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BILLY BISHOP TORONTO CITY AIRPORT – NOISE MANAGEMENT STUDY – INTERIM REPORT

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JACOBS Consultancy

Transportation Solutions

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I. NOISE BACKGROUND

Noise Measurement

Noise is defined as unwanted sound. In other words, noise is sound that disturbs routine activities or quiet, and/or causes feelings of annoyance. Whether sound is interpreted as pleasant (e.g., music), or unpleasant (e.g., jackhammer) depends largely on the listener's current activity, past experience, and attitude toward the source.

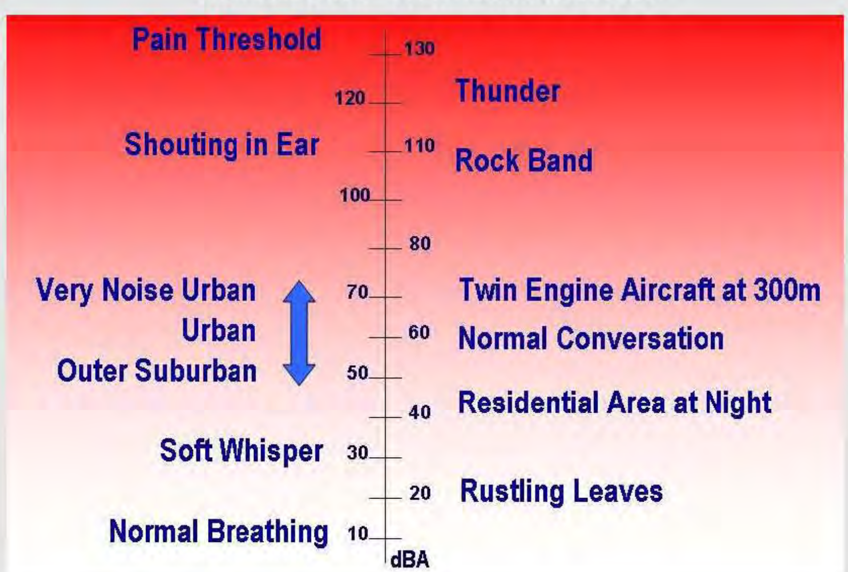
Characteristics of Sound

Sound is transmitted by alternating compression and decompression in air pressure. These relatively small changes in atmospheric pressure are called sound waves. The measurement and human perception of sound involves two physical characteristics—intensity and frequency. Intensity is a measure of the strength or magnitude of the sound vibrations, and is expressed in terms of the sound pressure level (SPL). The higher the SPL, the more intense is the perception of that sound. The other characteristic is sound frequency or "pitch"—the speed of vibration. Frequencies are expressed in terms of cycles per second or hertz (Hz). Low frequency sounds might be characterized as a rumble or roar, while high frequency sounds are typified by sirens or screeches. Noise analysis accounts for both of these characteristics in the units used to measure sound.

Decibel (dB). The human ear is sensitive to an extremely wide range of sound intensity, which covers a relative scale of 1 to 100,000,000. Representation of sound intensity using a linear index becomes difficult because of this wide range. As a result, the decibel—a logarithmic measure of the magnitude of sound—is typically used. Sound intensity is measured in terms of sound levels ranging from 0 dB, which is approximately the threshold of hearing, to 130 dB, which is the threshold of pain. Figure II-1 shows the sound pressure levels of typical events.

Figure II-1

NOISE METRICS—TYPICAL SOUND LEVELS

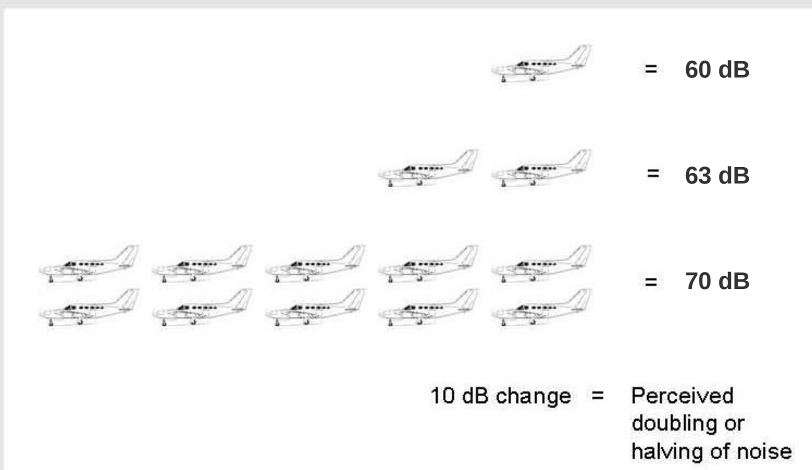


Because of the logarithmic unit of measurement, decibels cannot be added or subtracted linearly (see Figure II-2); however, the following apply:

- If two sounds of the same level are added, the sound level increases by approximately 3 dB. For example: 60 dB + 60 dB = 63 dB.
- The sum of two sounds of a different level is only slightly higher than the louder level. For example: 60 dB + 70 dB = 70.4 dB.
- Sound from a "point source," such as an aircraft, decreases approximately 6 dB for each doubling of distance.
- Although the human ear can detect a sound as faint as 1 dB, the typical person does not perceive changes of less than approximately 3 dB.
- A 10 dB change in sound level is perceived by the average person as a doubling, or halving, of the sound's loudness.

Figure II-2

NOISE METRICS—DECIBEL (dB) ADDITION

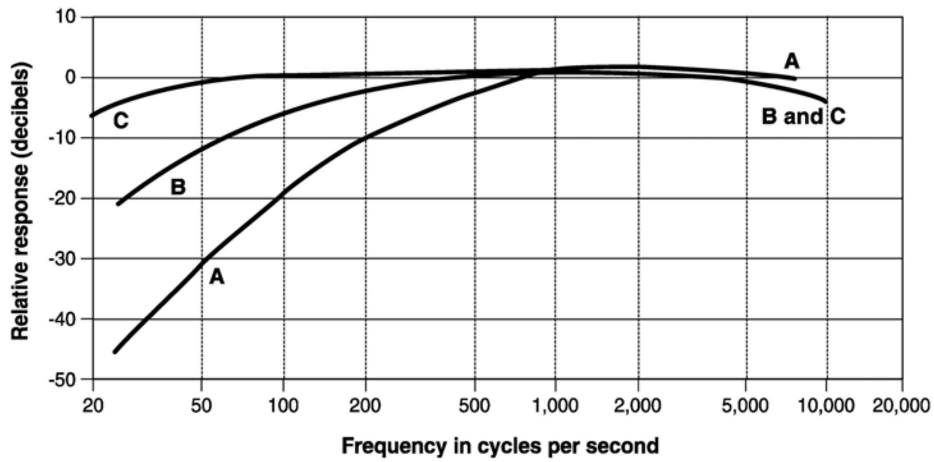


A-Weighted Decibel. Humans are most sensitive to frequencies near the normal range of speech communications. "A-weighting" reflects this sensitivity by emphasizing midrange frequencies and deemphasizing high and low frequencies (see Figure II-3). Since the A-weighted decibel (dBA) provides a better prediction of human reaction to environmental noise than the unweighted decibel, it is the metric most frequently used in noise compatibility planning.

C-Weighted Decibel. Another metric that is some times used in the assessment of aircraft noise is the C-weighted decibel. As illustrated in Figure II-3, the C-weighting is nearly flat throughout the audible frequency range with limited de-emphasis of the low frequency components of the total noise event. C-weighting may occasionally be preferable in evaluating sounds whose lower frequency components are responsible for secondary effects such as rattling windows or perceptible vibration. For aircraft activity, the C-weighted metric has been used to assess the effects of low frequency noise generated during take-off or when reverse thrust is applied during landing.

Figure II-3

NOISE METRICS—FREQUENCY RESPONSE



Source: A. Peterson and E. Gross, *Handbook of Noise Control*, West Concord: General Radio Company, 1967.

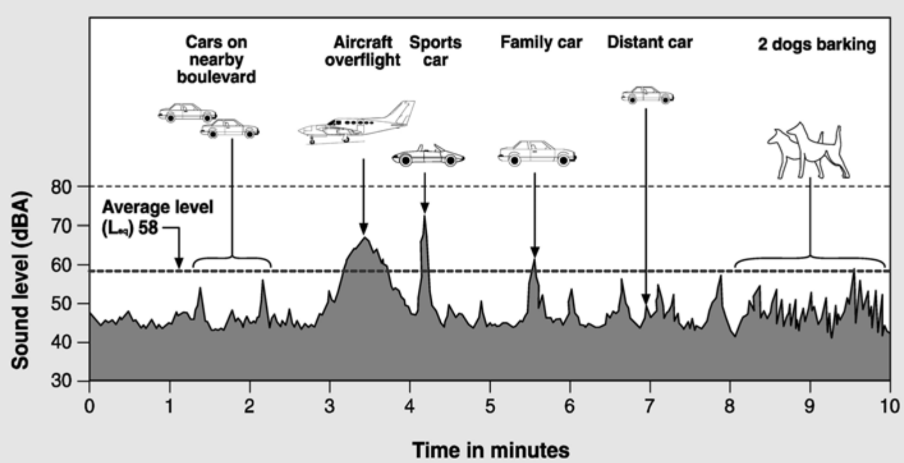
Supplemental Noise Metrics

The measurement of sound is not a simple task. Consider typical sounds in a suburban neighbourhood on a normal or "quiet" afternoon. If a short time in the history of those sounds is plotted on a graph, it would look very much like Figure II-4.

On Figure II-4, the background, or residential sound level in the absence of any identifiable noise sources, is approximately 45 dB. About three-quarters of the time, the sound level is 50 dB or less. The highest sound level, caused by a nearby sports car, is approximately 70 dB, while an aircraft generates a maximum sound level of about 68 dB. The following subsections provide a discussion of how variable community noise is measured.

Figure II-4

NOISE METRICS—COMPARATIVE NOISE LEVELS



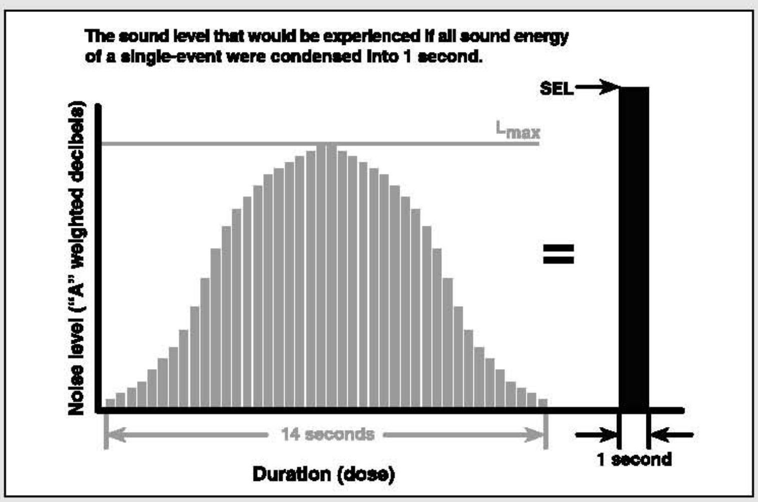
Source: United States Environmental Protection Agency, *Protective Noise Levels, Condensed Version of EPA Levels Document*, November 1978.

For example, in Figure II-4, the aircraft in this case is not as loud as the sports car, but the aircraft sound lasts longer. For most people, the aircraft would be more annoying than the sports car event. Thus, the maximum sound level alone is not sufficient to predict human reaction to environmental noise.

Sound Exposure Level. Clearly, the longer a noise lasts the more it disrupts activity and the more annoying it is likely to be. Laboratory tests indicate that the acceptability of noise decreases at a rate of roughly 3 dB per doubling of duration. In other words, two sounds would be judged equally acceptable if one had an intensity of 3 dB more than the other, but half the duration of the other. Accordingly, a second manner of describing noise is to measure the sound exposure level (SEL), which is the total sound energy of a single sound event. By accounting for both intensity and duration, the SEL allows us to compare the "annoyance" of different events. One way to understand SEL is to think of it as the sound level you would experience if all of the sound energy of a sound event occurred in one second (see Figure II-5). This normalization to a duration of one second allows the direct comparison of sounds of different duration. In the sample time history on Figure II-4, the sports car generated an SEL of about 77 dB, while the aircraft generates an SEL of about 81 dB.

Figure II-5

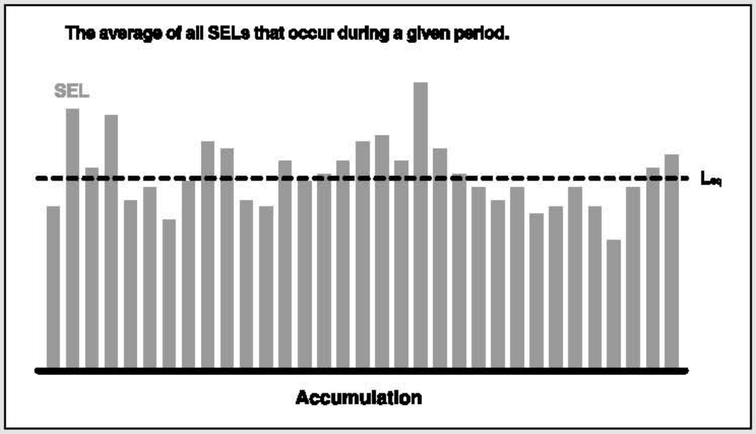
NOISE METRICS—SOUND EXPOSURE LEVEL (SEL)



Equivalent Sound Level. The maximum sound level and SEL are used to measure individual events. But the number of events can also be an important consideration in estimating the effect of noise. One way to describe this factor might be to count the number of events exceeding SEL 80 dBA, plus the number that exceed SEL 75 dBA, plus the number that exceed SEL 70 dBA, etc. A more efficient way to describe both the number of such events, and the sound exposure level of each is the time-average of the total sound energy over a specified period (see Figure II-6), referred to as the equivalent sound level (Leq). Research indicates that community reaction to noise corresponds to the total acoustic energy that is represented by the Leq. In the example shown on Figure II-4, the Leq is roughly 58 dBA. This measurement accounts for all of the sound energy during the sample period and provides a single-number descriptor.

