

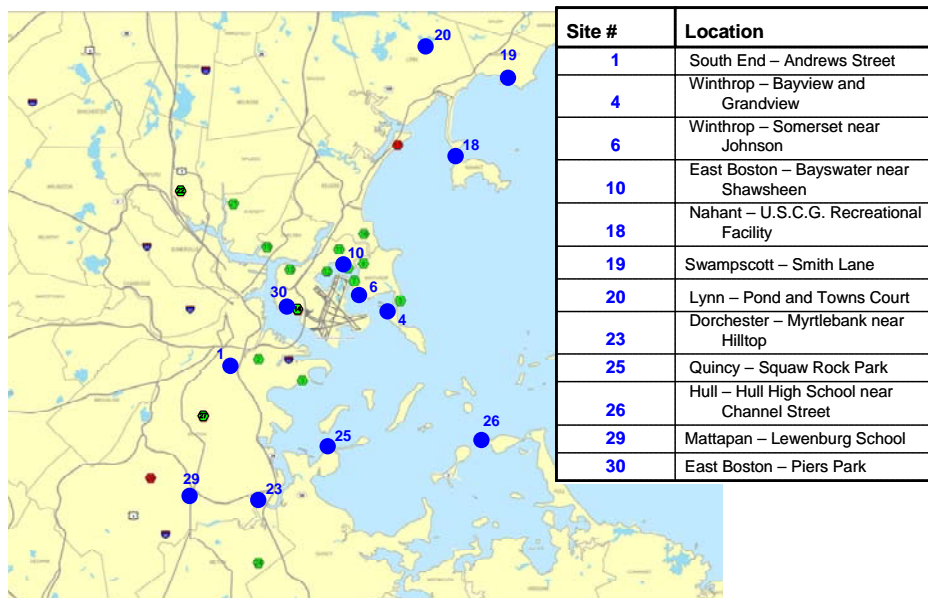
NOISE MEASUREMENT PROGRAM RESULTS SUMMARY

Comparative Side-by-Side Sites

This paper presents an overview of the comparative noise measurement program conducted by the Independent Consultant at twelve Massport permanent noise monitoring sites as part of the Boston Logan Airport Noise Study (BLANS). A brief summary of the measurement program, the results, and conclusions are presented below. Further detailed information is available in the results presentation PowerPoint file that will be made available in association with this summary.

Program Overview

A total of 12 Massport permanent noise monitor sites were selected at locations distributed across the region in areas over-flown by aircraft using Boston Logan Airport (BOS). The graphic below presents a listing of the selected sites and maps their locations around the airport.



Over a period of several weeks during mid-2007, a portable noise monitor was placed at each site indicated site for a temporary period of 4-hours of continuous measurements. The portable monitors met the Class 1 requirements of IEC 61672-1:2002 with recent certificates of calibration. Acoustical calibration checks were performed at the onset of the measurements at each site. On-site observers recorded a log of noise events that occurred at each location during the measurement period.

The portable monitors retained 1-second sound levels in A-weighted decibels for each measurement period. Simultaneous noise data from the corresponding Massport noise monitors was acquired in the form of ½-second sound level in A-weighted decibels for each measurement period. Similarly, radar flight track data were provided from the Massport system for each measurement period, along with a listing of noise events correlated to aircraft flights by the Massport system was provided for each site.

The observer logs contained noise event start and stop times, as well as notes on the noise source. This data was input into spreadsheets for subsequent analysis. Also, weather data statistics from the BOS station were gathered for each measurement period. The table below summarizes the measurement times, conditions, and airport operations for each site.

Measurement Site	Measurement Date	Monitoring Times	Weather	Temperature Range (°F.)	Airport Mode
1	May 11, 2007	12:12pm - 4:12pm	Rain/Mist - Overcast	64 - 66	Dep 27 Arv 33L / Dep 22R Arv 27&22's
4	May 29, 2007	8:56am - 12:56pm	Pt. Cloudy/Clear	68 - 76	Dep 33L Arv 27
6	May 30, 2007	8:17am - 12:17pm	Clear	71 - 74	Dep 9&4's Arv 4's
10	May 29, 2007	1:59pm - 5:59pm	Pt. Cloudy/Clear	77 - 78	Dep 33L Arv 27&32
18	May 31, 2007	7:30am - 11:30pm	Trace Rain Cloudy	61 - 65	Dep 4's & 9 Arv 4's
19	May 31, 2007	11:49am - 1:49pm	Cloudy	60 - 63	Dep 9 Arv 4R
19	June 1, 2007	11:59am - 1:59pm	Sct. Clouds	65 - 80	Arv 22L / Dep 4's
20	June 1, 2007	7:33am - 11:33am	Sct. Clouds	70 - 75	Arv 22's & 27 Dep 22R
23	June 16, 2007	2:49pm - 6:49pm	Cloudy	72 - 75	Arv 4's Dep 4R
25	May 10, 2007	8:38am - 12:38pm	Pt. Cloudy - Cloudy	68 - 80	Dep 22's
26	May 9, 2007	9:43am - 1:43pm	Pt. Cloudy	69 - 85	Dep 22's Arv 27
29	June 23, 2007	5:55am - 9:55am	Fair - Clear	57 - 67	Dep 27 & 33L
30	June 16, 2007	9:30am - 1:30pm	Sct. Clouds	69 - 73	Dep 22R Arv 22L / Dep 4R Arv 4's

