to and from the **Terminal Ramp** area are **prohibited.**

No part of a helicopter, **including rotor tips**, is to come closer than **100 feet** to the Terminal building. Parking spot 1 in front of the Terminal Building is reserved for fixed wing aircraft only.

Boarding and deplaning a helicopter with the rotors turning should be avoided. Use of a rotor brake, if installed is encouraged. **All passengers boarding or deplaning shall have an escort to and from the terminal or designated marshalling area.**

Operating rotors for an extended period of time on the ramp is discouraged. **More than ten (10) minutes is considered excessive.** Your cooperation with this limit is for noise and environmental considerations. Passengers who demand rotors turning when they arrive should be informed of this limit. If it is necessary to operate engines and/or rotors for extended periods of time, please move to one of the transient helicopter pads or as far from the Terminal Building as possible.

Other Considerations

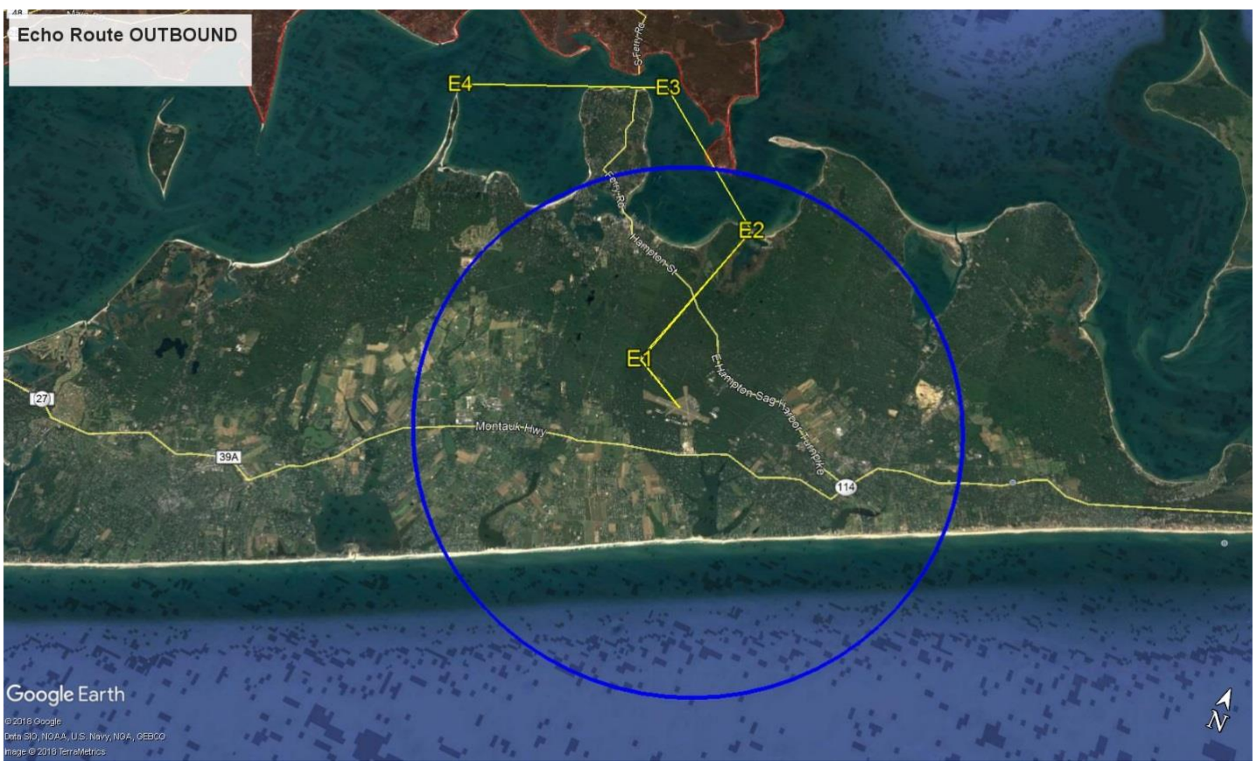
Helicopter operations are the most serious environmental challenges we have at HTO. Anything you can do to mitigate the environmental impact of your operations will be greatly appreciated by this office and the surrounding communities.

Non -Towered Operations: The area surrounding HTO has substantial air traffic during the summer months, some of which may have neither a radio nor transponder. Adherence to the suggested routes reduces the potential for conflicts but does not eliminate it. Frequent announcements of position, altitude and intended route are strongly encouraged. ***See and Avoid*** is paramount, all available aircraft lights should be illuminated day or night. Coordination with or monitoring of New York approach frequency is recommended to help avoid IFR traffic that may otherwise appear suddenly from IMC conditions.

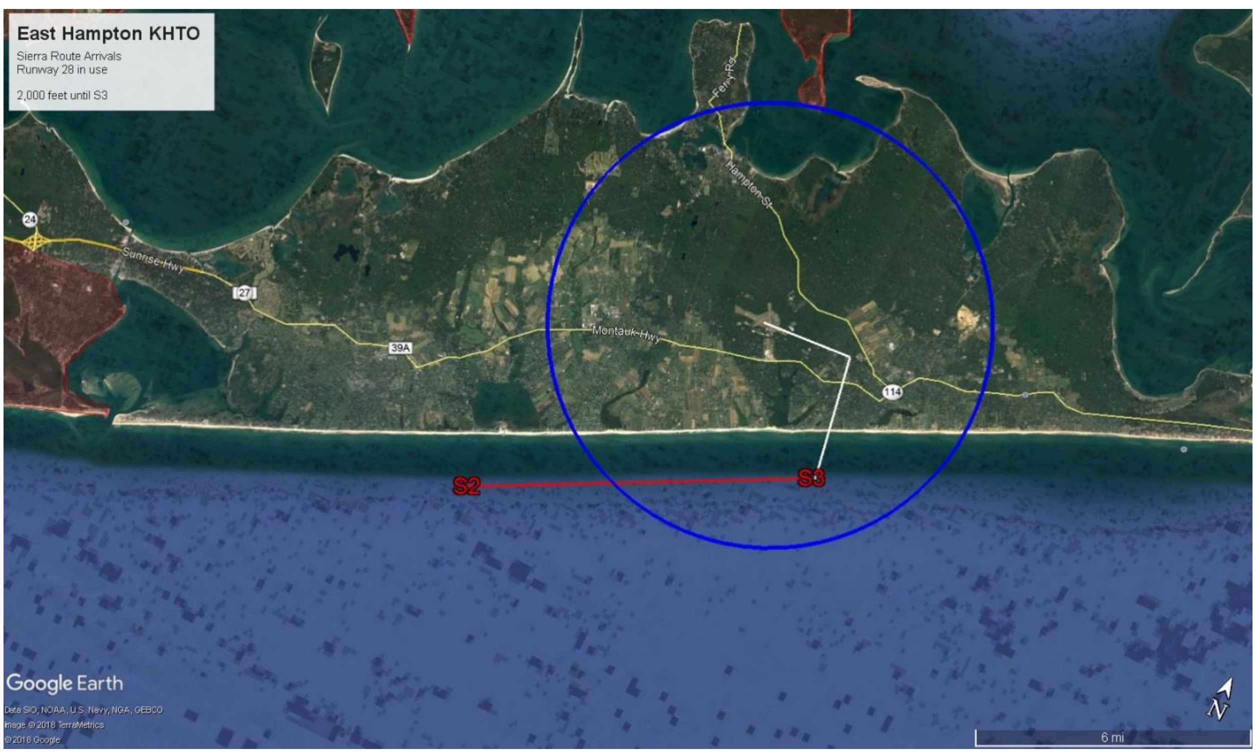
Sincerely,

James L. Brundige
Airport Director


East Hampton KHTO
November Route
INBOUND ONLY
C1 3,500
C2 3,500
N1 3,500
N2 3,000
N3 2,500
FOK
Google Earth
8 mi
N