Figure II-6

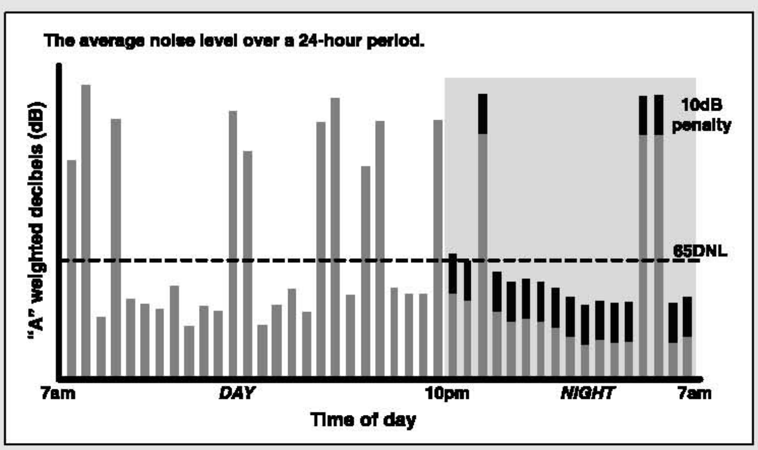
NOISE METRICS—EQUIVALENT SOUND LEVEL (L_{eq})



Day-Night Average Sound Level. One additional factor is also important in measuring a sound/sound events that occur during nighttime hours. People are normally more sensitive to intrusive sound events at night, and the background sound levels are normally lower at night because of decreased human activity. Therefore, noise events during the nighttime hours are likely to be more annoying than noise events at other times. To account for these factors, the DNL (under U.S. Federal Aviation Administration [FAA] requirements) adds a 10 dB penalty to sound levels occurring between 10:00 p.m. and 7:00 a.m. (see Figure II-7). In essence, the DNL is the 24-hour equivalent sound level (or Leq 24), including this 10 dB penalty. This 10 dB penalty means that one nighttime sound event is equivalent to 10 daytime events of the same level.

Figure II-7

NOISE METRICS—DAY-NIGHT AVERAGE SOUND LEVEL (DNL)



DNL is expressed as an average noise level on the basis of annual aircraft operations for a calendar year. To calculate the DNL at a specific location, SELs for that particular location are determined for each aircraft operation. The SEL for each operation is then adjusted to reflect the duration of the operation and arrive at a "partial" DNL for the operation. The partial DNLs are then added logarithmically—with the appropriate penalty for those operations occurring during the nighttime hours—to determine total noise exposure levels for the average day of the year. DNL is used to describe the existing and predicted cumulative noise exposure for communities in airport environs, and to estimate the effects of airport operations on land use compatibility. DNL has been widely accepted as the best available method to describe aircraft noise exposure.

Noise Exposure Forecast

The Noise Exposure Forecast (NEF) is a single number rating of overall aircraft noise. It combines the noise levels of individual aircraft and the numbers of aircraft to give a single number rating of the average negative impact of the aircraft noise. The current NEF metric evolved from the earlier Composite Noise Rating (CNR) which was initially developed for general community noise situations and later modified to evaluate aircraft noise.

NEF is defined as follows and is summed over all aircraft types and all flight paths:

$$NEF = \langle EPNL \rangle + 10 \bullet \log(N_d + 16.7 \bullet N_n) - 88$$

where <EPNL> is the mean Effective Perceived Noise Level of aircraft fly-overs; N_d and N_n are the numbers of day-time and night-time operations, respectively.

A National Research Council study (NRC completed in 1996 reviewed the NEF system to determine its validity as a prediction system. The results of the study showed that the Canadian NEF system compared favourably with other prediction models in use throughout the world.

For comparison purposes, it was determined in the study that the Canadian NEF System could be equated to the Day-Night Level (DNL) system contained in the Integrated Noise Model (developed by the U.S. Federal Aviation Administration and in wide use in the United States and internationally) by adding thirty one to the NEF value (NEF+31=DNL).

Transport Canada's methodology for producing NEF's in Canada requires that a 12.2 dB penalty be applied to all nighttime aircraft/rotorcraft operations which equates to a factoring of nighttime movements by 16.7 times. The 12.2 dB penalty (the highest in common use) is higher than the more common 10 dB penalty used in U.S. FAA's DNL. The Transport Canada methodology dictates that nighttime operations be deemed to occur between 2200 and 0700 local time, and thus the penalty is applied through this time period. (The BBTCA's current official curfew is between 2300 and 0645.)

II. COMMUNITY NOISE MEASUREMENT

Community Noise Model

The Noise Exposure Forecast (NEF) contours are an accepted means of planning for airport noise emissions but they represent only noise from aircraft, and thereby do not provide a means of comparing aircraft noise to other noise in the environment, or assessing the cumulative impact of noise from various sources, aircraft included. The need for an improved method of expressing the actual or predicted noise levels was expressed in meetings with the Noise Management Study Advisory Group (NMSAG).

As a result of consultations with the NMSAG and the TPA, the scope of the study was broadened to include the field monitoring of noise near the Airport and within the surrounding community. The field noise monitoring was undertaken and collected in such a way that the resultant data could be used in the calibration of a future community noise model which would more realistically present the level and distribution of cumulative community noise from not only airport related sources but other urban sources such as automobiles, trains, boats, pedestrians, building equipment, machinery and wave action.

The field data was collected under the following parameters and criteria:

i) Sound level measurements captured during rain or high wind events were excluded from the analysis as the measured levels will not reflect the actual background sound.

ii) Twenty minute (20) attended visual observations and measurements (using hand-held measuring devices) were taken twice during daytime, evening and nighttime hours during the monitoring period, as well during initial equipment set-up and pick-up. These visits aid in validating the unattended noise monitoring result and in calibrating any community noise model the data may be utilized in.

iii) Where possible, measurement equipment was placed on rooftops in order to obtain better quality readings with less extraneous localized noise events.

iv) The final locations for the noise measurement equipment were determined in the field to ensure representative noise measurements (e.g. keeping the monitoring equipment away from loud industrial sources such as cooling towers, construction sites, fire/ambulance stations) and the security of the equipment.

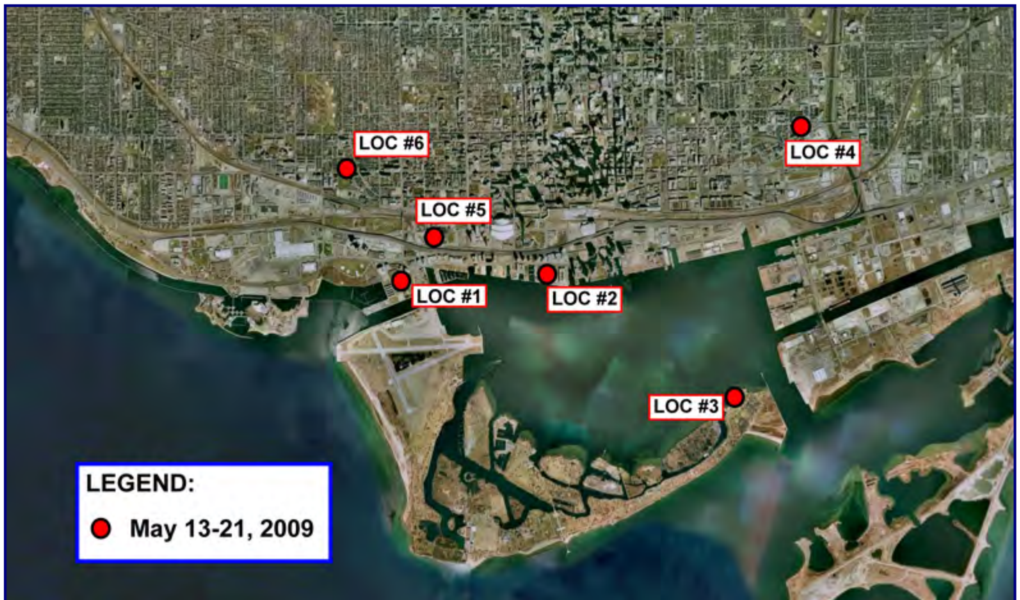
Unattended Acoustic Measurements

Measurement Locations. Unattended sound level measurements were conducted at six (6) monitoring locations within the community surrounding the BBTCA from May 13 until May 21, 2009. The unattended sound level monitoring locations are identified as locations M1 through M6, in Figure II-1. The six (6) monitoring locations were selected to capture the sound levels of typical urban activity, including aircraft, vehicular and rail traffic. The monitoring locations are summarized below:

- Location 1 (M1) - 680 Queens Quay, balcony of unit 702, facing south;
- Location 2 (M2) - 3rd floor rooftop of Harbour Front Centre, north building;
- Location 3 (M3) - Wards Island, northeast shore;
- Location 4 (M4) - 3rd floor rooftop, northwest corner, Queen and River Street;

- Location 5 (M5) - City Place development, approx. 50 m north of Gardiner Expressway;
- Location 6 (M6) - 7th floor rooftop, 833 King Street West.

Figure II-1: Noise Monitoring Locations (May 13 to 21, 2009)



Instrumentation. Ontario Ministry of the Environment technical publication NPC-102, "Instrumentation" provides specifications for sound level measurement instrumentation. All equipment used for these measurements met these requirements.

Six (6) Bruel & Kjaer Sound Level Meters were used for the unattended monitoring. The instruments are described in Table II-1 below.

Table II-1: Instrumentation Used For Unattended Sound Level Measurements

Measurement Location	Instrument Make and Model	Instrument Serial No.
Location #1	Bruel and Kjaer Type 2236	1849429
Location #2	Bruel and Kjaer Type 2238	2342948
Location #3	Bruel and Kjaer Type 2236	2039554
Location #4	Bruel and Kjaer Type 2238	2448501
Location #5	Bruel and Kjaer Type 2236	2151071
Location #6	Bruel and Kjaer Type 2238	2562611

All the listed meters are maintained in yearly laboratory calibration. In addition, correct calibration of the acoustic instrumentation was verified using Bruel and Kjaer and Rion acoustic calibrators. Wind screens were used on all microphones, consistent with the requirements of technical publication NPC-103, "Procedures".

Analysis and Results. The unattended sound level monitoring results are presented graphically in Figures 2 through 7 in Appendix A. The graphs contain the ten minute L_{EQ} sound levels, the one hour L_{EQ} sound levels and the hourly wind speed and direction from Environment Canada. Table II-2 presents the average daytime and nighttime hourly L_{EQ} sound levels. The sound levels provided in Table II-2 and Table II-3 do not include levels measured during poor weather or high winds.

The Leq (1s) is for all intents and purposes the instantaneous sound level occurring at any time. It is typically used to identify the sound levels of various events. The Leq (10m) is the sound level energy averaged over a 10 minute period, which is the optimum averaging time for the automated monitors when deployed over a number of days. It includes all sounds occurring during a 10 minute period. The Leq (1hr) is the sound level energy averaged over a 1 hour period and includes all sounds occurring during a 1 hour period. It can be useful in setting criteria, such as determining the quietest daytime or nighttime hour. The Leq (1hr) and Leq (10 min) are also useful along with the other statistical descriptors recorded during the measurements to determine if single events dominated the background environment or if the background is steady with little variation. Typically, shorter averaging times produce more variation (ups and downs) in the graphical output.

Table II-2: Unattended Sound Level Monitoring Average Daytime and Nighttime Sound Levels, L_{EQ} (dBA)

Location	Daytime, L_{EQ}	Evening, L_{EQ}	Nighttime, L_{EQ}
#1	64	62	54
#2	64	63	59
#3	54	54	50
#4	62	62	59
#5	70	68	66
#6	62	62	59

Table II-2 indicates that the average daytime (07:00-19:00), evening (19:00-23:00) and nighttime (23:00-07:00) hourly sound levels vary from 50-70 dBA depending on location and are typical of an urban environment.

Table II-3 presents the minimum hourly L_{EQ} for daytime and nighttime hours at each monitored location.

The measurements indicate that the quietest location is Location #3 (Toronto Island) where sound levels consistently fall below 50 dBA. At other locations, sound levels are higher due to road traffic and typical urban activities.

Table II-3: Unattended Sound Level Monitoring Minimum Daytime and Nighttime $L_{EQ\text{-}1\ hr}$ (dBA)

Location	Daytime (07:00-19:00)	Evening (19:00-23:00)	Nighttime (23:00-07:00)
#1	54	53	48
#2	59	59	55
#3	46	47	43
#4	58	58	55
#5	64	65	60
#6	50	54	48

Attended Acoustic Measurements

Measurement Locations. Attended acoustic measurements were conducted at or near the unattended monitoring locations. At some locations, only the first (deployment) and last (retrieval) attended sound level measurements were conducted at the monitoring location because of accessibility. Where the monitor was located on a rooftop or on a balcony, attended measurements were conducted in the near vicinity at ground level. The attended measurements were utilized to qualitatively and quantitatively identify sound sources that the unattended sound level monitors were recording.

Instrumentation. Three (3) Hewlett Packard Type 3569A Real Time Frequency Analyzers (SN 3222A00134, 3222A00199, and 3442A00141), in conjunction with Bruel & Kjaer microphones, a Larson Davis Sound Track LXT1 (SN 001724) Sound Level Meter or a Bruel & Kjaer 2270 Integrating Sound Level Meter (SN 2623039) were used for the attended measurements. Correct calibration of the acoustic instrumentation was verified using Bruel and Kjaer and Rion acoustic calibrators. Wind screens were used on all microphones, consistent with the requirements of technical publication NPC-103.