Analysis Methodology

The data analysis began with a comparison of the 1-sec. portable monitor data to the Massport measurements for the same period to check for anomalies. While some expected subtle differences were found due to the difference in precise microphone locations and elevations, the two data sets generally matched well.

Hourly average noise levels (Leq) for total noise were computed for each site from both data sets and four-hour measurement period average noise levels for noise from all sources were also computed for each site from both the portable and Massport data sets.

Aircraft flights were correlated to noise data for the portable monitors at each site using the Massport radar data.¹ Once the aircraft noise was identified through the correlation process, hourly average (Leq) aircraft noise levels were computed from the correlated events for the portable monitors. Similar values were also computed from the correlated aircraft events listing generated from the Massport system aircraft event report for the Massport monitors. The listings of correlated aircraft events for each system were then tallied for each site to identify the number of correlated events per hour. The correlated events that were a match between the two systems were also identified by hour for each site. Finally, the SEL noise values for each of the matching aircraft events from each system were evaluated by hour to identify single event noise SEL capture differences.

¹ Details of the correlation process of observed and radar data to the portable noise monitor results are provided in the associated PowerPoint presentation.

It should be noted that the Massport system correlates aircraft radar flights to noise events using a fixed threshold system. Thus, a noise event must exceed a preset noise level and a minimum duration, and also fit within event logic for multiple sequential monitors for it to be identified as a possible aircraft event. In cases where an actual aircraft causes noise that doesn't exceed the noise level threshold or the minimum duration or appear at sequential monitors, the system may miss the event. Generally, the expectation is that these quieter and/or shorter events represent only a small contribution to the aircraft DNL at a site and that the louder and/or longer aircraft events will dominate the noise.

The following sections present a summary of the results for each site along with a brief interpretation of the comparison between the Massport data and the portable monitor data.

Results Summary

The following paragraphs provide summary results of the comparative measurements at each of the twelve side-by-side sites. More detail is provided in an associated PowerPoint presentation describing the measurement program.

Site 1 – South End – 27 Departure Corridor

Measurement Results - S1

Site S1	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	66.3	66.5	64.4	64.1	23	15	15
2	65.1	67.5	58.1	56.5	13	5	5
3	61.2	62.1	46.8	49.6	3	2	1
4	60.0	61.2	50.5	N/A	5	0	0
Total	63.9	65.1	59.5	58.9	44	22	21

- Total noise values compared well with the Massport microphone reading just slightly higher, owing to the difference in position between the two monitors.
- Background noise came from nearby construction, rain, occasional sirens, and local traffic. Aircraft events mainly came from departures using Runway 27.
- Massport's system identified louder events (above 80 dB SEL) well, quieter events poorly.
- Massport cumulative Aircraft Leq was fairly accurate due to good correlation of louder events.

Site 4 – Winthrop – 9 Departure/27 Approach Corridor**Measurement Results - S4**

Site S4	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	70.8	71.1	70.7	70.5	30	16	16
2	72.4	72.9	72.3	72.2	30	23	21
3	71.0	71.3	71.0	70.1	36	21	19
4	71.5	71.9	71.2	71.3	39	21	21
Total	71.5	71.9	71.4	71.1	135	81	77

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from nearby lawn mowers, shoreline waves, and occasional local traffic, while aircraft noise events were primarily from arrivals on Runway 27 with some sideline departure noise from Runway 33L activity.
- Massport's system identified louder aircraft events (Runway 27 arrivals) well, but quieter events (Runway 33L departures) poorly
- Massport cumulative Aircraft Leq was fairly accurate due to good capture of louder events.