Echo Route OUTBOUND
E4
E3
E2
E1
Google Earth
N


East Hampton KHTO
Echo Route
East Extension
For choppers weighing more than 6,000 lbs
BROC to above 3,000 feet.
A2
A1
E2
E1
Google Earth
9 mi


East Hampton KHTO
Sierra Route Arrivals
Runway 28 in use
2,000 feet until S3
S2
S3
Google Earth
6 mi


East Hampton KHTO
Sierra Route Inbound
Runway 10 in use
2000ft to S2 then descending approach to S1. ATC will clear you across the runway.
Fair Rd
Hampton St
Sunrise Hwy
Montauk Hwy
24
27
39A
114
S1
S2
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2018 TerraMetrics
© 2018 Google
N
6 mi


East Hampton KHTO
Sierra Route Departures
Runway 28 in use
BROC to 1,500ft at S1 then 2,000ft at S2
Fair Rd
Hampton St
Sunrise Hwy
Montauk Hwy
24
27
39A
114
S1
S2
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2018 TerraMetrics
© 2018 Google
N
6 mi


East Hampton KHTO
Sierra Route Outbound
Runway 10 in use
BROC to 1,500. ATC will call your right turn to cross the extended center line of RWY 10 then BROC to 2,000 to S3 and S2.
Sunrise Hwy
27
39A
Montauk Hwy
114
Hampton St
S Ferry Rd
S2
S3
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2018 TerraMetrics
© 2018 Google
6 mi
N

Appendix B: AAM Analysis of November Arrival Routes

This Appendix contains figures which summarize the noise exposure predictions made to evaluate the noise benefits of the four modified procedures (Nov-1, Nov-2, Nov-1alt and Nov-2alt) compared to the current November procedure (Nov 0). AAM was used to predict the maximum sound level and sound exposure level at locations under the predicted flight track and at lateral points 1000, 2000 and 3000 ft to the North (N) and South (S) of the flight track (Figure 48). This analysis included evaluations of the locations along the high speed (blue), middle (green) and approach (yellow) segments for two aircraft speeds, 120 and 140 kt.

Figure 48. AAM Analysis locations (lateral points) 1000, 2000 and 3000 ft to the North (N) and South (S) of the flight track during 'high speed', 'middle' and 'approach' segments of November Noise Abatement Arrival Route

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.61	81.8	82.57
HS-2N	58.95	66.03	66.24	74.09	83.3	83.88
HS-1N	60.52	68.3	68.45	75.62	84.6	85.1
HS-0	61.37	69.74	69.87	76.5	85.68	86.15
HS1-1S	61.14	69.99	70.2	76.18	85.93	86.44
HS1-2S	59.95	69.33	69.64	75.07	85.22	85.86
HS-3S	55.8	67.07	67.85	72.36	83.72	84.65
Mid-3N	57.2	64.92	65.32	73.01	82.96	83.7
Mid-2N Hic	59.65	68.77	69.04	75.3	85.1	85.68
Mid-1N	63.07	71.3	71.5	77.6	87.16	87.62
Mid-0	63.73	73.38	73.57	78.77	88.66	89.08
Mid-1S	64.04	74.6	74.81	78.55	89.5	89.93
Mid-2S	61.7	72.35	72.69	76.9	88.03	88.64
Mid-3S	59.59	70.72	71.37	75.05	86.44	87.28
App-3N	57.38	62.58	63.1	73.66	82.46	83.44
App-2N	62.43	67.15	67.4	76.95	84.73	85.55
App-1N	67.36	72.71	72.83	80.62	87.88	88.5
App-0	69.71	76.47	76.61	82.27	90.7	91.22
App-0aS Li	69.49	76.8	76.98	81.72	90.94	91.51
App-1S	66.08	74.9	75.4	79.89	89.66	90.45
App-2S	61.85	70	71.31	76.37	86.96	88.12
App-3S	56.81	67.86	69.41	73.38	85.07	86.39

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.79	65	65.72	73.09	83.19	83.97
HS-2N	59.36	67.78	68.15	75.47	84.68	85.3
HS-1N	62.77	70.71	70.93	77.32	86.14	86.63
HS-0	64.41	72.21	72.43	78.24	87.01	87.47
HS1-1S	63.23	71.71	71.93	77.75	87.18	87.74
HS1-2S	60.41	69.7	69.98	76.13	86.57	87.32
HS-3S	56.15	67.11	68.02	73.47	85.74	86.8
Mid-3N	58.38	65.67	65.9	73.77	83.79	84.52
Mid-2N Hi	59.64	68.1	68.38	75.66	85.45	86.06
Mid-1N	62.71	70.88	71.12	77.58	87.26	87.8
Mid-0	63.84	73.16	73.35	78.7	88.68	89.16
Mid-1S	64.15	74.91	75.15	78.47	89.59	90.12
Mid-2S	62.78	73.54	74.01	76.85	88.65	89.37
Mid-3S	59.82	70.68	71.51	75.07	87.37	88.28
App-3N	57.38	62.58	63.38	73.81	83.43	84.41
App-2N	62.43	67.15	67.4	77.05	85.42	86.25
App-1N	67.36	72.71	72.83	80.67	88.24	88.88
App-0	69.71	76.47	76.61	82.31	90.92	91.44
App-0aS Li	69.49	76.8	76.98	81.76	91.15	91.72
App-1S	66.08	74.9	75.4	79.93	89.92	90.7
App-2S	61.85	70	71.31	76.41	87.44	88.58
App-3S	56.81	67.86	69.41	73.47	85.84	87.11

Figure 49. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 route, 120 kt airspeed (left pane) and 140 kt airspeed (right pane)

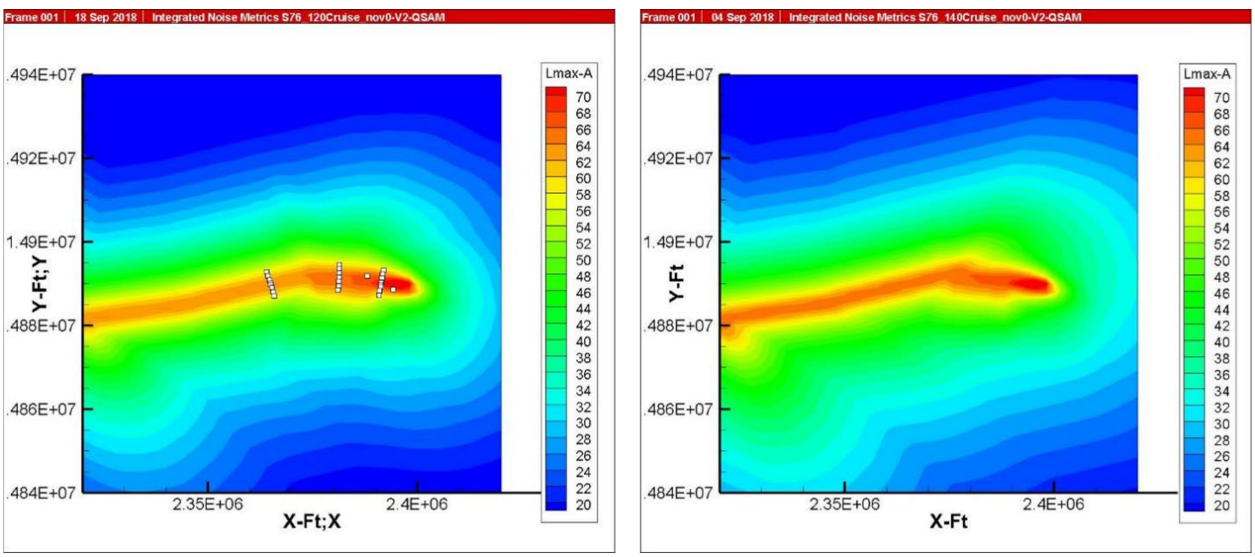


Figure 50. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 route, 120 kt airspeed (left pane) and 140 kt airspeed (right pane)