Analysis and Results. In accordance with the requirements of NPC-103, several 20-minute attended measurements were conducted at the six (6) monitoring locations during the daytime, evening and nighttime hours of the measurement period. The measured sound levels and brief site observations are summarized in Tables II-4 through II-9.

Table II-4: Attended Sound Level Monitoring, Location #1

Date & Time	$L_{EQ\ 20\ min}$ (dBA)	Comments
May 14, 2009, 20:00	53	Gardiner Expressway audible, air conditioning unit at neighbouring condo unit, aircraft flyover (probably originating/destined for Pearson Airport), traffic helicopter, light traffic on local road, ferry horn.
May 14, 2009, 17:45	61	Turboprop aircraft take-off, turboprop aircraft landing, kids in the park, traffic on Queens Quay, turboprop aircraft takeoff, motorbike.
May 15, 2009, 1:55	56	Noise from Airport mechanical equipment, urban hum, local vehicle pass-bys and idling.
May 15, 2009, 9:15	58	Helicopter overhead, street cleaner, aircraft take-off (twice), local traffic, traffic noise steady in background.
May 19, 2009, 13:45	59	Turboprop aircraft landing, seagulls, fire truck at airport, aircraft take-off, distant traffic audible, local traffic.
May 19, 2009, 21:10	61	Local traffic on Stadium Road dominant, aircraft take-off and landing, single engine aircraft touch and go operation.
May 20, 2009, 5:35	48	Gardiner Expressway audible, port ferry horn noise, birds, activity at airport.
May 22, 2009, 7:35	60	Helicopter overhead, cars on Queens Quay, birds, construction activity, Porter plane landing, “urban hum” steady

Table II-5: Attended Sound Level Monitoring, Location #2

Date & Time	$L_{EQ\ 20\ min}$ (dBA)	Comments
May 14, 2009, 11:50	69	Outdoor music to the west, kids playing, turboprop aircraft take-off.
May 14, 2009, 19:15	61	Gardiner Expressway dominant, streetcar on Queens Quay, helicopter, turboprop aircraft landing.
May 15, 2009, 8:10	63	Streetcar, helicopter, traffic on the Gardiner Expressway steady, typical urban hum, aircraft from BBTCA barely audible.
May 15, 2009, 1:15	59	Traffic on Queens Quay steady, traffic on Gardiner Expressway and Lakeshore Blvd, three streetcar passbys, people and music.
May 19, 2009, 8:45	63	Helicopter overhead (twice), turboprop aircraft, birds, Gardiner Expressway steady, Queens Quay traffic dominant, construction noise to the west, turboprop aircraft take-off, streetcars.
May 19, 2009, 21:50	64	Aircraft passby overhead (3 times), traffic noise from Queens Quay, Gardiner Expressway and Lakeshore Blvd, streetcar (5 times).
May 20, 2009, 4:30	54	Traffic on the Gardiner Expressway dominant, occasional traffic on Queens Quay, aircraft flyover (probably originating/destined for Pearson).
May 21, 2009, 8:15	64	Traffic on Gardiner Expressway and Queens Quay dominant, streetcars, birds, traffic, construction activity, fire pump test on island, aircraft flyover (probably originating/destined for Pearson Airport).

Table II-6: Attended Sound Level Monitoring, Location #3

Date & Time	$L_{EQ\ 20\ min}$ (dBA)	Comments
May 13, 2009, 16:32	55	Wind in trees, distant traffic, children talking, turboprop aircraft landing, boat, single engine aircraft overhead.
May 14, 2009, 23:00	50	Aircraft flyover (probably originating/destined for Pearson Airport), steady urban traffic noise, occasional wave action.
May 15, 2009, 6:45	52	Turboprop aircraft takeoff, ferry approaching, birds, distant traffic, ferry horn, aircraft flyover (probably originating/destined for Pearson airport)
May 15, 2009, 7:10	51	Turboprop aircraft landing, aircraft flyover (probably originating/ destined for Pearson Airport), ferry horn, urban hum, Gardiner Expressway traffic, port ferry departing, turboprop aircraft takeoff.
May 19, 2009, 6:50	48	Wind in trees, distant traffic, birds, occasional wave action, ferry horn, Aircraft flyover (probably originating/destined for Pearson Airport), single engine aircraft landing, port ferry approaching island.
May 19, 2009, 7:12	53	Turboprop aircraft takeoff and another landing, ferry horn, occasional wave action, birds, traffic from mainland, port ferry leaving the dock, GO train, helicopter, turboprop aircraft overflight.
May 19, 2009, 10:18	55	Turboprop aircraft, boat, helicopter overhead, waves, cicadas, birds, dog barking, duck quack, turboprop aircraft take-off, aircraft overhead.
May 19, 2009, 10:44	54	Turboprop aircraft take-off, turboprop aircraft overhead, waves, distant traffic audible, turboprop aircraft landing (twice).
May 19, 2009, 22:48	50	Steady noise from the city, aircraft overhead.
May 21, 2009, 6:50	57	Turboprop aircraft take-off (twice), overhead aircraft, helicopter.
May 21, 2009, 7:20	55	Ferry departing island, turboprop aircraft landing (twice), construction activity, ferry horn at mainland, birds.

Table II-7: Attended Sound Level Monitoring, Location #5

Date & Time	$L_{EQ\ 20\ min}$ (dBA)	Comments
May 14, 2009, 13:30	70	Gardiner Expressway dominant, some wind noise.
May 14, 2009, 20:35	62	Gardiner Expressway dominant, truck passby, train, siren, turboprop aircraft not audible during take-off, aircraft flyover audible (probably originating/destined for Pearson Airport).
May 14, 2009, 1:02	56	Gardiner Expressway dominant, security guard on-site.
May 15, 2009, 9:25	65	Gardiner Expressway dominant, construction noise (banging trucks, cement mixer), geese honking, helicopter overhead
May 19, 2009, 14:16	73	Gardiner Expressway dominant, trucks, construction noise.
May 19, 2009, 21:48	63	Traffic noise is dominant, chirping animals, local car passby (twice).
May 20, 2009, 5:00	59	Gardiner Expressway dominant, helicopter passby, GO trains, construction vehicle, trucks.
May 21, 2009, 11:00	71	Gardiner Expressway dominant, construction activity, train horn, dump truck, turboprop aircraft take-off.

Table II-8: Attended Sound Level Monitoring, Location #4

Date & Time	$L_{EQ\ 20\ min}$ (dBA)	Comments
May 15, 2009, 10:10	62	Vehicle traffic on Queen Street, Eastern Avenue, Adelaide Street, Richmond Street and the Don Valley Parkway, streetcars on Queen Street, float plane activity, turboprop aircraft takeoff not audible.
May 15, 2009, 13:50	64	Single engine aircraft activity, streetcar (twice), traffic on Queen Street, Eastern Avenue and the Don Valley Parkway dominant, occasional truck activity.
May 19, 2009, 12:00	67	Don Valley Parkway dominant, other local traffic, streetcars, turboprop aircraft overhead.
May 19, 2009, 21:05	63	Urban hum, streetcars, local traffic.
May 20, 2009, 00:40	59	Traffic noise is dominant, streetcars.
May 20, 2009, 4:00	64	Streetcar, street cleaner, idling bus, Don Valley Parkway occasionally audible, bus and car passbys on Queen Street.
May 20, 2009, 14:49	68	Traffic on Queen Street is dominant, streetcars, heavy trucks, excavating activity at West Donlands.
May 20, 2009, 21:30	62	Construction vehicle passby, streetcars on Lakeshore Blvd, motorcycle passby.
May 21, 2009, 9:15	62	Steady traffic on Queen Street, King Street, DVP, etc – "urban hum", construction activity, turboprop aircraft landing, streetcars, turboprop aircraft passby, GO trains, turboprop aircraft landing, single engine aircraft take-off, aircraft flyover (probably originating/destined for Pearson Airport).

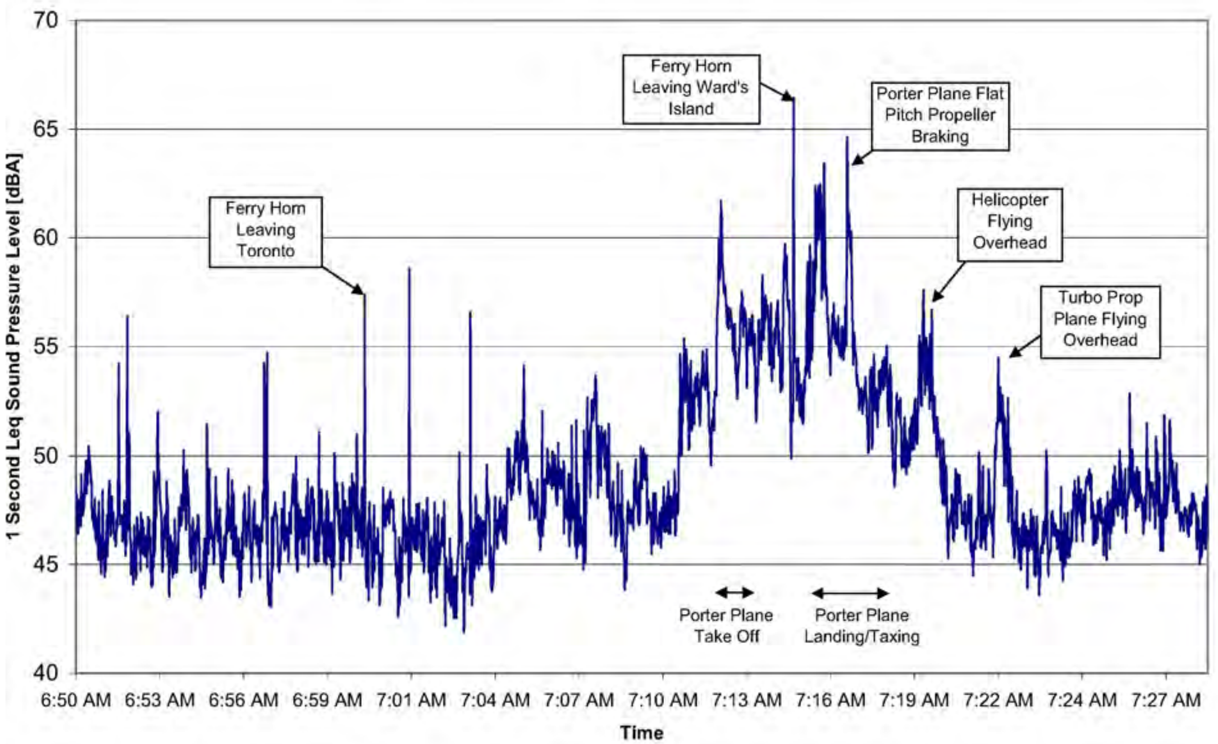
Table II-9: Attended Sound Level Monitoring, Location #6

Date & Time	$L_{EQ\ 20\ min}$ (dBA)	Comments
May 14, 2009, 14:06	63	Gardiner Expressway steady and dominant, general urban hum, wind gusts, GO Train.
May 14, 2009, 22:21	55	Automobile idling, people talking, automobile with loud music.
May 15, 2009, 2:17	51	Traffic noise from King Street and surrounding area, car door slamming, loud talking.
May 15, 2009, 7:41	62	General traffic noise from King Street and area, loud school bus.
May 19, 2009, 13:08	62	Gardiner Expressway traffic is audible and dominant, aircraft overhead, streetcars, truck and motorcycle on King Street.
May 19, 2009, 22:30	60	Traffic noise is dominant, motorcycle passby, automobile startup.
May 20, 2009, 1:25	56	Traffic noise.
May 20, 2009, 7:28	62	Traffic noise, truck passby, people talking.
May 21, 2009, 10:20	65	Gardiner Expressway dominant, single engine aircraft overhead, helicopter overhead (twice), traffic on King Street, turboprop aircraft landing.

The attended sound level measurements provide an indication of what types of activity are typical at the monitoring locations. It also allows for a correlation between events and actual recorded sound levels.