Site 6 – Winthrop – Ground Noise/All Flights**Measurement Results - S6**

Site S6	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	66.8	67.1	66.4	66.1	57	27	22
2	61.7	62.0	61.1	58.7	53	12	10
3	61.1	62.0	60.5	58.1	43	12	8
4	62.6	63.6	62.0	61.7	39	15	11
Total	63.7	64.2	63.2	62.4	192	66	51

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from nearby shoreline waves, and occasional local traffic. Aircraft noise was from a variety of sources including arrivals and departures on Runways 04L/R and departures on Runway 09.
- Massport's system identified louder aircraft events (above 80 SEL) well, but quieter events poorly
- Massport cumulative Aircraft Leq was fairly accurate due to good capture of louder events.

Site 10 – East Boston – 4 Departure Corridor/22 Approach Corridor**Measurement Results - S10**

Site S10	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	60.3	60.0	58.3	53.2	28	3	3
2	60.9	60.3	58.3	54.5	31	4	4
3	66.3	64.8	62.4	59.8	34	11	10
4	61.4	60.9	58.5	51.2	37	2	2
Total	63.0	62.0	59.8	56.0	130	20	19

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from nearby shoreline waves and occasional local traffic while aircraft noise events were nearly all departures on Runway 33L.
- Massport's system identified louder aircraft events (above 82 dB SEL) well, but quieter events poorly.
- Massport cumulative Aircraft Leq was considered to be too low due to high percentage of un-captured aircraft events at levels less than the system threshold.

Site 18 – Nahant – 4 Departure Corridor**Measurement Results - S18**

Site S18	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	55.8	58.1	50.5	48.2	4	1	1
2	56.8	58.9	49.4	N/A	9	0	0
3	56.5	59.3	43.9	N/A	3	0	0
4	56.7	61.0	50.6	N/A	6	0	0
Total	56.5	59.5	49.3	42.2	22	1	1

- Total noise values were approximately 3 dB higher for Massport microphone than for the temporary portable monitor. This was because the portable monitor microphone placement was partially shielded from the wave action at the shoreline.
- Background noise came from nearby shoreline waves, and occasional local traffic. Aircraft noise was mostly departures from Runways 04R/04L.
- The Massport's system identified the only aircraft event greater than 82 SEL. Massport's system did not identify any of the 21 aircraft events less than 82 SEL.
- Massport cumulative Aircraft Leq is considered to be too low due to inadequate capture and consideration of quieter aircraft events which are the norm at this site.

Site 19a – Swampscott – 4 Departure Corridor/22 Approach Corridor

Measurement Results - S19a

Site S19a	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	52.7	52.0	31.8	N/A	1	0	0
2	49.8	50.1	N/A	N/A	0	0	0
3							
4							
Total	51.5	51.2	25.8	N/A	1	0	0

- Only 2 measurement hours performed on May 31, 2007. Site was re-measured for an additional 2 hours the following day (Site 19b).
- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from occasional local road traffic. Only one aircraft event was captured by portable monitor with an SEL of 67.4 dB. The aircraft was a departure from Runway 09. The Massport system did not correlate the event.

Site 19b – Swampscott - 4 Departure Corridor/22 Approach Corridor

Measurement Results - S19b

Site S19b	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	52.2	52.5	41.9	N/A	7	0	0
2	54.1	55.1	43.0	N/A	4	0	0
3							
4							
Total	53.3	54.0	39.5	N/A	11	0	0

- Only 2 measurement hours were performed on June 1, 2007. The site was measured for 2 hours on the previous day (Site 19a).
- Total noise values compared well between the Massport microphone and the portable monitor.
- Background noise came from occasional local road traffic. Aircraft events in the first hour were arrivals to Runways 22L/22R. In the second hour aircraft events were departures from Runways 04L/R. All events measured less than 80 SEL.
- Massport’s system did not identify any noise from aircraft at this site.

Site 20 – Lynn – 22 Approach Corridor

Site S20	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event
	Temp	MassPort	Temp	MassPort	Temp	MassPort	Matches
1	59.1	59.2	56.3	N/A	26	0	0
2	54.4	55.0	52.6	N/A	13	0	0
3	57.8	57.3	53.5	N/A	11	0	0
4	59.1	58.6	55.6	N/A	24	0	0
Total	58.0	57.8	54.7	N/A	74	0	0

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from occasional local road traffic. Aircraft noise was predominantly from arrivals to Runways 22L/22R.
- Massport's system identified none of the 74 aircraft events detected by the temporary portable monitor and observers. Most events were between 70 dB and 80 dB SEL. 10 events exceeded 80 dB SEL, yet were not captured by the Massport system.
- Massport cumulative Aircraft Leq was not computed since no aircraft events were identified. Hence cumulative aircraft noise levels at the site are considered to be inadequately reported by the Massport system.