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.61	81.8	82.57
HS-2N	58.95	66.03	66.24	74.09	83.3	83.88
HS-1N	60.52	68.3	68.45	75.62	84.6	85.1
HS-0	61.37	69.74	69.87	76.5	85.68	86.15
HS1-1S	61.14	69.99	70.2	76.18	85.93	86.44
HS1-2S	59.95	69.33	69.64	75.07	85.22	85.86
HS-3S	55.8	67.07	67.85	72.36	83.72	84.65
Mid-3N	57.2	64.92	65.32	73.01	82.96	83.7
Mid-2N Hic	59.65	68.77	69.04	75.3	85.1	85.68
Mid-1N	63.07	71.3	71.5	77.6	87.16	87.62
Mid-0	63.73	73.38	73.57	78.77	88.66	89.08
Mid-1S	64.04	74.6	74.81	78.55	89.5	89.93
Mid-2S	61.7	72.35	72.69	76.9	88.03	88.64
Mid-3S	59.59	70.72	71.37	75.05	86.44	87.28
App-3N	57.38	62.58	63.1	73.66	82.46	83.44
App-2N	62.43	67.15	67.4	76.95	84.73	85.55
App-1N	67.36	72.71	72.83	80.62	87.88	88.5
App-0	69.71	76.47	76.61	82.27	90.7	91.22
App-0aS Li	69.49	76.8	76.98	81.72	90.94	91.51
App-1S	66.08	74.9	75.4	79.89	89.66	90.45
App-2S	61.85	70	71.31	76.37	86.96	88.12
App-3S	56.81	67.86	69.41	73.38	85.07	86.39

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.55	81.68	82.45
HS-2N	58.95	66.03	66.24	74.04	83.14	83.72
HS-1N	60.52	68.3	68.45	75.58	84.44	84.93
HS-0	61.37	69.74	69.87	76.46	85.55	86.02
HS1-1S	61.14	69.99	70.2	76.14	85.83	86.33
HS1-2S	59.95	69.33	69.64	75.02	85.13	85.76
HS-3S	55.8	67.07	67.85	72.29	83.61	84.54
Mid-3N	55.45	64.17	64.4	72.81	82.52	83.2
Mid-2N Hi	59.71	67.76	67.94	75.17	84.29	84.81
Mid-1N	60.3	69	69.16	76.36	85.59	86.06
Mid-0	61.22	70.52	70.67	76.95	86.51	86.96
Mid-1S	60.66	70.18	70.37	76.31	86.4	86.9
Mid-2S	58.79	69.03	69.32	74.68	85.22	85.9
Mid-3S	56.76	67.03	67.56	72.86	84.04	84.95
App-3N	57.11	62.25	62.81	74.45	82.55	83.46
App-2N	62.24	67	67.23	77.89	85.01	85.74
App-1N	67.38	72.53	72.63	81.67	88.34	88.84
App-0	70.05	76.26	76.39	83.23	91.24	91.68
App-0aS Li	69.52	76.66	76.81	82.6	91.41	91.9
App-1S	65.8	73.92	74.27	80.73	89.94	90.64
App-2S	61.59	68.84	69.91	76.99	86.89	88.04
App-3S	56.6	66.6	68.05	73.85	84.9	86.27

Figure 51. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 1 (right pane) routes, 120 kt airspeed

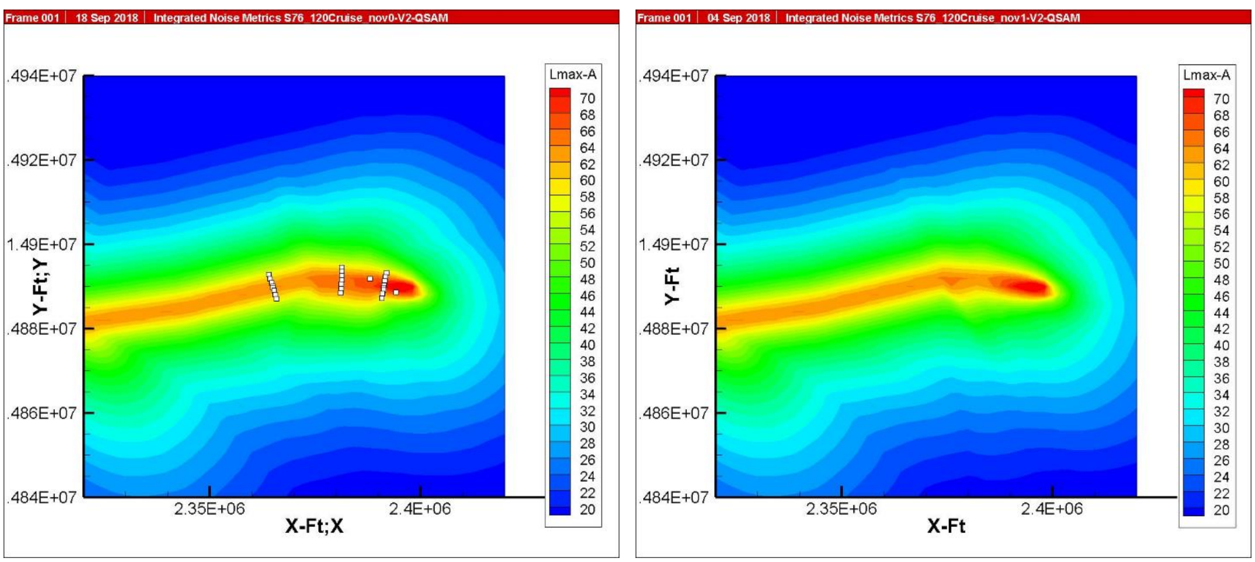


Figure 52. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 1 (right pane) routes, 120 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.61	81.8	82.57
HS-2N	58.95	66.03	66.24	74.09	83.3	83.88
HS-1N	60.52	68.3	68.45	75.62	84.6	85.1
HS-0	61.37	69.74	69.87	76.5	85.68	86.15
HS1-1S	61.14	69.99	70.2	76.18	85.93	86.44
HS1-2S	59.95	69.33	69.64	75.07	85.22	85.86
HS-3S	55.8	67.07	67.85	72.36	83.72	84.65
Mid-3N	57.2	64.92	65.32	73.01	82.96	83.7
Mid-2N Hic	59.65	68.77	69.04	75.3	85.1	85.68
Mid-1N	63.07	71.3	71.5	77.6	87.16	87.62
Mid-0	63.73	73.38	73.57	78.77	88.66	89.08
Mid-1S	64.04	74.6	74.81	78.55	89.5	89.93
Mid-2S	61.7	72.35	72.69	76.9	88.03	88.64
Mid-3S	59.59	70.72	71.37	75.05	86.44	87.28
App-3N	57.38	62.58	63.1	73.66	82.46	83.44
App-2N	62.43	67.15	67.4	76.95	84.73	85.55
App-1N	67.36	72.71	72.83	80.62	87.88	88.5
App-0	69.71	76.47	76.61	82.27	90.7	91.22
App-0aS Li	69.49	76.8	76.98	81.72	90.94	91.51
App-1S	66.08	74.9	75.4	79.89	89.66	90.45
App-2S	61.85	70	71.31	76.37	86.96	88.12
App-3S	56.81	67.86	69.41	73.38	85.07	86.39