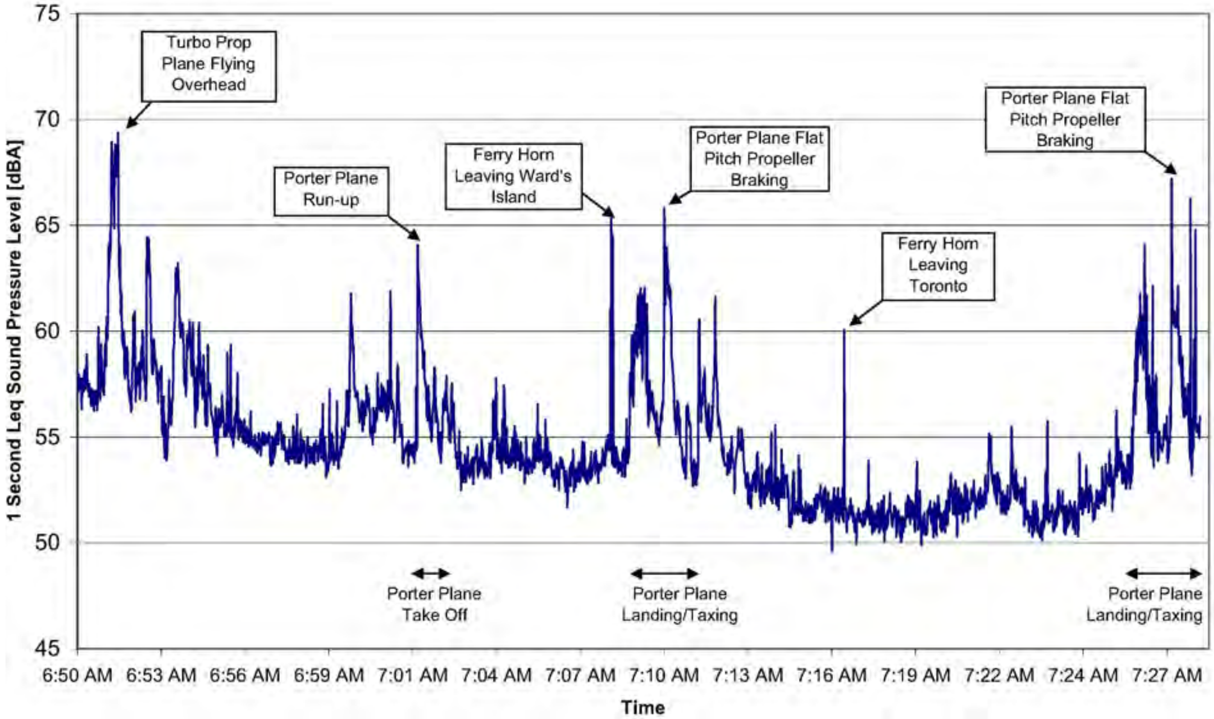
Sound levels were recorded every second over the course of each 20-plus minute measurement. Figure II-2 through Figure II-4 show the time history of the overall L_{EQ} sound level recorded during three selected measurement periods. All three selected measurement periods illustrate two 20-minute measurements conducted continuously. Key events have been noted on the figures. At Location 3 there were a number of bird calls not identified on the graphs. Additionally, at Location 1 there were a number of vehicle passbys (buses, trucks, etc.) that have not been specifically identified on the figures.

Figure II-2: Attended Sound Level Monitoring $Leq_{(1s)}$, Location #3, May 19, 2009 Between 06:50 and 07:30 (South Winds, 10 km/h)



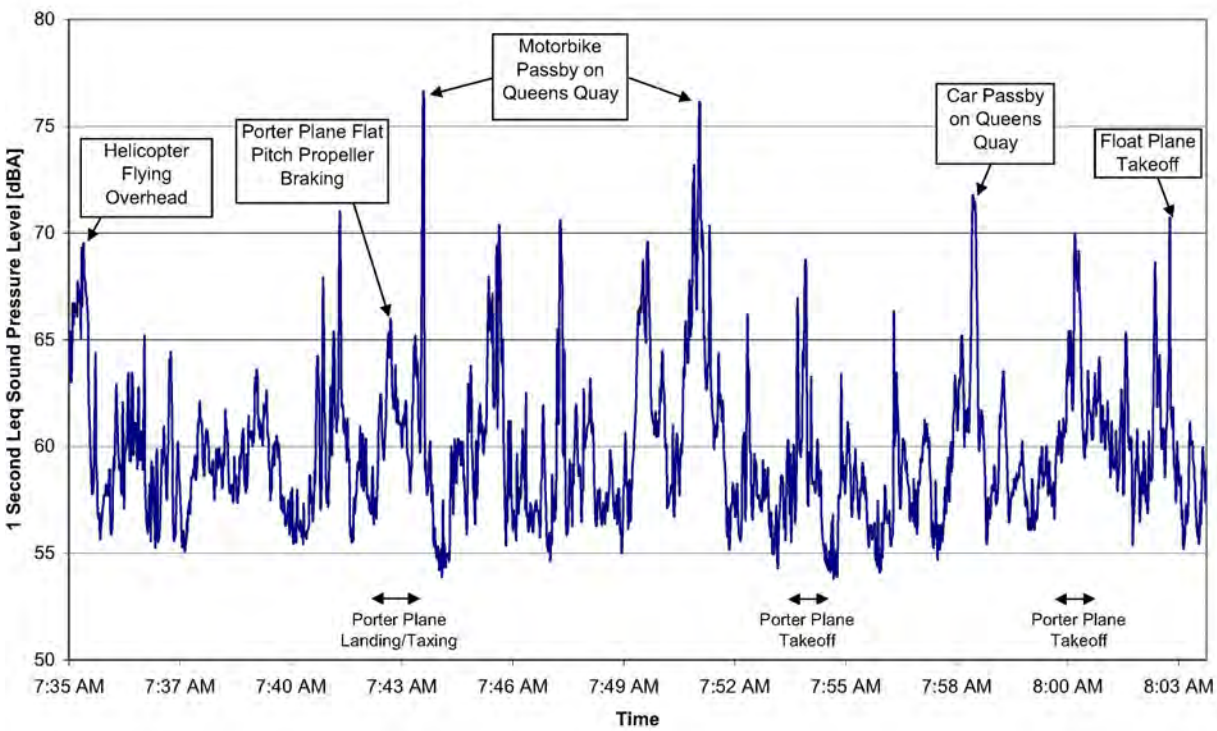
Source: HGC Engineering

Figure II-3: Attended Sound Level Monitoring $Leq_{(1s)}$, Location #3, May 21, 2009 Between 06:50 and 07:30 (Southwesterly Winds, 6 km/h)



Source: HGC Engineering

Figure II-4: Attended Sound Level Monitoring $Leq_{(1s)}$, Location #1, May 22, 2009 Between 07:35 and 08:05 (North Winds, 20 km/h)



III. AIRCRAFT NOISE MODELING

Aircraft Noise Modeling Methodology

Aircraft noise compatibility planning emphasizes the identification of community annoyance and incompatible land use using noise contours. The analysis of noise exposure around the Airport and the expression as noise contours in this study were prepared using Transport Canada's (TC) in-house developed software (NEF_1.8 program) to model aircraft noise and produce the NEF contours.

Inputs to the NEF model include the runway definition, number of aircraft operations during the period evaluated, the types of aircraft flown, how frequently each runway is used for arriving and departing aircraft, and the routes of flight used to and from the runways. The NEF program uses a database of aircraft noise characteristics for a selected list of commonly used aircraft types. The NEF model calculates noise exposure for the area around the Airport and outputs contours of equal noise exposure. The primary use of NEF models is to produce estimates of annual average noise conditions in the airport environs. For this study, equal noise exposure forecast (NEF) contours for the levels NEF 25, 28, 30 and 35 were calculated.

Limitations of Noise Modeling

The validity and accuracy of noise modeling depend on the basic information used in the calculations. For future airport activities, the reliability of calculations is affected by a number of uncertainties:

- Aviation activity levels—e.g., the number of aircraft operations, the types of aircraft serving the airport, the times of operation (daytime, evening, and nighttime), and aircraft flight tracks—continual change over time.
- Aircraft acoustical and performance characteristics are estimates. When new aircraft designs are involved, aircraft noise data and flight characteristics must be estimated.
- The NEF and related metrics represent typical human response to aircraft noise. Because people vary in their responses to noise, the NEF scale can show only an average response to aircraft noise that might be expected from a community, but cannot predict an individual's reaction.
- Single flight tracks are used, as required, in computer modeling to represent a wider band of actual flight tracks.

Integrated Noise Model Input Data

This section describes the input data used for the noise analysis. Input data include:

- Airfield layout;
- Aircraft operations by aircraft type and time-of-day;
- Departure and arrival flight tracks;
- Climb and descent profiles; and

- Average runway use.

Airfield Description

Latitude and longitude coordinates for all runway ends and displaced thresholds were specified for model input. The airfield has three intersecting runways, Runway 06-24, 08-26 and Runway 15-33. Runway 8-26 serves as the primary arrival and departure runway. The landing thresholds of Runways 15 and 33 are both displaced by about 89.91 metres (295 feet).

NEF Database

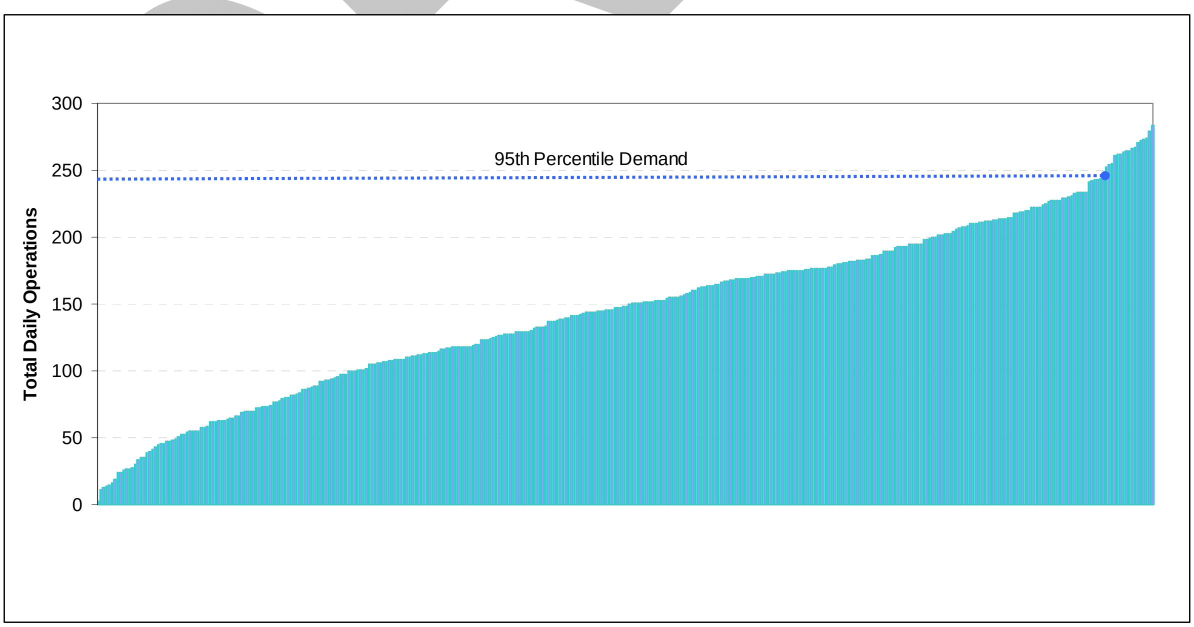
The NEF aircraft database includes information for commercial, general aviation, and military aircraft powered by turbojet, turbofan, or propeller-driven engines. For each aircraft in the database, the following information is provided: (1) a set of departure profiles for each applicable trip length, (2) a set of approach parameters, and (3) noise versus distance curves.

The Transport Canada NEF software only has 81 aircraft types in its database. The user must assign a surrogate or may define an aircraft type by supplying take-off, sideline, and approach noise levels for those aircraft that do not have a direct NEF equivalent.

Scenarios, Aircraft Operations, and Fleet Mix

The Year 2008 baseline, which represents actual conditions for that calendar year, was the study scenario. The 95th percentile planning day was used for the analysis. Nav Canada Aircraft Movement System (NCAMS) data for the 2008 calendar year (January to December) was analyzed to obtain aircraft demand and fleet mix.

The 95th percentile demand was derived to be 244 total operations per day. The airport accommodated 286 total operations on the busiest day in 2008. The figure below shows the variation in the daily demand. The fleet mix used was the typical fleet mix for the 2008 calendar year operating at the airport. The typical fleet mix is derived from NCAMS data from the total annual operations of each aircraft type as a proportion of the total annual operations for all aircraft types.



Time-of-Day Aircraft Activity

Since the NEF metric applies additional weights to nighttime noise events, the operations and fleet mix data must be input for two time periods – day (between 7:00 a.m. and 9:59 p.m.), and night (between 10:00 p.m. and 6:59 a.m.). Day-night split patterns for operations were based on arrival and departure times recorded in the 2008 NCAMS data. Due to the increased subjective response to noise at night, the NEF applies a 12.2 dB weighting to noise at night. This is equivalent to multiplying the number of night operations at night by a factor of 16.7.

Flight Path Definitions

Representative aircraft flight tracks were developed and incorporated into the model. Aircraft movements conducted during instrument meteorological conditions (IMC) were deemed to follow established approach and departure paths as documented in the *Canada Air Pilot* published by Nav Canada. In the case of flight operations conducted during visual meteorological conditions (VMC), actual historical flight tracks during a typical day (i.e. Nav Canada radar tracking) were used to construct a series of representative flight tracks.

Departure Paths

To define a departure path in the NEF program, the user can assign a turn start point based on altitude or a set distance away from brake release. The user is only able to define a maximum of two turn points for each departure path. If the start point of the turn is based on altitude, the NEF model accounts for the differing climb profiles for each aircraft and the turn will be executed at different distances from the airport for each aircraft.

Using the above information, the following NEF departure paths were defined:

- Runway 06 - climb runway heading to 3,000 ft, then right turn 5° (heading 065°)
- Runway 08 - climb runway heading for 10,000 ft from brake release, then right turn 61° (heading 141°)
- Runway 15 - climb to 650 ft, then right turn 51° (heading 201°)
- Runway 24 - climb to 400 ft, then left turn 39° (heading 201°)
- Runway 26 - climb to 450 ft, then left turn 59° (heading 201°)
- Runway 33 - climb to 500 ft, then right turn 15° (heading 345°)

Arrival Paths

The NEF model will only allow the user to define straight in approaches to the runway.

The arrival flight paths for each of the runways were modeled as straight in approaches with a glide slope of 3°. Scheduled turboprop aircraft arriving on Runway 26 were assigned a glide slope of 4.8°, and all other itinerant aircraft landing on this runway were assigned a glide slope of 3°.

Local movements (assumed to be operating under VFR conditions and procedures) were assigned a glide slope of 4.8°. Helicopter movements were assigned a glide slope of 5.0°.

Single engine GA aircraft were distributed 75% with variable pitch propellers and 25% with flat pitch propellers.

Local Training Circuits

A right hand circuit was assigned to Runway 08, and a left hand circuit was assigned to Runway 15, a left hand circuit was assigned to Runway 24, a left hand circuit was assigned to Runway 26, a left hand circuit was assigned to Runway 33, and a right hand circuit was assigned to Runway 06.