Site 23 – Dorchester – 4 Approach Corridor

Site S23	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event
	Temp	MassPort	Temp	MassPort	Temp	MassPort	Matches
1	61.3	62.4	59.6	59.3	21	17	13
2	60.3	61.4	58.4	56.2	26	11	8
3	60.4	61.5	58.9	56.9	24	12	8
4	60.6	62.3	56.3	53.4	14	4	4
Total	60.7	61.9	58.5	56.9	85	44	33

- Total noise values compared well between the Massport microphone and the portable monitor.
- Background noise came from children on a playground, nearby lawn mowers, sirens, and occasional local traffic. Aircraft noise was mostly arrivals to Runways 04L/R.
- Massport's system identified louder aircraft events (above 80 dB SEL) well, but quieter events poorly.
- Massport cumulative Aircraft Leq was only slightly low due to good capture of louder events.

Site 25 – Quincy – 4 Approach Corridor/22 Departure Corridor

Site S25	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	50.2	51.6	47.7	N/A	23	0	0
2	49.8	51.9	47.2	N/A	16	0	0
3	54.9	55.2	54.4	50.3	20	1	1
4	50.4	51.9	48.6	N/A	17	0	0
Total	51.9	52.9	50.6	44.2	76	1	1

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from dogs, church bells, an air conditioner at nearby building, and occasional local traffic. Aircraft noise was nearly all departures from Runway 22L.
- Only one aircraft event measured above 82 dB SEL. This event was identified by Massport system. None of the 75 events less than 82 dB SEL were identified by the Massport system as aircraft noise.
- Massport cumulative Aircraft Leq is considered to be too low due to inadequate identification and consideration of the quieter aircraft events common at this site.

Site 26 – Hull – 22 Departure Corridor/32-33 Approach Corridor

Site S26	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	56.7	56.3	56.2	51.8	22	2	2
2	54.2	55.6	53.3	N/A	30	0	0
3	55.5	57.3	50.9	N/A	20	0	0
4	55.2	56.2	54.0	48.0	18	1	1
Total	55.5	56.4	54.0	47.3	90	3	3

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from cars in adjacent parking lot, motorboats, a nearby wind turbine, and students at nearby school. Aircraft noise was nearly all associated with departures from Runways 22L/22R.
- Massport's system identified the three louder aircraft events (above 82 dB SEL), but missed 87 observed events with SEL's less than 82 dB.
- Massport cumulative Aircraft Leq is considered to be too low due to inadequate identification and consideration of quieter aircraft events common at this site.

Site 29 – Mattapan – 4 Approach Corridor/27 Departure Corridor

Site S29	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	55.8	55.9	52.8	N/A	18	0	0
2	55.5	55.7	53.3	N/A	17	0	0
3	54.9	55.2	53.8	46.4	18	1	1
4	51.8	52.5	43.6	N/A	8	0	0
Total	54.7	55.0	52.2	40.3	61	1	1

- Total noise values compared well between the Massport microphone and the temporary portable monitor.
- Background noise came from birds, wind in trees and local traffic. Aircraft noise was mostly departures from Runways 27 and 33L. Departures from 27 were generally louder.
- Massport's system identified only 1 of the 6 aircraft events louder than 80 dB SEL, and none of the 55 events less than 80 SEL.
- Massport cumulative Aircraft Leq is considered to be too low due to inadequate identification and consideration of almost all aircraft events.

Site 30 – East Boston – Ground Noise/All Flights

Site S30	Cumulative Metrics				Correlated Aircraft Events		
	Overall Leq (dB)		Aircraft Leq (dB)		Number of Aircraft Events		# of AC Event Matches
	Temp	MassPort	Temp	MassPort	Temp	MassPort	
1	57.1	58.3	49.3	50.4	31	1	0
2	55.9	56.9	49.2	45.4	16	1	0
3	56.6	59.3	46.5	58.8	11	2	0
4	64.0	65.8	36.0	63.6	1	6	0
Total	59.8	61.7	47.3	59.0	59	10	0

- Total noise values are approximately 1.9 dB higher for the Massport monitor than for temporary portable monitor. The higher elevation of the Massport microphone allowed it to capture more ambient noise than the partially obstructed portable monitor.
- Background noise came from birds, local traffic, boats in harbor, nearby lawn mowers, and occasional helicopters. Aircraft noise during the first 2 hours was from departures on Runway 22L. In the last 2 hours aircraft events were arrivals and departures to Runways 04L/R.
- Based on correlations of observed events and measured data, all 10 events identified by the Massport system as aircraft were either truck noise or lawn-mower noise with

similar noise characteristics. The Massport system identified none of the 59 observed aircraft events, all of which were measured below 80 dB SEL.