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.4	63.33	63.88	71.48	82.37	83.2
HS-2N	58.94	66.1	66.33	73.91	83.67	84.31
HS-1N	60.51	68.34	68.49	75.43	84.86	85.4
HS-0	61.39	70.31	70.51	76.37	86.03	86.52
HS1-1S	61.34	71.07	71.28	76.15	86.41	86.92
HS1-2S	60.78	70.63	70.89	75.21	85.89	86.51
HS-3S	57.27	68.6	69.16	72.72	84.61	85.47
Mid-3N	55.45	64.17	64.4	72.73	82.71	83.43
Mid-2N Hi	59.71	67.76	67.94	75.1	84.4	84.96
Mid-1N	60.3	69	69.16	76.29	85.67	86.17
Mid-0	61.22	70.52	70.67	76.89	86.58	87.05
Mid-1S	60.66	70.18	70.37	76.24	86.45	86.98
Mid-2S	58.79	69.03	69.32	74.61	85.32	86.01
Mid-3S	56.76	67.03	67.56	72.81	84.18	85.11
App-3N	57.36	62.49	62.91	73.7	82.29	83.24
App-2N	62.02	67.04	67.26	76.93	84.56	85.35
App-1N	66.93	72.11	72.21	80.43	87.54	88.11
App-0	69.2	75.58	75.71	81.92	90.19	90.67
App-0aS Li	68.82	76.03	76.18	81.43	90.47	91
App-1S	65.33	74.01	74.35	79.9	89.41	90.13
App-2S	61.29	69.17	70.15	76.48	86.67	87.8
App-3S	56.53	66.41	67.88	73.52	84.76	86.08

Figure 53. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 1-alt (right pane) routes, 120 kt airspeed

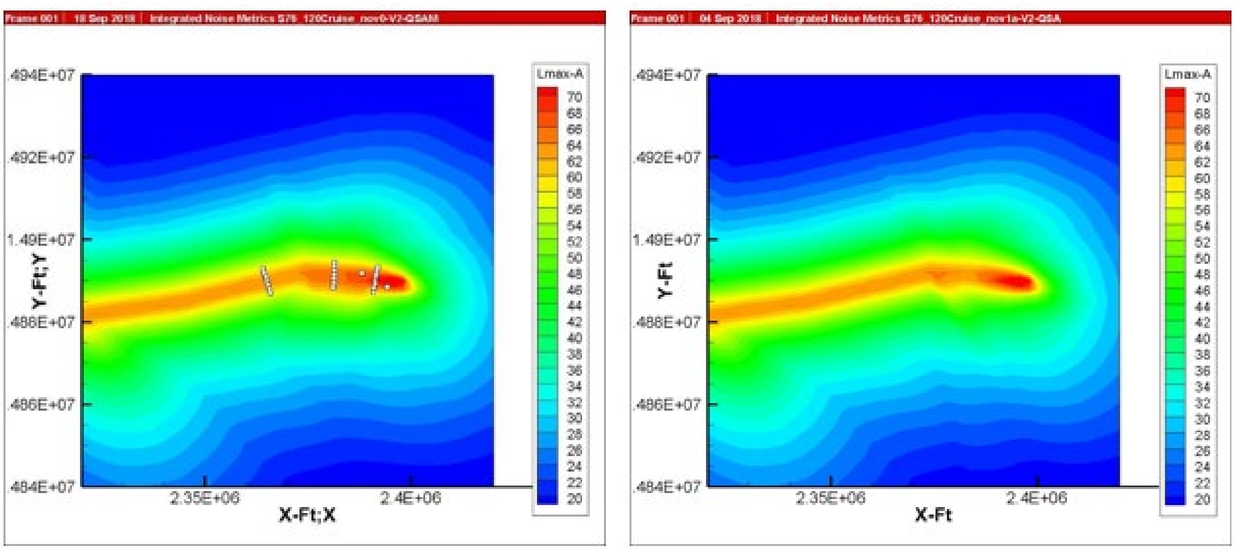


Figure 54. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 1-alt (right pane) routes, 120 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.61	81.8	82.57
HS-2N	58.95	66.03	66.24	74.09	83.3	83.88
HS-1N	60.52	68.3	68.45	75.62	84.6	85.1
HS-0	61.37	69.74	69.87	76.5	85.68	86.15
HS1-1S	61.14	69.99	70.2	76.18	85.93	86.44
HS1-2S	59.95	69.33	69.64	75.07	85.22	85.86
HS-3S	55.8	67.07	67.85	72.36	83.72	84.65
Mid-3N	57.2	64.92	65.32	73.01	82.96	83.7
Mid-2N Hic	59.65	68.77	69.04	75.3	85.1	85.68
Mid-1N	63.07	71.3	71.5	77.6	87.16	87.62
Mid-0	63.73	73.38	73.57	78.77	88.66	89.08
Mid-1S	64.04	74.6	74.81	78.55	89.5	89.93
Mid-2S	61.7	72.35	72.69	76.9	88.03	88.64
Mid-3S	59.59	70.72	71.37	75.05	86.44	87.28
App-3N	57.38	62.58	63.1	73.66	82.46	83.44
App-2N	62.43	67.15	67.4	76.95	84.73	85.55
App-1N	67.36	72.71	72.83	80.62	87.88	88.5
App-0	69.71	76.47	76.61	82.27	90.7	91.22
App-0aS Li	69.49	76.8	76.98	81.72	90.94	91.51
App-1S	66.08	74.9	75.4	79.89	89.66	90.45
App-2S	61.85	70	71.31	76.37	86.96	88.12
App-3S	56.81	67.86	69.41	73.38	85.07	86.39

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.61	81.87	82.65
HS-2N	58.95	66.03	66.24	74.08	83.26	83.85
HS-1N	60.52	68.3	68.45	75.62	84.52	85.02
HS-0	61.37	69.74	69.87	76.5	85.62	86.09
HS1-1S	61.14	69.99	70.2	76.19	85.9	86.4
HS1-2S	59.95	69.33	69.64	75.08	85.2	85.83
HS-3S	55.8	67.07	67.85	72.37	83.7	84.63
Mid-3N	57.52	66.44	66.66	74.32	84.01	84.67
Mid-2N Hi	61.57	69.31	69.46	76.54	85.77	86.34
Mid-1N	63.44	73.99	74.2	78.19	88.56	88.99
Mid-0	64.24	74.45	74.64	78.84	89.57	89.97
Mid-1S	63.15	72.7	72.93	78.32	88.65	89.16
Mid-2S	60.84	71.28	71.77	76.63	87.71	88.38
Mid-3S	58.56	69.06	69.84	75.16	86.43	87.29
App-3N	57.09	62.28	62.83	73.59	82.16	83.16
App-2N	62.16	67.03	67.27	77.01	84.57	85.4
App-1N	67.39	72.55	72.66	80.77	87.75	88.34
App-0	69.79	76.24	76.36	82.35	90.59	91.08
App-0aS Li	69.52	76.65	76.8	81.77	90.82	91.37
App-1S	65.72	74.18	74.58	79.93	89.48	90.26
App-2S	61.62	68.98	70.14	76.2	86.61	87.82
App-3S	56.58	66.64	68.14	73.18	84.72	86.1

Figure 55. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 2 (right pane) routes, 120 kt airspeed