Aircraft Mix

The 2008 NCAMS files were used to determine the aircraft mix. The NCAMS aircraft types and their NEF surrogates are provided in the table below.

NCAMS	INM	NEF
AA5	AA5A	"GASEPV"
AC11	CNA172	"GASEPV"
AC90	CNA441	"BEC58P"
B350	BEC300	"DHC6"
BE10	BEC100	"DHC6"
BE20	BEC200	"DHC6"
BE36	BEC33	"GASEPV"
BE9L	BEC90	"DHC6"
C150	CNA172	"GASEPV"
C172	CNA172	"GASEPV"
C180	CNA180	"GASEPV"
C182	CNA182	"GASEPV"
C185	CNA185	"GASEPV"
C206	CNA206	"GASEPV"
C208	CNA208	"DHC6"
C414	CNA414	"BEC58P"
DH8D	DHC830	"DHC8"
MU2	MU2	"DHC6"
P28A	PA28	"GASEPV"
P28R	PA28AR	"GASEPV"
PA27	PA28AR	"BEC58P"
PA31	PA31	"PA31"*
PA34	PA34	"BEC58P"
PA36	PA36	"GASEPV"
PA38	PA38	"GASEPV"
PA44	PA44	"BEC58P"
PA46	PA46	"GASEPV"
PAY2	CNA441	"DHC6"
PC12	GASEPV	"DHC6"
SR20	CNA401	"GASEPV"
SR22	CNA401	"GASEPV"
Helicopters		"B212"*

* user defined

Aircraft Day/Night Split –Runway Allocation

The following tables show the day/night splits and runway allocations derived from NCAMS data:

Itinerant Operations (248.19 operations)

	ARRIVALS											
	Day						Night					
	Rwy 6	Rwy 8	Rwy 15	Rwy 24	Rwy 26	Rwy 33	Rwy 6	Rwy 8	Rwy 15	Rwy 24	Rwy 26	Rwy 33
"BEC58P"	0.01	0.99	0.00	0.01	1.53	0.12	0.00	0.01	0.00	0.00	0.01	0.00
"DHC6"	0.00	5.09	0.00	0.01	9.92	0.62	0.00	0.10	0.00	0.00	0.26	0.00
"DHC8"	0.00	12.40	0.00	0.00	25.41	0.00	0.00	1.01	0.00	0.00	2.02	0.00
"GASEPV"	0.41	19.64	0.01	2.40	34.97	4.09	0.00	0.80	0.00	0.00	1.53	0.00
"PA31"	0.00	0.34	0.00	0.01	0.83	0.01	0.00	0.02	0.00	0.00	0.02	0.00

	DEPARTURES											
	Day						Night					
	Rwy 6	Rwy 8	Rwy 15	Rwy 24	Rwy 26	Rwy 33	Rwy 6	Rwy 8	Rwy 15	Rwy 24	Rwy 26	Rwy 33
"BEC58P"	0.00	0.96	0.01	0.01	1.66	0.00	0.00	0.03	0.00	0.00	0.02	0.00
"DHC6"	0.00	5.31	0.03	0.01	10.11	0.01	0.00	0.16	0.00	0.00	0.20	0.00
"DHC8"	0.00	13.60	0.00	0.01	25.03	0.00	0.00	0.56	0.00	0.00	1.32	0.00
"GASEPV"	0.06	20.27	0.79	1.86	38.56	1.03	0.00	0.33	0.00	0.00	0.43	0.00
"PA31"	0.00	0.38	0.01	0.01	0.79	0.00	0.00	0.02	0.00	0.00	0.03	0.00

Local Operations (104.65 operations)

	Day						Night					
NEF	Rwy 6	Rwy 8	Rwy 15	Rwy 24	Rwy 26	Rwy 33	Rwy 6	Rwy 8	Rwy 15	Rwy 24	Rwy 26	Rwy 33
"GASEPV"	0.11	33.17	1.23	3.26	63.70	1.81	0.00	0.14	0.00	0.00	0.18	0.00
"BEC58P"	0.00	0.34	0.01	0.03	0.64	0.02	0.00	0.00	0.00	0.00	0.00	0.00

Helicopter Operations (28.61 operations)

	Day	Night
Arr	13.28	0.50
Dep	14.25	0.57

Aircraft Stage Length

Aircraft noise characteristics vary depending on the takeoff profiles (or climb rates) of aircraft. Takeoff weight directly affects the departure profiles. Because of the difficulty of obtaining data on aircraft takeoff weight, stage length is often used as a surrogate. Stage length refers to the average distance an aircraft travels non-stop. Departure operations in the NEF model are divided into stage lengths that correspond to approximate non-stop flight distances. Each stage length associates the aircraft operation with a takeoff weight that represents a typical passenger load factor and fuel requirement. The longer the stage length, the shallower the climb profile. This is because the heavier the fuel load carried on the longer stage lengths.

For BBTCA, a single stage length of 0 to 500 nm was used based on information derived from the Statistics Canada historical data for the Airport's aircraft movements. Overflying aircraft were not addressed in the NEF model.

Runway End Utilization

Average annual runway use assumptions for 2008 were developed from Statistics Canada's 2008 NCAMS data by time of day. Runway 08 tends to be the primary arrival runway while Runway 26 tends to be the dominant departure runway due to predominant wind direction, local terrain and airspace constraints. The 2008 data reflect both formal and informal runway use policies in effect at the Airport. Because of the proximity of the airport to downtown, there is a restriction on nighttime flights. Only air ambulance and other emergency operations are permitted.

Runway assignments were distributed in proportion by operation type, event time, aircraft type, and runway use percentages. Runway end utilization percentages were calculated based on the NCAMS data and are presented in Table III-1 below.

Table III-1 - RUNWAY USAGE BY TIME OF DAY AT YTZ

Runway End	Day		Night	
	Arrival	Departure	Arrival	Departure
6	0.31%	0.04%	---	---
8	29.28%	31.55%	1.88%	0.96%
15	0.74%	0.67%	---	---
24	1.76%	1.37%	---	---
26	56.03%	59.19%	3.00%	1.69%
33	3.55%	0.76%	---	---
60	3.80%	3.76%	0.004%	0.01%
TOTALS	95.45%	97.34%	4.55%	2.66%

Source: 2008 NCAMS Data

Notes: 1. Runway "60" represents movements that do not use or report a runway, such as helicopter movements.

NEF Modeling Output

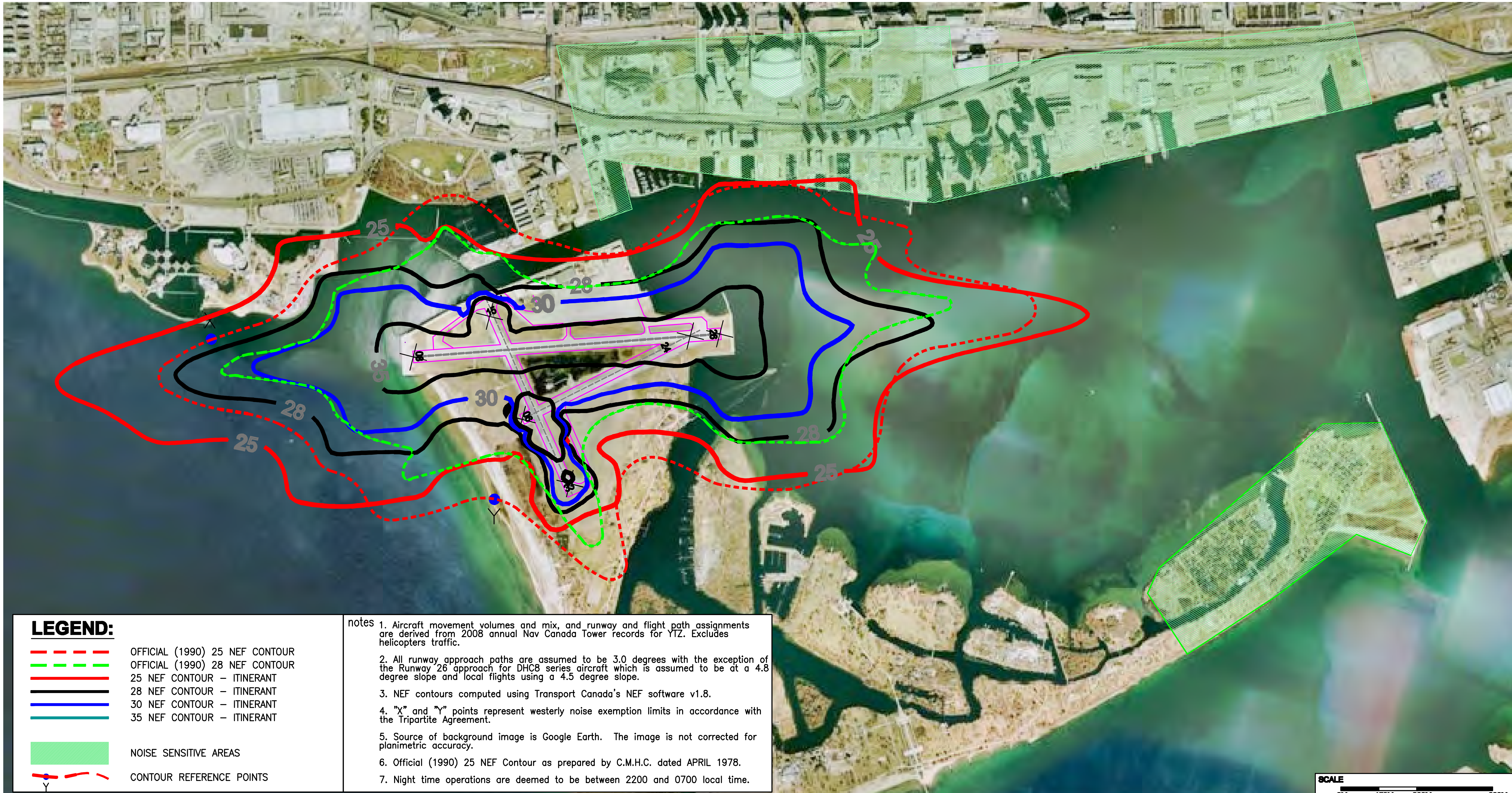
The NEF outputs generated from the model have been superimposed on an aerial image of the airport and surrounding areas, along with the official 25 NEF and 28 NEF contours (1990) from the Tripartite Agreement. The figures also show the approximate NSA areas which are taken from the most current version of the CFS.

Figure III-1 illustrates the NEF contours excluding helicopter operations and Figure III-2 illustrates the NEF contours including helicopter operations.

Tripartite Agreement Noise Limitations

In accordance with the Tripartite Agreement, aircraft/helicopter operations at the Airport are limited by the 1990 NEF contours prepared in April 1978 by the Federal Ministry of Transport. The 28 NEF contour, produced by modeling the 95% percentile annual movements at airport, must remain within the limits of the official 25 NEF contour (1990). The modeled 28 NEF contour may only exceed the official 25 NEF (1990) contour between the two designated points (marked as “X” and “Y” on the official plan and on the attached figures) situated at the western most limits of the Airport property.

Figures III-1 and III-2 show that the modeled 28 NEF contour using 2008 annual movement data is within the official 25 NEF contour in compliance with the Tripartite Agreement.



LEGEND:

- OFFICIAL (1990) 25 NEF CONTOUR
- OFFICIAL (1990) 28 NEF CONTOUR
- 25 NEF CONTOUR – ITINERANT
- 28 NEF CONTOUR – ITINERANT
- 30 NEF CONTOUR – ITINERANT
- 35 NEF CONTOUR – ITINERANT
- NOISE SENSITIVE AREAS
- CONTOUR REFERENCE POINTS

notes

1. Aircraft movement volumes and mix, and runway and flight path assignments are derived from 2008 annual Nav Canada Tower records for YTZ. Excludes helicopters traffic.
2. All runway approach paths are assumed to be 3.0 degrees with the exception of the Runway 26 approach for DHC8 series aircraft which is assumed to be at a 4.8 degree slope and local flights using a 4.5 degree slope.
3. NEF contours computed using Transport Canada's NEF software v1.8.
4. "X" and "Y" points represent westerly noise exemption limits in accordance with the Tripartite Agreement.
5. Source of background image is Google Earth. The image is not corrected for planimetric accuracy.
6. Official (1990) 25 NEF Contour as prepared by C.M.H.C. dated APRIL 1978.
7. Night time operations are deemed to be between 2200 and 0700 local time.