- Massport cumulative Aircraft Leq is considered to be too low due to lack of capture of aircraft noise events less than 80 dB SEL.

Conclusions

Overall, **total** noise levels measured by the Massport system correlate well to those recorded by the portable monitors indicating no microphone or sound level meter bias. The analysis showed that using full-time on-site observers and full analytical review of measurement data can yield a high degree of confidence in aircraft event correlation, although such an approach would be at very high cost. However, no approach can guarantee 100% aircraft event correlation. The table below presents a comparative summary of the results for each site.

Measurement Results Comparison by Site												
Site	Cumulative Metrics						Correlated Aircraft Events					
	Overall Leq (dB)			Aircraft Leq (dB)			Number of Aircraft Events			# of AC Event Matches	Avg Diff SEL (Temp - MassPort) (dB)	Avg Abs Diff SEL Temp - MassPort (dB)
	Temp	MassPort	Difference	Temp	MassPort	Difference	Temp	MassPort	Difference			
1	63.9	65.1	1.2	59.5	58.9	-0.6	44	22	-22	21	0.49	0.68
4	71.5	71.9	0.4	71.4	71.1	-0.3	135	81	-54	77	0.16	0.26
6	63.7	64.2	0.5	63.2	62.4	-0.8	192	66	-126	51	-0.11	0.79
10	63.0	62.0	-1.0	59.8	56.0	-3.8	130	20	-110	19	1.26	1.28
18	56.5	59.5	3.0	49.3	42.2	-7.0	22	1	-21	1	1.22	1.22
19a	51.5	51.2	-0.3	25.8	N/A	N/A	1	0	-1	0	N/A	N/A
19b	53.3	54.0	0.7	39.5	N/A	N/A	11	0	-11	0	N/A	N/A
20	58.0	57.8	-0.2	54.7	N/A	N/A	74	0	-74	0	N/A	N/A
23	60.7	61.9	1.2	58.5	56.9	-1.5	85	44	-41	33	0.49	0.69
25	51.9	52.9	1.0	50.6	44.2	-6.4	76	1	-75	1	1.75	1.75
26	55.5	56.4	0.9	54.0	47.3	-6.7	90	3	-87	3	1.69	1.69
29	54.7	55.0	0.3	52.2	40.3	-11.9	61	1	-60	1	1.37	1.37
30	59.8	61.7	1.9	47.3	59.0	11.7	59	10	-49	0	N/A	N/A
	Indicates good match between Massport result and Temporary monitor result											
	Indicates moderate match between Massport result and Temporary monitor result											
	Indicates poor match between Massport result and Temporary monitor result											

The identification of a portion of the overall noise level to aircraft sources using BOS is generally a function of three key factors: rigorous data availability, signal to noise ratio (in this case the aircraft noise is the signal and the ambient and other noise sources are the noise), and correlation methodology. When the original Massport system was developed, Stage 2 aircraft dominated the fleet and were much louder than most of today's aircraft. Thus, the signal to noise ratio was much higher, even for sites further from the airport. Today's quieter fleet means a lower signal to noise ratio and more difficulty for an automated system to capture aircraft single events in the midst of other background sources². The following bullet points summarize the conclusions drawn from the side-by-side comparative measurement analysis.

- The Massport system missed notable numbers of aircraft events at all sites. Generally, the missed events tend to be at noise levels less than 80 SEL.

² It should be noted that Massport has been installing a new monitoring system with an updated correlation technology over the past two years. At the time of the comparative measurement program, the new system microphones were in place, but the correlation system technology had not been implemented. Another comparison of information after new correlation methodology is in place may result in better correlations of noise events at lower noise levels – or it may not, dependent upon the decisions made regarding required durations and noise levels to consider an event to be aircraft related.

- The Massport system was effective at identifying enough of the higher noise level events as from aircraft sources to lead to reasonable cumulative aircraft noise values at sites near the airport, or sites that had a high number of direct overflights.
- The Massport system was ineffective at identifying individual noise events at sites at greater distance from the airport, and consequently underreported the aircraft-specific cumulative noise levels at them.
- It is not practical for a permanent long-term monitoring system to use full-time observers and full manual analysis. However, following a rigorous threshold setting process and refining those thresholds periodically based on variations in ambient noise levels will help ensure that the system will identify a larger proportion of the aircraft events, particularly at lower single event noise levels. Such information would be more useful in confirming or refining the results of computer-based modeling of aircraft noise levels.