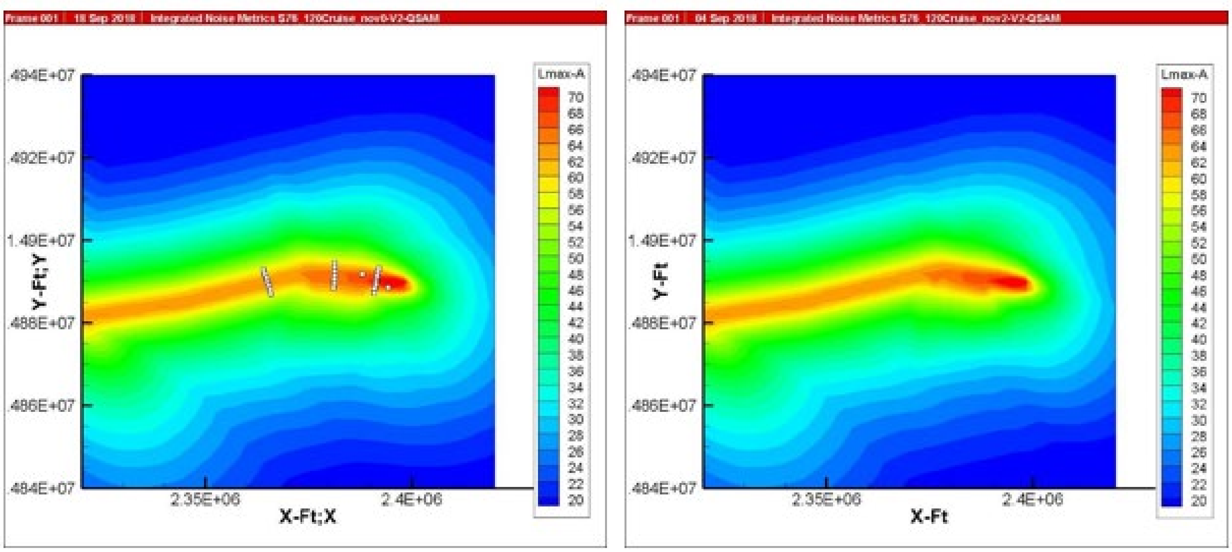


Figure 56. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 2 (right pane) routes, 120 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.38	63.24	63.76	71.61	81.8	82.57
HS-2N	58.95	66.03	66.24	74.09	83.3	83.88
HS-1N	60.52	68.3	68.45	75.62	84.6	85.1
HS-0	61.37	69.74	69.87	76.5	85.68	86.15
HS1-1S	61.14	69.99	70.2	76.18	85.93	86.44
HS1-2S	59.95	69.33	69.64	75.07	85.22	85.86
HS-3S	55.8	67.07	67.85	72.36	83.72	84.65
Mid-3N	57.2	64.92	65.32	73.01	82.96	83.7
Mid-2N Hic	59.65	68.77	69.04	75.3	85.1	85.68
Mid-1N	63.07	71.3	71.5	77.6	87.16	87.62
Mid-0	63.73	73.38	73.57	78.77	88.66	89.08
Mid-1S	64.04	74.6	74.81	78.55	89.5	89.93
Mid-2S	61.7	72.35	72.69	76.9	88.03	88.64
Mid-3S	59.59	70.72	71.37	75.05	86.44	87.28
App-3N	57.38	62.58	63.1	73.66	82.46	83.44
App-2N	62.43	67.15	67.4	76.95	84.73	85.55
App-1N	67.36	72.71	72.83	80.62	87.88	88.5
App-0	69.71	76.47	76.61	82.27	90.7	91.22
App-0aS Li	69.49	76.8	76.98	81.72	90.94	91.51
App-1S	66.08	74.9	75.4	79.89	89.66	90.45
App-2S	61.85	70	71.31	76.37	86.96	88.12
App-3S	56.81	67.86	69.41	73.38	85.07	86.39

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	50.63	58.68	59.25	68.56	79.56	80.54
HS-2N	54.38	61.55	61.84	70.83	80.85	81.7
HS-1N	56.75	64.94	65.15	72.8	82.58	83.27
HS-0	59.76	67.27	67.47	74.93	84.11	84.67
HS1-1S	60.4	68.65	68.81	76.07	85.32	85.82
HS1-2S	60.69	69.9	70.07	76.46	86.02	86.53
HS-3S	60.18	69.15	69.33	75.72	85.75	86.33
Mid-3N	54.5	62.06	62.46	71.45	80.99	81.78
Mid-2N Hi	56.88	64.85	65.06	73.32	82.6	83.27
Mid-1N	59.89	66.78	67	75.39	84.38	84.97
Mid-0	60.3	68.7	68.94	76.47	85.72	86.28
Mid-1S	60.49	68.67	68.84	76.59	86.11	86.68
Mid-2S	60.11	68.69	68.91	75.94	85.85	86.49
Mid-3S	56.79	66.9	67.33	73.72	84.54	85.38
App-3N	57.33	62.45	62.85	73.85	82.08	83.05
App-2N	62.03	67.05	67.27	77.12	84.43	85.2
App-1N	66.87	72.11	72.21	80.65	87.51	88.04
App-0	69.26	75.59	75.72	82.11	90.21	90.66
App-0aS Li	68.83	76.01	76.15	81.61	90.45	90.95
App-1S	65.3	73.8	74.1	80.07	89.31	89.99
App-2S	61.28	68.78	69.73	76.55	86.36	87.5
App-3S	56.54	66.38	67.81	73.44	84.27	85.65

Figure 57. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 2-alt (right pane) routes, 120 kt airspeed