Client: Toronto Port Authority

Project Title: **BILLY BISHOP TORONTO CITY AIRPORT- NOISE MANAGEMENT STUDY**

Consultant: JACOBS Consultancy

Rev	Date	Drawn By	Approved By	Description
5	08/01/2010	M.Z.	J.D.	REVISED NSA BOUNDARIES

Drawing Title: **NOISE EXPOSURE FORECAST- CURRENT (2008) YTZ AIRCRAFT MOVEMENTS**

Date	Revision	Drawing Status
25-NOV-2009	5	DRAFT

Scale	Drawing
1:15000	III-1

Jan 19, 2010 – 8:38pm

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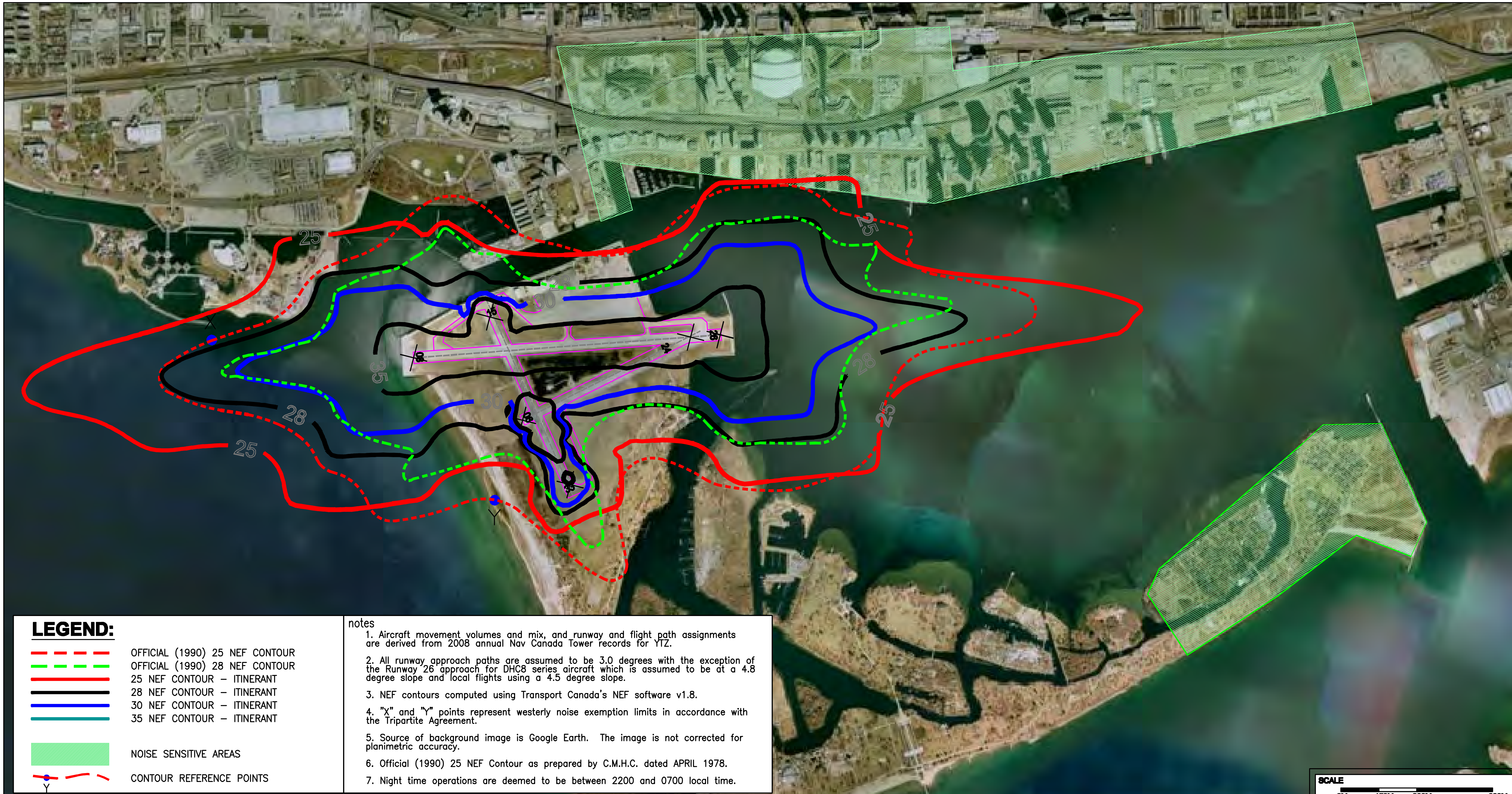

LEGEND:

- OFFICIAL (1990) 25 NEF CONTOUR
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Client

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BILLY BISHOP TORONTO CITY AIRPORT-
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Consultant

JACOBS Consultancy

Rev	Date	Drawn By	Approved By	Description
5	08/01/2010	M.Z.	J.D.	REVISED NSA BOUNDARIES

Drawing Title

NOISE EXPOSURE FORECAST-
CURRENT (2008) YTZ AIRCRAFT MOVEMENTS

Date	Revision	Drawing Status
25-NOV-2009	5	DRAFT

Scale	Drawing
1:15000	III-2

Jan 19, 2010 – 8:36pm

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IV. RECOMMENDED NOISE ABATEMENT MEASURES

One of the main objectives of the Noise Management Study is to provide guidance for the development and implementation of noise abatement measures. The following are the recommended noise abatement measures resulting from the study.

Noise From Ground Operations – Reverse Thrust Braking

The use of reverse thrust after landing improves safety margins by providing a retardation largely independent of runway surface conditions. Its use also increases runway capacity. The full value of reverse thrust however is only realized at high engine thrust and this surge of power, particularly during the evening and night, or in a period when there are no take-offs dominating the noise environment, may create a noise problem.

Because of the safety considerations it is not possible to altogether ban the use of this technique. In practice, however, it is often possible to balance the safety aspect in terms of the actual runway length available. Consequently, for sufficiently long runways, the selection of idle rather than full reverse thrust will significantly reduce the noise, while ensuring that the full reverse thruster is immediately available in case an emergency develops.

In the past, the Airport has promoted the concept of a balanced use of reverse thrust. In the case of Porter Airlines, they have adopted a corporate policy to discourage the use of reverse thrust to only whenever safety considerations require it. Instead Porter uses a technique available with turboprop aircraft known as "flat pitch propeller braking" which helps to slow down the aircraft but at a considerably lower noise level than conventional reverse thrust. Other operators have differing policies with respect to the use of reverse thrust, but in general, operators are beginning to limit unnecessary reverse thrust because of the potential fuel savings and decrease in noise levels. Smaller and lighter single engine aircraft do not generally require reverse thrust because of their much lighter weight.

RECOMMENDATION #1 – TPA to develop a formal policy encouraging operators to limit the use of reverse thrust, above idle power, consistent with the safe operation of the aircraft. Further, the policy is to be actively communicated to the pilot community.

Noise from Ground Operations – Engine Run-ups

Aircraft engine run-ups are required for both aircraft maintenance and for pre-flight checks. Although engine run-ups are not necessarily a regulatory requirement, they are a part of most aircraft manufacturers' standard operating procedures (SOP). For example, the SOPs for single and twin engine aircraft typically require that pre-flight engine run-ups be undertaken prior to each flight segment in order to check engine instruments and performance. During a run-up procedure, aircraft are generally positioned in a heading within 20 degrees (plus or minus) of the actual wind direction.

Maintenance engine run-ups are considered to be any operation of aircraft engines for the purpose of assessing engine performance before, during, and after maintenance and/or repairs. All other engine run-ups not covered under the maintenance category are deemed to be operator engine run-ups and may include (i.) routine engine and instrument checks carried out by a pilot(s) prior to a take-off procedure, and (ii.) the warming-up of piston or turboprop engines.

Although the Airport has requested based and itinerant pilots to refrain from engine run-ups on the apron areas and during night-time hours, there continue to be pilots who ignore the requests. A review of historical noise reports filed by community members suggests that on occasion engine run-ups have contributed to the report filings. There are a number of measures that can be undertaken in order to mitigate the noise generated from aircraft engine run-ups.

RECOMMENDATION #2 – TPA to develop and enact aircraft engine run-up policies and procedures which are formally communicated to the pilot community, addressing allowable times, specific areas, exceptions.

At present, the Airport has designated the end of Runway 33 as an engine run-up area. Although this area is suitable for maintenance related run-ups, it is not practical from a runway capacity and safety perspective for pre-flight run-ups due to its distance from the main runway (08-26) and apron areas. Pre-flight run-ups would be better suited at or near the predominant runway ends. These run-up areas or pads should allow the ability for other aircraft to bypass while an aircraft engine run-up is being performed in order to maintain runway system capacity.

RECOMMENDATION #3 – TCCA to assess and potentially develop designated engine run-up areas, including a maintenance run-up area (i.e. end of Runway 33) and runway end run-up pads (i.e. end of Runway 15; eastern edge of the Terminal Apron near Runway 26 end). Further, the TCCA should seek approval to have the designated run-up areas identified in the Canada Flight Supplement (CFS).

Occasionally, the placement of engine run-up areas or pads allow for the introduction of noise control barriers which may aid in further mitigating the noise impacts resulting from engine run-up procedures. Noise barriers are typically designed to absorb a majority of the sound vibrations rather than allowing them to reflect off of the surface. Some noise control barriers are able to absorb up to 70% of the sound vibrations reaching it.

RECOMMENDATION #4 – TPA to assess the potential of implementing noise control barriers at or near any proposed aircraft engine run-up areas or pads.

Noise from Ground Operations – Aircraft Taxing

Pilots taxing an aircraft to or from a runway will generally apply a low power or throttle setting except when they are starting from a standing position. In this instance, the pilot will apply 70 to 80 percent of the so-called "breakaway" thrust for a short period (typical 3 to 5 seconds) until the aircraft begins to roll. There are occasions where pilots of twin or turboprop aircraft will choose to taxi with a single engine in order to save on fuel burn (since a low throttle setting is much less efficient than at higher throttle settings) and engine wear. Use of a single engine for aircraft taxi may increase the noise generated but only marginally. In and of itself, aircraft taxi operations contribute only a small fraction of the noise generated within an airport environment.

Some past noise reports filed by community members appeared to have originated because of aircraft taxiing on Taxiway Alpha around the Runway 15 end which has exposure to the adjacent Yacht Club and Bathurst Quay residences. It is believed that the reports were a result of pre-flight engine run-ups rather than actual taxi operations. In addition, aircraft waiting to take-off from Runway 08 would have their tails directed in a north or north-easterly direction during a pre-flight engine run-up thus exacerbating the situation. This issue could be addressed by adopting the same measures discussed above for the engine run-up areas.

Noise Sensitive Areas

Noise sensitive areas (NSA) are specifically designated zones, primarily constituting residential uses, where aviation activity is limited in order to mitigate noise impacts on the community.

There are three (3) NSAs surrounding the Airport, as published in the current version of the CFS, which limits aviation activity to above 2500 ft ASL. The NSA was recently revised by Nav Canada to incorporate the eastern portion of Ward's Island. There are a number of recently developed residential areas that just fall outside the current NSA, including some high-rise condominiums. Consideration should be given to determining whether these areas should be incorporated into the NSA boundaries in order minimize noise impacts from close flying aircraft.

TPA would need to formally request Nav Canada to review the viability of any proposed revisions to the NSAs from an airspace, flight routing and safety perspective. If deemed acceptable by Nav Canada and other relevant stakeholders, such as change would require final approval from Transport Canada and the Canadian Aviation Regulation Advisory Council (CARAC) in order to publish in the CFS and Canada Air Pilot (CAP).

RECOMMENDATION #5 – TPA to discuss with Nav Canada possible revisions to Noise Sensitive Areas in order to better reflect the current land uses in the communities surrounding the airport lands while maintaining safety and capacity in the surrounding airspace.

The current NSAs in the vicinity of the Airport, are designated as areas to "avoid flight below 2500 ASL". Any infraction into these zones are not enforceable by the Airport, but are enforceable by Transport Canada in accordance with CAR 602.105. Overlying the Airport and the NSAs is the Toronto Terminal controlled airspace which limits operations above 2500 ASL to aircraft which are properly outfitted with a Mode C transponder and radio, and with the authorization of ATC.

Despite the current NSAs being published in the CFS and the CAP and continual reminders by the Airport Management, there are a number of pilots who occasionally track through NSAs. However, there are instances when Nav Canada do direct air traffic through the NSAs. The Toronto/City Centre VFR Terminal Procedure Chart, contained in the CFS, shows three aircraft flight routes. These are:

- Don Valley Route which accommodates inbound and outbound traffic;
- HWY 2 Route which handles inbound traffic from the east over land; and
- Lakeshore Route which handles outbound traffic to the east over water.

The HWY 2 Route tracks over one of the NSA zones north of the Beaches VFR check point. (VFR check points are geographical points which VFR traffic uses for position reporting to ATC.)

An alternative to the HWY 2 Route could be to relocate the southward segment that currently overflies the NSA to airspace over the R.C. Harris Water Treatment Plant and intercept the Beaches VFR check point at its current location. Although this would bring inbound traffic closer to outbound traffic over the lake, aircraft would keep watch for oncoming traffic and maintain radio contact as they currently do on the Don Valley Route, which handles inbound and outbound traffic.

RECOMMENDATION #6 – TPA to discuss with Transport Canada and Nav Canada the feasibility of redesigning the HWY 2 Flight Route to avoid tracking through the Greenwood Section of the Noise Sensitive Area.

Rotorcraft Operations

Like propeller aircraft, helicopters, or more appropriately referred to as rotorcraft, have an acoustical signature which is dependent on the type and size of powerplant. In addition, rotorcraft noise consists of a broadband spectrum generated by vortex formation and shedding in the flow past the rotorcraft blade. In addition, superimposed on the broadband spectrum for rotorcraft is a rotational noise known as blade slap. This high amplitude periodic noise plus highly modulated vortex noise caused by fluctuating forces on the blade due to the cutting of one blade's tip vortices by another blade and transonic shock. Blade slap is a distinctive, low frequency throbbing sound which increases during certain descent, maneuvering and high-speed cruise operations.

At BBTCA, the predominant rotorcraft operations are medevac and sightseeing related. Rotorcraft operators are required to file flight plans and take approach and departure instructions from Nav Canada ATC.

According to the Tripartite Agreement, once the threshold of rotorcraft movements is reach, rotorcraft approach and departure paths are to be established. As a result of this threshold being reached, Transport Canada, Nav Canada and the TPA held discussions during the first half of 2009. It was agreed among the parties to publish a procedure in the CFS to specify that established flight paths must be used by all rotorcraft operating to and from the BBTCA. The following procedure was adopted into the CFS as of October 2009: "Unless authorized by ATC, rotary wing aircraft are to conform to established circuit pattern.".