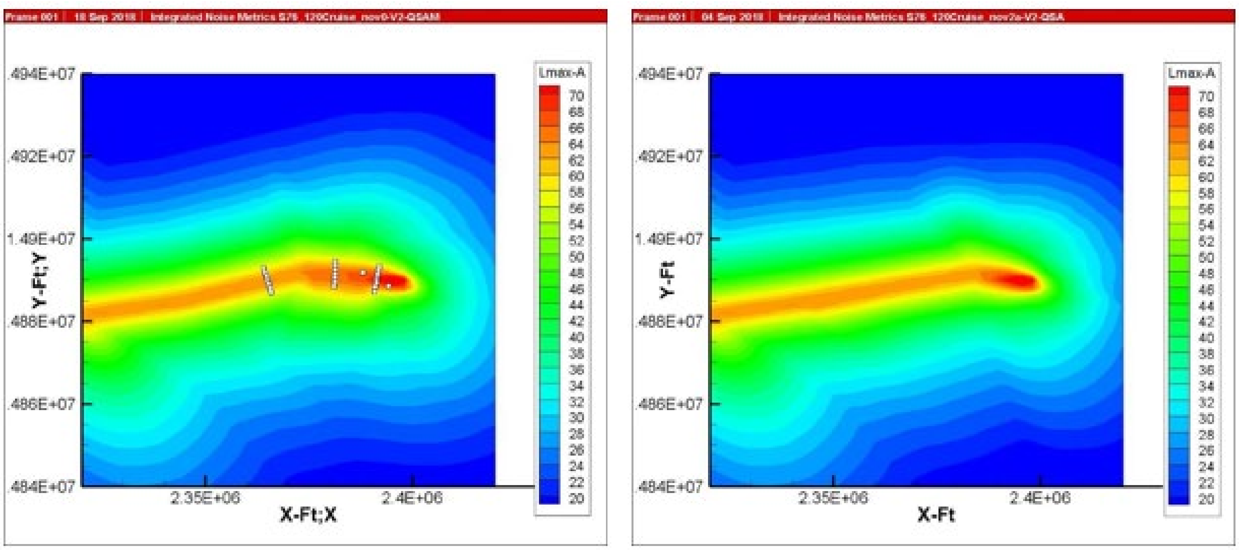


Figure 58. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 2-alt (right pane) routes, 120 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.79	65	65.72	73.09	83.19	83.97
HS-2N	59.36	67.78	68.15	75.47	84.68	85.3
HS-1N	62.77	70.71	70.93	77.32	86.14	86.63
HS-0	64.41	72.21	72.43	78.24	87.01	87.47
HS1-1S	63.23	71.71	71.93	77.75	87.18	87.74
HS1-2S	60.41	69.7	69.98	76.13	86.57	87.32
HS-3S	56.15	67.11	68.02	73.47	85.74	86.8
Mid-3N	58.38	65.67	65.9	73.77	83.79	84.52
Mid-2N Hi	59.64	68.1	68.38	75.66	85.45	86.06
Mid-1N	62.71	70.88	71.12	77.58	87.26	87.8
Mid-0	63.84	73.16	73.35	78.7	88.68	89.16
Mid-1S	64.15	74.91	75.15	78.47	89.59	90.12
Mid-2S	62.78	73.54	74.01	76.85	88.65	89.37
Mid-3S	59.82	70.68	71.51	75.07	87.37	88.28
App-3N	57.38	62.58	63.38	73.81	83.43	84.41
App-2N	62.43	67.15	67.4	77.05	85.42	86.25
App-1N	67.36	72.71	72.83	80.67	88.24	88.88
App-0	69.71	76.47	76.61	82.31	90.92	91.44
App-0aS Li	69.49	76.8	76.98	81.76	91.15	91.72
App-1S	66.08	74.9	75.4	79.93	89.92	90.7
App-2S	61.85	70	71.31	76.41	87.44	88.58
App-3S	56.81	67.86	69.41	73.47	85.84	87.11

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.4	63.33	63.88	71.48	82.38	83.2
HS-2N	58.94	66.1	66.33	73.91	83.67	84.31
HS-1N	60.51	68.34	68.49	75.44	84.86	85.4
HS-0	61.39	70.31	70.51	76.37	86.03	86.52
HS1-1S	61.34	71.07	71.28	76.15	86.41	86.92
HS1-2S	60.78	70.63	70.89	75.21	85.89	86.51
HS-3S	57.27	68.6	69.16	72.72	84.62	85.47
Mid-3N	55.45	64.17	64.4	72.82	82.77	83.47
Mid-2N Hi	59.71	67.76	67.94	75.18	84.45	85
Mid-1N	60.3	69	69.16	76.36	85.72	86.2
Mid-0	61.22	70.52	70.67	76.96	86.62	87.08
Mid-1S	60.66	70.18	70.37	76.31	86.51	87.03
Mid-2S	58.79	69.03	69.32	74.69	85.38	86.07
Mid-3S	56.76	67.03	67.56	72.89	84.26	85.17
App-3N	57.11	62.25	62.81	74.46	82.69	83.61
App-2N	62.24	67	67.23	77.89	85.09	85.83
App-1N	67.38	72.53	72.63	81.67	88.38	88.88
App-0	70.05	76.26	76.39	83.23	91.26	91.7
App-0aS Li	69.52	76.66	76.81	82.6	91.43	91.93
App-1S	65.8	73.92	74.27	80.73	89.97	90.67
App-2S	61.59	68.84	69.91	76.99	86.95	88.1
App-3S	56.6	66.6	68.05	73.86	85	86.36

Figure 59. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 1 (right pane) routes, 140 kt airspeed

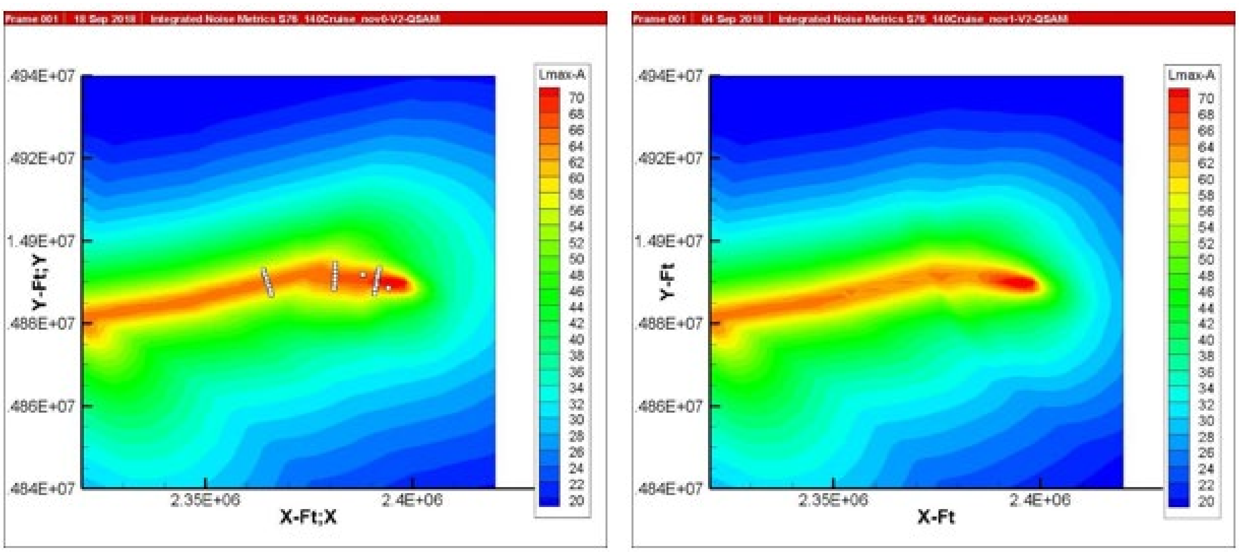


Figure 60. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 1 (right pane) routes, 140 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.79	65	65.72	73.09	83.19	83.97
HS-2N	59.36	67.78	68.15	75.47	84.68	85.3
HS-1N	62.77	70.71	70.93	77.32	86.14	86.63
HS-0	64.41	72.21	72.43	78.24	87.01	87.47
HS1-1S	63.23	71.71	71.93	77.75	87.18	87.74
HS1-2S	60.41	69.7	69.98	76.13	86.57	87.32
HS-3S	56.15	67.11	68.02	73.47	85.74	86.8
Mid-3N	58.38	65.67	65.9	73.77	83.79	84.52
Mid-2N Hi	59.64	68.1	68.38	75.66	85.45	86.06
Mid-1N	62.71	70.88	71.12	77.58	87.26	87.8
Mid-0	63.84	73.16	73.35	78.7	88.68	89.16
Mid-1S	64.15	74.91	75.15	78.47	89.59	90.12
Mid-2S	62.78	73.54	74.01	76.85	88.65	89.37
Mid-3S	59.82	70.68	71.51	75.07	87.37	88.28
App-3N	57.38	62.58	63.38	73.81	83.43	84.41
App-2N	62.43	67.15	67.4	77.05	85.42	86.25
App-1N	67.36	72.71	72.83	80.67	88.24	88.88
App-0	69.71	76.47	76.61	82.31	90.92	91.44
App-0a5 Li	69.49	76.8	76.98	81.76	91.15	91.72
App-1S	66.08	74.9	75.4	79.93	89.92	90.7
App-2S	61.85	70	71.31	76.41	87.44	88.58
App-3S	56.81	67.86	69.41	73.47	85.84	87.11