In order to mitigate rotorcraft noise on the surrounding communities during hovering exercises, the TPA has established procedures governing rotorcraft ground operations at the Airport. During normal operating hours, rotorcraft maintenance or training that requires hovering exercises must be conducted on the threshold of Runway 33. If Runway 33 is unavailable, then the threshold of Runway 06 becomes the alternative. After normal operating hours and for Ministry of Health medical evacuation flights only, rotorcraft maintenance is permitted in front of Hangar 4A; however, operators are encouraged to use the threshold of Runway 33 or 06.

It is suggested that the TPA encourage helicopter operators which conduct movements particularly during nighttime operations (principally Ministry of Health air ambulance) to utilize the Runway 08 end upon return from an emergency call and to utilize an approach slope of 5 degrees or greater.

Use of Preferential Runway

Preferred runway directions for takeoff are designated for noise abatement purposes; the objective being to use, whenever possible, those runways that permit aircraft to avoid noise-sensitive areas during the initial departure and final approach phases of flight.

Noise abatement is not the determining factor in runway designation under the following circumstances:

- if the runway is not clear and dry, i.e., it is adversely affected by snow, slush, ice, water, mud, rubber, oil or other substances;
- when the crosswind component, including gusts, exceeds 25 KT; and
- when the tail wind component, including gusts, exceeds 5 KT.

Although ATC personnel may select a preferential runway in accordance with the foregoing criteria, pilots are not obligated to accept the runway for taking off or landing. It remains the pilot's responsibility to decide if the assigned runway is operationally acceptable.

> RECOMMENDATION #7 – TPA to discuss with Transport Canada and Nav Canada the feasibility of designating preferential runway use in order to avoid Noise Sensitive Areas. Refer to example preferred runway use procedures.

ATC are also able to use preferential runway procedures to distribute traffic away from approaches that have a greater noise impact on surrounding communities, provided that meteorological conditions allow. This is particularly helpful during nighttime operations. Typically, when winds are less than 5 knots, pilots can use other than prevailing wind runways.

EXAMPLE OF PREFERRED RUNWAY PROCEDURE:

- Consistent with safe operating procedures, ATC will assign runways to minimize as many departures and arrivals as possible over residential areas adjacent to the airport.
- The order of preference is:

DEPARTUES	ARRIVALS
26	08
XX	XX
XX	XX
XX	XX

- Under conditions where there is a mixture of arrivals and departures and it is not operationally practicable for ATC to use multiple runways, the preferential runway determination will be based on the runway preference for departures.
- Limiting Factors: (affecting order of preference):
  - Wet, snow covered or icy runway surface conditions.
  - Strong winds favoring non-preferential runways which are beyond safety limits of aircraft being operated with an effective crosswind exceeding 15 knots for arrivals and departures or tailwind exceeding 5 knots.
  - Use of a less preferred runway is acceptable if a backlog of aircraft traffic builds up on the airport due to aircraft waiting for departure.
  - Preferential runway out of service due to airfield maintenance reasons, or an aircraft halted on the runway due to mechanical problems which preclude its immediate removal.
  - Medivac aircraft may deviate from the preferred runway system as circumstances require.
- Note: These procedures shall not limit the discretion of either the ATC or the pilot with respect to the full utilization of the airport in the event of an unusual situation.

Redesign of Approach and Departure Flight Paths

As part of the work of the Noise Management Study, a review was conducted of the existing VFR and IFR approach and departure flight paths to identify opportunities for mitigating community noise impacts while maintaining airspace safety, integrity and capacity. Earlier in this brief, it was identified that a potential redesign of the existing HWY 2 VFR Approach Path could eliminate transiting through the Greenwood section of the NSA northeast of the Airport (if found feasible following a thorough technical assessment).

The review identified that the existing published non-precision RNAV (GNSS) A approach path tracks over portions of Algonquin and Ward's Island and the corresponding NSA. It is believed that the approach could potentially be redesigned to avoid the NSA; however, it would require a thorough review of the impacts to the adjacent airspace, approach and departure paths and existing obstacles.

RECOMMENDATION #8 – TPA to discuss with Transport Canada and Nav Canada the feasibility of redesigning the non-precision RNAV A approach path in order to avoid the Algonquin and Ward's Island Noise Sensitive Area.

Improvements to Published Noise Abatement Procedures

As previously noted, Airport noise abatement procedures and restrictions are published in the CFS and the CAP. Any changes to these procedures and restrictions must first be vetted through Nav Canada and other relevant stakeholders, and then, if there are no objections, the changes must be approved by Transport Canada and CARAC prior to publishing.

As part of the work of the Noise Management Study, a review was conducted of the existing procedures and restrictions contained in the CFS and CAP. From the review, it is believed that there is opportunity for improvement and additions to the wording. For example, language should be included advising of the engine run-up policy and locations.

RECOMMENDATION #9 – TPA to discuss with Transport Canada, Nav Canada and other stakeholders the potential for improvements to the stated procedures and restrictions in the CFS and CAP as they relate specifically to noise abatement and other matters which impact community noise.

V. COMMUNICATIONS AND COMMUNITY OUTREACH

The following are the recommended communication and outreach strategies and initiatives.

RECOMMENDATION #10 – Implement improvements to the summary noise reporting metrics to make them clear and more understandable to the community and provide comparisons to prior year's results.

RECOMMENDATION #11 – Improve response time (e.g. within 96 hours) and communication procedure for community noise reports.

RECOMMENDATION #12 – Conduct quarterly meetings with tenants and key users to communicate progress of noise management program and to discuss and resolve specific noise issues and noise mitigation opportunities.

RECOMMENDATION #13 – Provide further opportunities for educating the community regarding aircraft noise and noise abatement procedures through the TPA website and printed media.

RECOMMENDATION #14 – Establish a "Fly Quiet" voluntary compliance and pilot participation program which rewards pilots for compliance with mandatory and recommended noise mitigation procedures.

VI. ON-GOING NOISE MANAGEMENT EFFORTS

Establishing a Noise Management Program

In order for noise management policies, procedures and promotion to be effective and meaningful, it is crucial that the TPA establish a permanent noise management program. In so doing, the TPA recognizes that the conditions at the airport, within the aviation community and the surrounding communities change over time and require that noise mitigative measures keep pace.

The corner stones of an effective noise management program are:

- Periodic monitoring and assessment of airport generated noise;
- Consultative process with airport stakeholders and the community to assess the effectiveness of policy and procedures and recommend changes to reflect changing conditions;
- Compliance monitoring, reporting and enforcement; and
- Effective communication and program promotion to the aviation community and the general public.

In order to implement such a program, the TPA will need to allocate sufficient resources which current may not exist.

RECOMMENDATION #15 – Assess possible organizational changes to better address and implement noise management initiatives, including assessing the cost-benefits of outsourcing noise reporting and monitoring functions.

RECOMMENDATION #16 – Establish a permanent noise consultative process, involving airport and community stakeholders. The process would address the assessment of noise events and reports, trends in the frequency or type of noise issues, recommend changes to procedures, ensure transparency and timely response and information.

APPENDIX A – UNATTENDED NOISE MONITORING RESULTS

Figure 2: Sound Levels Measured at Location 1
680 Queens Quay, Unit 702, Toronto, South Facing Balcony with an Automated Sound Level Meter
HGC Engineering, May 14 to May 22, 2009
Comparison to Wind Speed & Direction

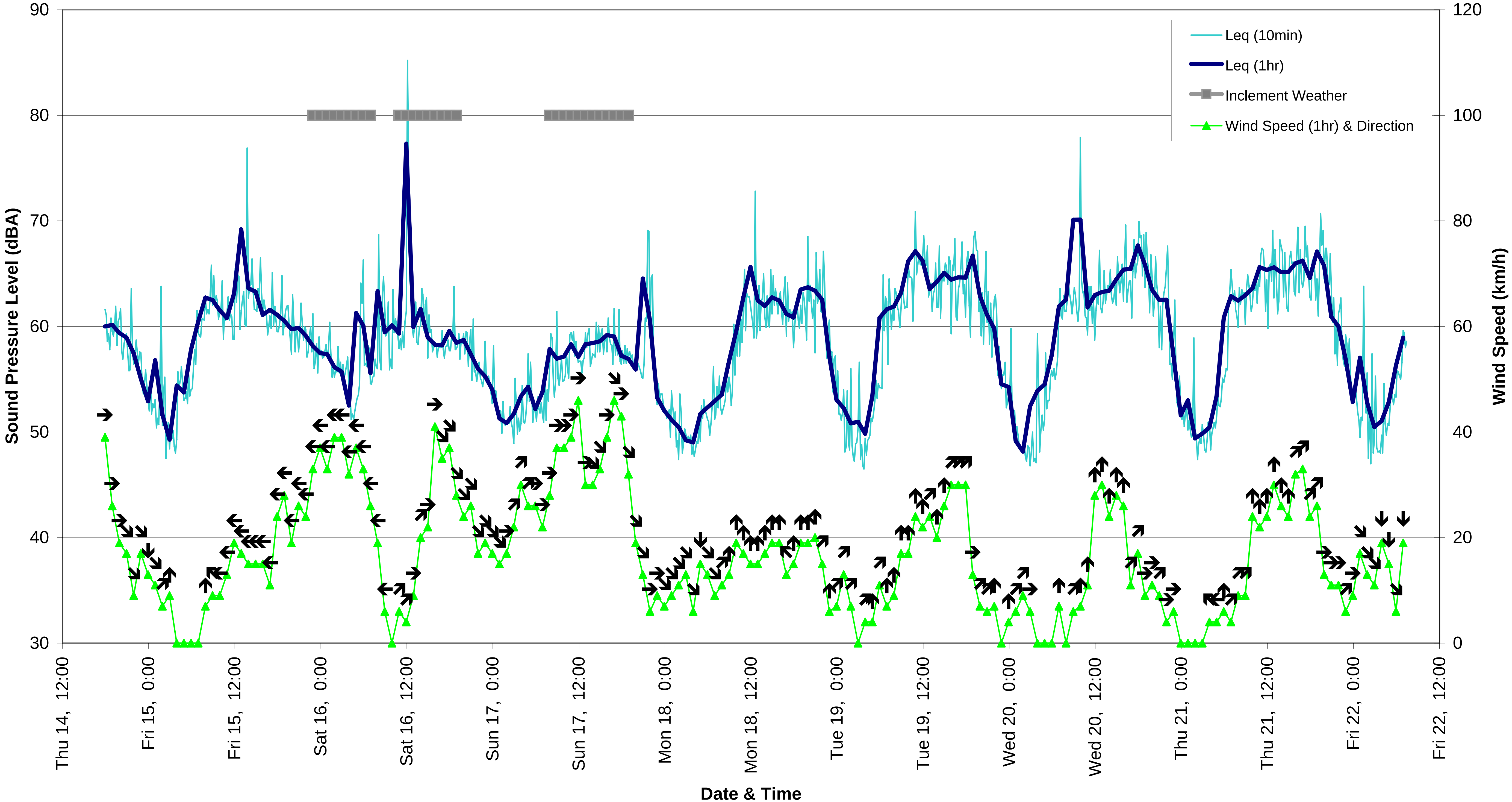

Figure 3: Sound Levels Measured at Location 2
Harbour Front Centre, 3rd Floor Rooftop with an Automated Sound Level Meter
HGC Engineering, May 14 to May 21, 2009
Comparison to Wind Speed & Direction

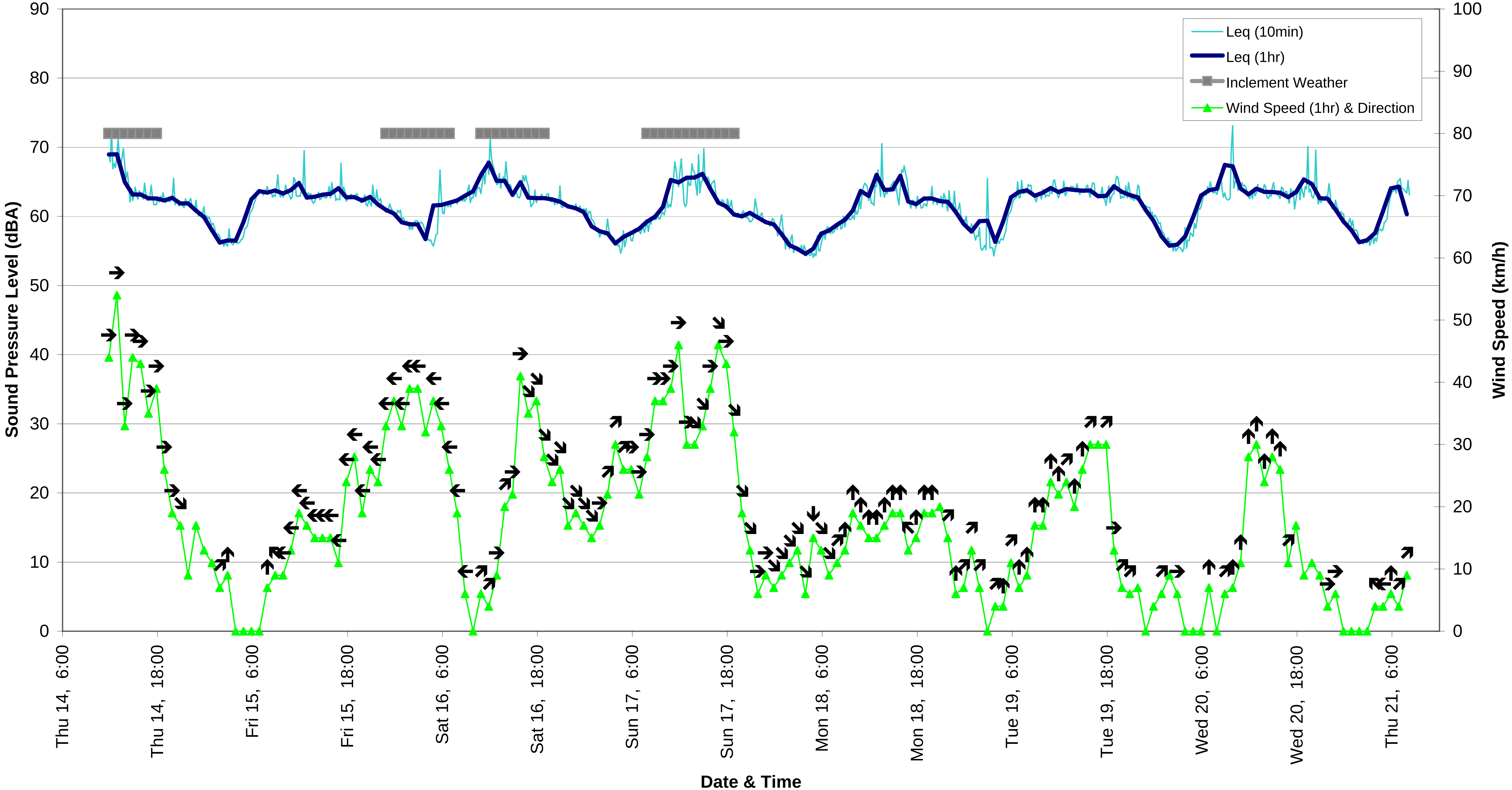

Figure 4: Sound Levels Measured at Location 3
Ward's Island, Toronto, with an Automated Sound Level Meter
HGC Engineering, May 13 to May 21, 2009
Comparison to Wind Speed and Direction