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.4	63.33	63.88	71.48	82.37	83.2
HS-2N	58.94	66.1	66.33	73.91	83.67	84.31
HS-1N	60.51	68.34	68.49	75.43	84.86	85.4
HS-0	61.39	70.31	70.51	76.37	86.03	86.52
HS1-1S	61.34	71.07	71.28	76.15	86.41	86.92
HS1-2S	60.78	70.63	70.89	75.21	85.89	86.51
HS-3S	57.27	68.6	69.16	72.72	84.61	85.47
Mid-3N	55.45	64.17	64.4	72.73	82.71	83.43
Mid-2N Hi	59.71	67.76	67.94	75.1	84.4	84.96
Mid-1N	60.3	69	69.16	76.29	85.67	86.17
Mid-0	61.22	70.52	70.67	76.89	86.58	87.05
Mid-1S	60.66	70.18	70.37	76.24	86.45	86.98
Mid-2S	58.79	69.03	69.32	74.61	85.32	86.01
Mid-3S	56.76	67.03	67.56	72.81	84.18	85.11
App-3N	57.36	62.49	62.91	73.7	82.29	83.24
App-2N	62.02	67.04	67.26	76.93	84.56	85.35
App-1N	66.93	72.11	72.21	80.43	87.54	88.11
App-0	69.2	75.58	75.71	81.92	90.19	90.67
App-0a5 Li	68.82	76.03	76.18	81.43	90.47	91
App-1S	65.33	74.01	74.35	79.9	89.41	90.13
App-2S	61.29	69.17	70.15	76.48	86.67	87.8
App-3S	56.53	66.41	67.88	73.52	84.76	86.08

Figure 61. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 1-alt (right pane) routes, 140 kt airspeed

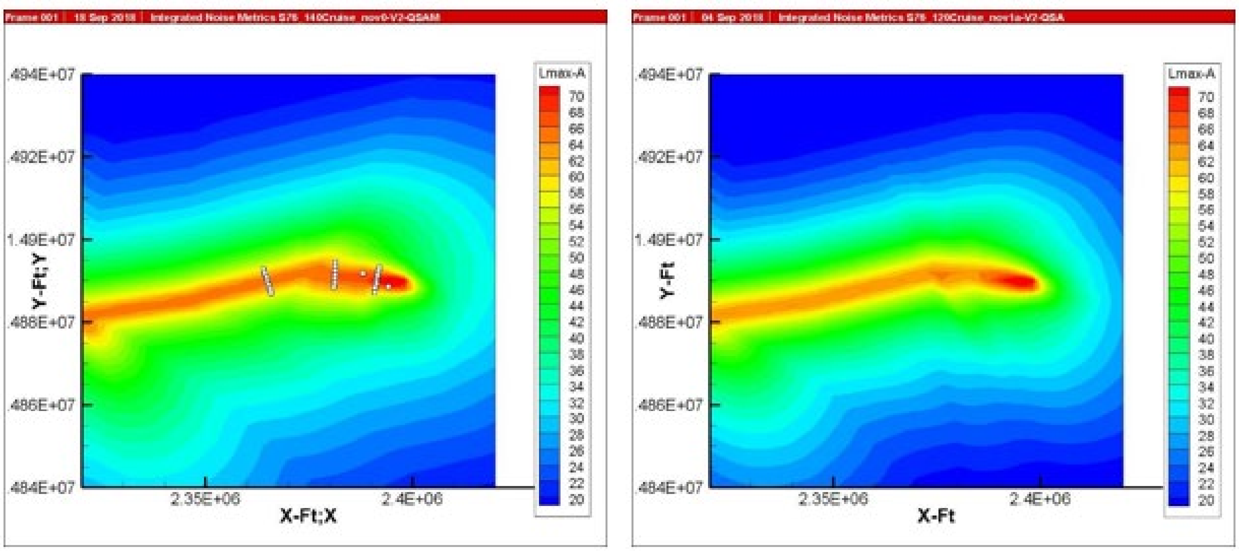


Figure 62. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 1-alt (right pane) routes, 140 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.79	65	65.72	73.09	83.19	83.97
HS-2N	59.36	67.78	68.15	75.47	84.68	85.3
HS-1N	62.77	70.71	70.93	77.32	86.14	86.63
HS-0	64.41	72.21	72.43	78.24	87.01	87.47
HS1-1S	63.23	71.71	71.93	77.75	87.18	87.74
HS1-2S	60.41	69.7	69.98	76.13	86.57	87.32
HS-3S	56.15	67.11	68.02	73.47	85.74	86.8
Mid-3N	58.38	65.67	65.9	73.77	83.79	84.52
Mid-2N Hi	59.64	68.1	68.38	75.66	85.45	86.06
Mid-1N	62.71	70.88	71.12	77.58	87.26	87.8
Mid-0	63.84	73.16	73.35	78.7	88.68	89.16
Mid-1S	64.15	74.91	75.15	78.47	89.59	90.12
Mid-2S	62.78	73.54	74.01	76.85	88.65	89.37
Mid-3S	59.82	70.68	71.51	75.07	87.37	88.28
App-3N	57.38	62.58	63.38	73.81	83.43	84.41
App-2N	62.43	67.15	67.4	77.05	85.42	86.25
App-1N	67.36	72.71	72.83	80.67	88.24	88.88
App-0	69.71	76.47	76.61	82.31	90.92	91.44
App-0aS Li	69.49	76.8	76.98	81.76	91.15	91.72
App-1S	66.08	74.9	75.4	79.93	89.92	90.7
App-2S	61.85	70	71.31	76.41	87.44	88.58
App-3S	56.81	67.86	69.41	73.47	85.84	87.11

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.29	63.28	63.75	71.7	82.42	83.24
HS-2N	58.9	66.49	66.72	74.17	83.9	84.54
HS-1N	60.42	68.27	68.42	75.7	85.17	85.7
HS-0	61.17	70.04	70.24	76.63	86.3	86.78
HS1-1S	61.03	70.78	70.96	76.4	86.6	87.1
HS1-2S	60.85	70.6	70.83	75.52	86.08	86.68
HS-3S	57.67	68.69	69.14	73.08	84.77	85.62
Mid-3N	58.24	64.25	64.45	73.93	83.17	83.92
Mid-2N Hi	61.62	67.89	68.02	76.44	84.97	85.59
Mid-1N	63.43	70.21	70.38	77.75	86.64	87.18
Mid-0	63.79	72.24	72.42	78.01	87.92	88.45
Mid-1S	61.89	71.2	71.54	76.96	87.41	88.11
Mid-2S	58.61	68.43	69.3	74.22	85.75	86.77
Mid-3S	55.86	66.95	68.22	72.04	84.47	85.7
App-3N	56.52	61.72	62.26	73.06	81.98	83.03
App-2N	62.88	67.16	67.4	76.67	84.43	85.31
App-1N	68.05	73.44	73.55	81.19	88.1	88.7
App-0	72.55	78.65	78.81	83.87	91.83	92.32
App-0aS Li	71.23	78.34	78.54	83.14	91.86	92.44
App-1S	67.33	74.5	75.16	80.2	89.68	90.62
App-2S	61.53	71.13	72.47	76.59	87.01	88.3
App-3S	56.22	68.4	69.93	72.88	85.04	86.43

Figure 63. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 2 (right pane) routes, 140 kt airspeed