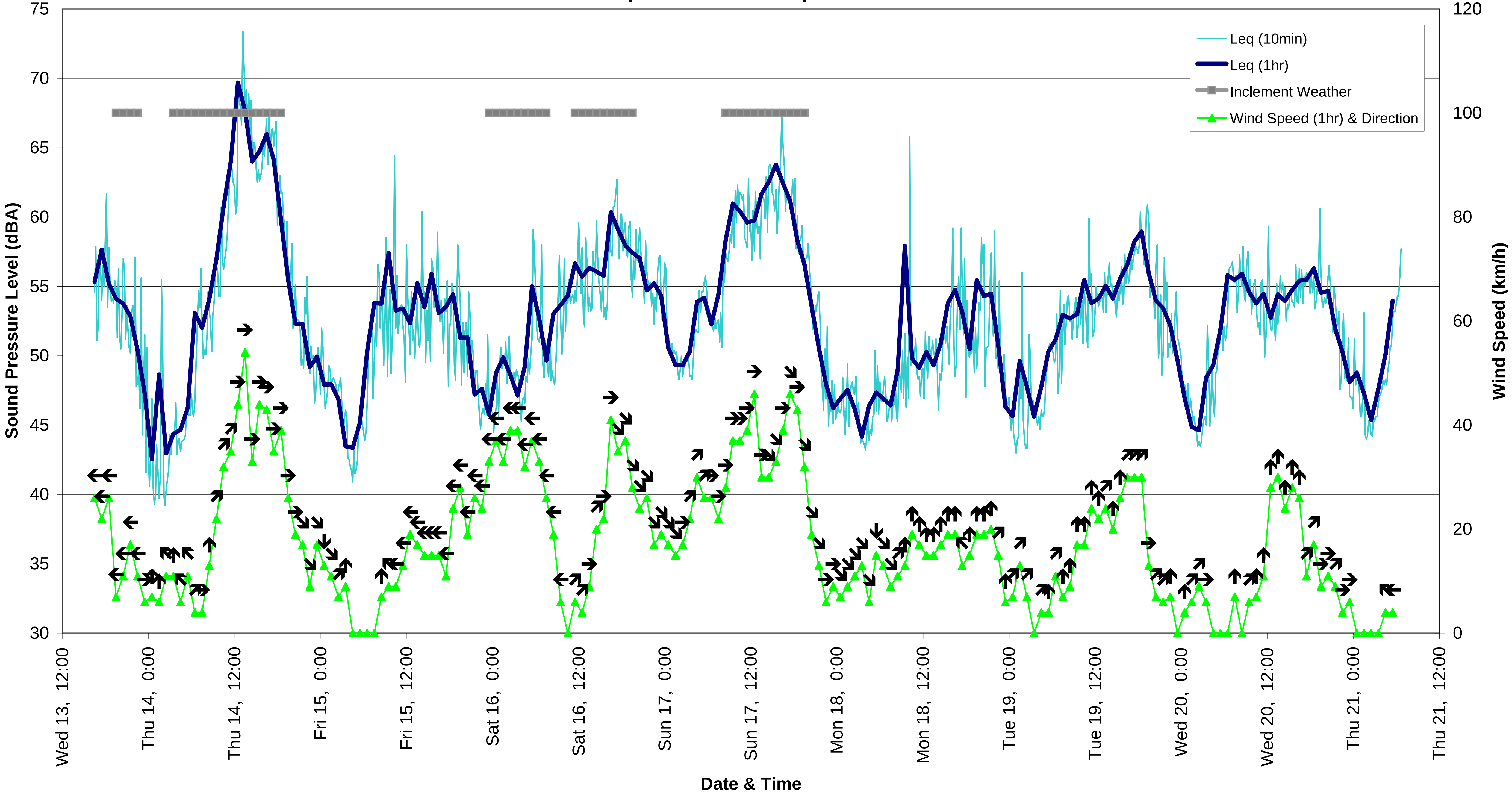

Figure 5: Sound Levels Measured at Location 4
Queen and River Street, NW Corner, 3rd Floor Roof, with an Automated Sound Level Meter
HGC Engineering, May 15 to May 21, 2009
Comparison to Wind Speed and Direction

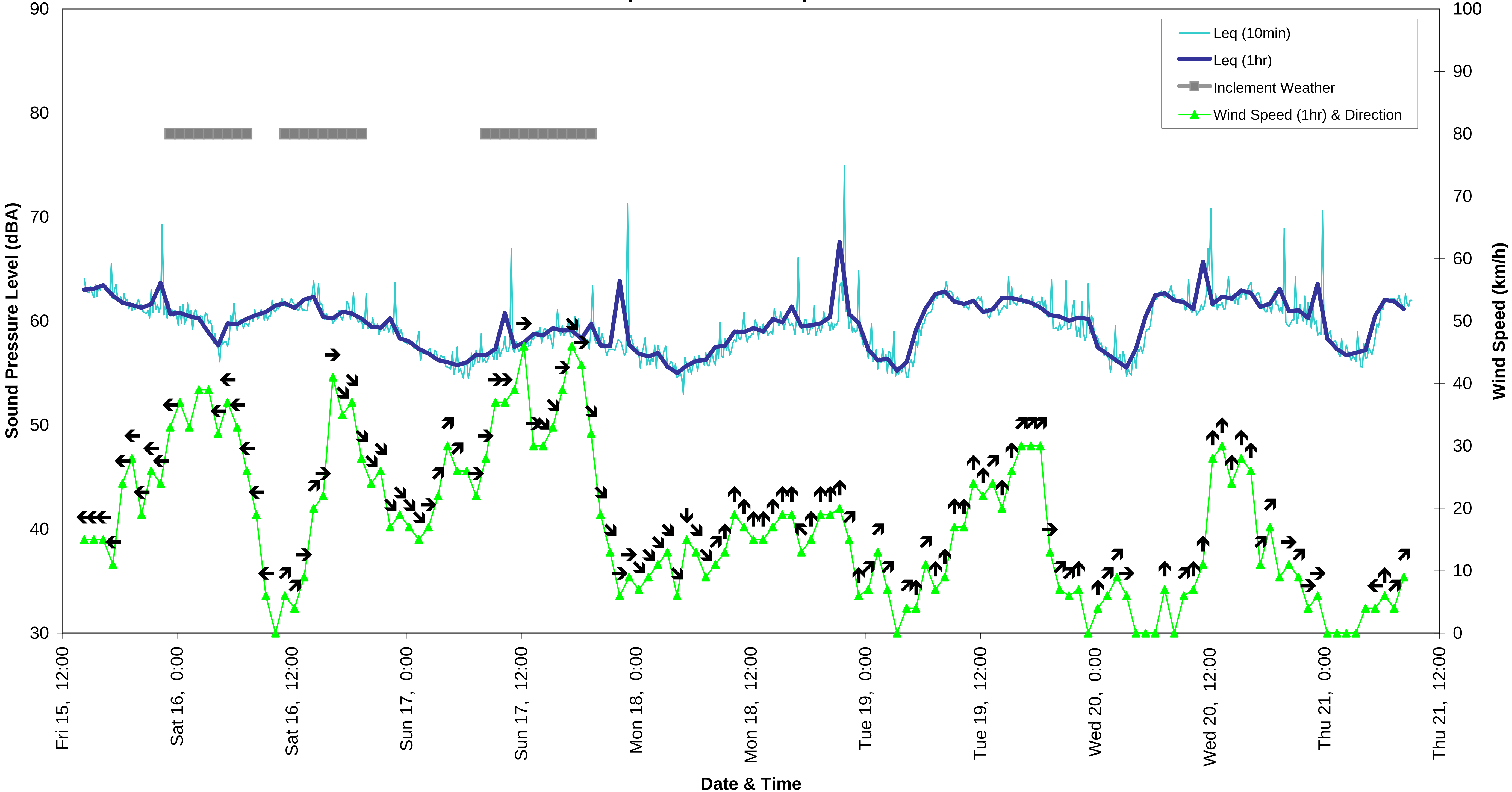

Figure 6: Sound Levels Measured at Location 5
City Place Park, 50 metres North of Gardiner, with an Automated Sound Level Meter
HGC Engineering, May 14 to May 21, 2009
Comparison to Wind Speed and Direction

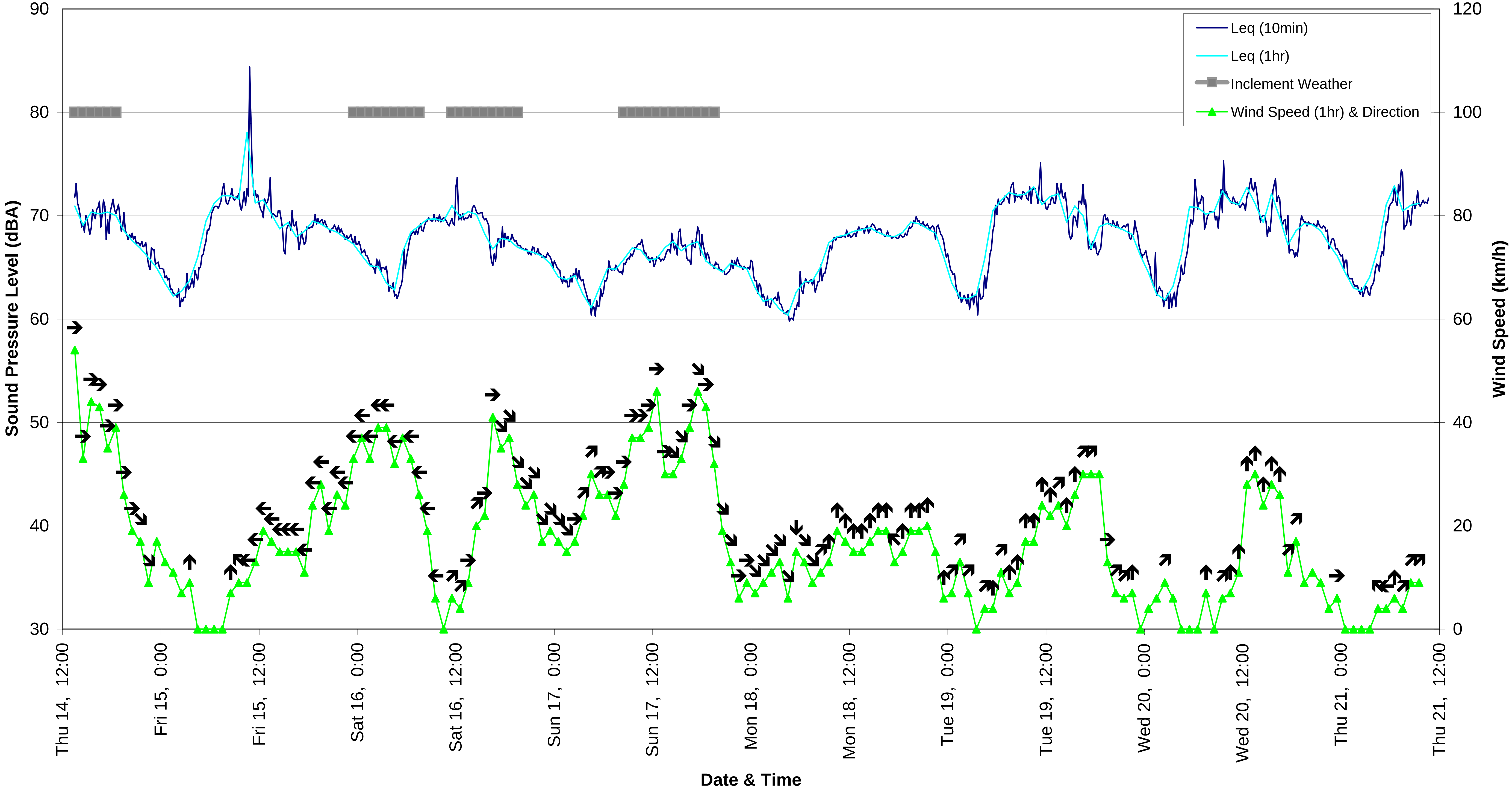

Figure 7: Sound Levels Measured at Location 6
833 King Street West, 7th Floor Roof, South Side, with an Automated Sound Level Meter
HGC Engineering, May 14 to May 21, 2009
Comparison to Wind Speed and Direction