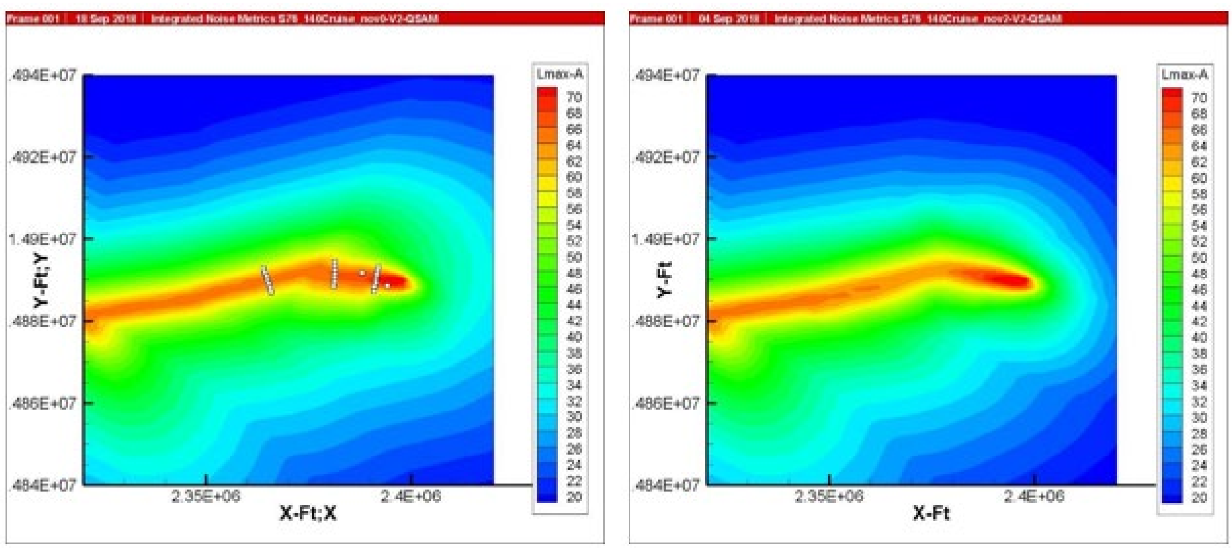


Figure 64. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 2 (right pane) routes, 140 kt airspeed

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	55.79	65	65.72	73.09	83.19	83.97
HS-2N	59.36	67.78	68.15	75.47	84.68	85.3
HS-1N	62.77	70.71	70.93	77.32	86.14	86.63
HS-0	64.41	72.21	72.43	78.24	87.01	87.47
HS1-1S	63.23	71.71	71.93	77.75	87.18	87.74
HS1-2S	60.41	69.7	69.98	76.13	86.57	87.32
HS-3S	56.15	67.11	68.02	73.47	85.74	86.8
Mid-3N	58.38	65.67	65.9	73.77	83.79	84.52
Mid-2N Hi	59.64	68.1	68.38	75.66	85.45	86.06
Mid-1N	62.71	70.88	71.12	77.58	87.26	87.8
Mid-0	63.84	73.16	73.35	78.7	88.68	89.16
Mid-1S	64.15	74.91	75.15	78.47	89.59	90.12
Mid-2S	62.78	73.54	74.01	76.85	88.65	89.37
Mid-3S	59.82	70.68	71.51	75.07	87.37	88.28
App-3N	57.38	62.58	63.38	73.81	83.43	84.41
App-2N	62.43	67.15	67.4	77.05	85.42	86.25
App-1N	67.36	72.71	72.83	80.67	88.24	88.88
App-0	69.71	76.47	76.61	82.31	90.92	91.44
App-0aS Li	69.49	76.8	76.98	81.76	91.15	91.72
App-1S	66.08	74.9	75.4	79.93	89.92	90.7
App-2S	61.85	70	71.31	76.41	87.44	88.58
App-3S	56.81	67.86	69.41	73.47	85.84	87.11

POIname	Lmax_dBA	Lmax_dbC	Lmax_dB	SEL_dBA	SEL_dBC	SEL_dB
HS-3N	50.82	60.04	61.08	68.59	80.7	81.73
HS-2N	54.51	62.05	62.79	70.8	81.72	82.62
HS-1N	56.82	64.91	65.26	72.79	83.09	83.81
HS-0	59.87	67.15	67.33	74.95	84.42	84.98
HS1-1S	60.75	69	69.15	76.21	85.64	86.13
HS1-2S	61.3	70.36	70.55	76.67	86.47	86.94
HS-3S	61.01	70.9	71.12	76.06	86.46	86.99
Mid-3N	54.53	62.16	62.57	71.51	81.5	82.32
Mid-2N Hi	56.9	64.98	65.2	73.36	82.96	83.65
Mid-1N	59.89	67.07	67.27	75.45	84.67	85.26
Mid-0	60.31	68.69	68.93	76.56	85.99	86.55
Mid-1S	60.53	69.16	69.33	76.73	86.44	87
Mid-2S	60.19	68.85	69.08	76.08	86.18	86.8
Mid-3S	56.96	67.12	67.52	73.88	84.86	85.68
App-3N	57.33	62.45	62.85	73.88	82.28	83.25
App-2N	62.03	67.05	67.27	77.13	84.56	85.33
App-1N	66.87	72.11	72.21	80.66	87.58	88.11
App-0	69.26	75.59	75.72	82.12	90.25	90.71
App-0aS Li	68.83	76.01	76.15	81.61	90.49	90.99
App-1S	65.3	73.8	74.1	80.08	89.36	90.05
App-2S	61.28	68.78	69.73	76.56	86.47	87.6
App-3S	56.54	66.38	67.81	73.47	84.44	85.8

Figure 65. Predicted maximum sound level (Lmax_dBA) and sound exposure level (SEL_dBA) at point-of-interest (POI) locations for November 0 (left pane) and November 2-alt (right pane) routes, 140 kt airspeed

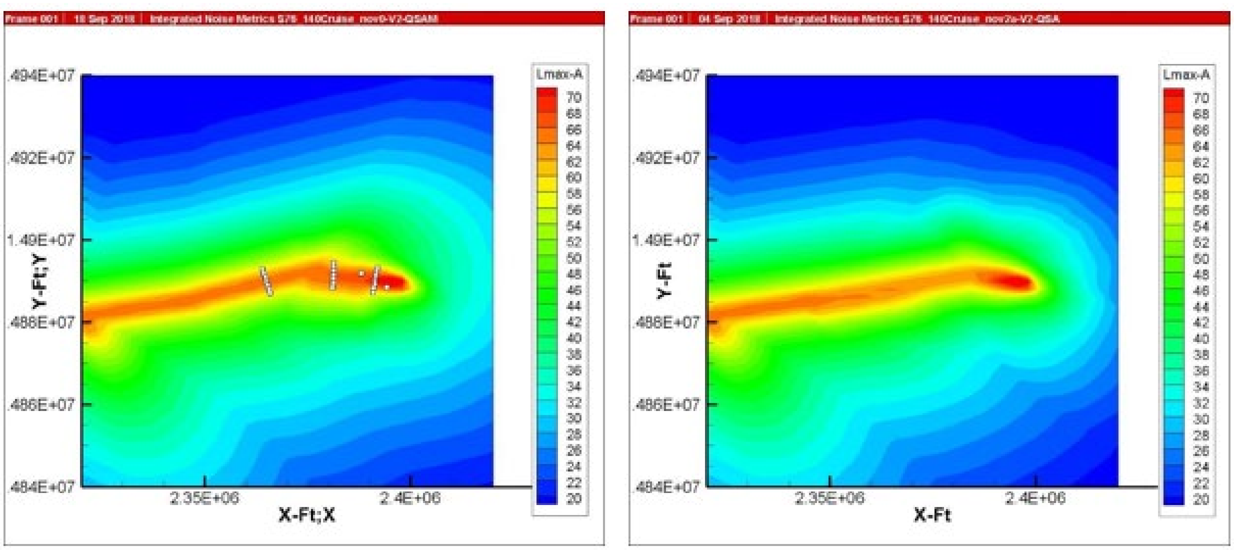


Figure 66. Predicted A-weighted maximum sound level (Lmax-A) footprint covering middle and approach segments, November 0 (left pane) and November 2-alt (right pane) routes, 140 kt airspeed