STATE OF ILLINOIS
POLUTION CONTROL BOARD
JAMES R. THOMPSON CENTER
100 W. RANDOLPH STREET, SUITE 11-500
CHICAGO, IL 60601

PETER ARENDOVICH, Complainant,	)	
v.	)	PCB 29009-102
ILLINOIS STATE TOLL HIGHWAY AUTHORITY, Respondent.	)	

NOTICE OF FILING

To

Mr Robert T. Lane
Illinois Toll Highway Authority
2700 Ogden Avenue
Dovners Grove Il. 60515

Mr. Bradley Halloran
Hearing Officer. IPCB
James R.Thompson Center, Suite 11-500
100 W. Randolph Street
Chicago. Il. 60601

Please take notice that on the 28 th. day of March 2011 Complainant, Peter Arendovich's MOTION FOR JUDGEMENT was filled with the Clerk of the Pollution Control Board, James R. Thompson Center 100 W. Randolph Street,suite 11-500 Chicago, Il. 60601

Peter Arendovich
1388 Gordon Ln
Lemont, Il. 60439
(630) 257-8753

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ILLINOIS POLLUTION CONTROL BOARD

PETER ARENDOVICH	)	
COMPLAINANT	)	
V	)	PCB 09-102
THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY	)	
RESPONDENT	)	

SUMMARY OF FACTS FROM PETER ARENDOVICH AND UNDERSIGNED TO FORWARD FOR A JUDGEMENT

I bought the land where my house is standing at 1388 Gordon Ln, in1987. My adjacent neighbor's house, V. Pytlewski, was built in 1957 and has lived in since.

I started to build my house on the same lot in 1989 (My house location is available on a drainage map of 1990. The map was given to me by IDOT. It can be seen on the map from IDOT the center line was not permanent.). ISTHA claims that there was a recorded centerline at the time. I would definitely like to see this document.

Accordingly, in 1993 the legislators approved and authorized ISTHA to study feasibility for construction of a tollway.

During the time in which ISTHA was preparing the FEIS, we, the residents along the projected road, organized a petition against its construction. As everybody knows by now, petitions are simply a formality for IDOT and commonly are filed into their garbage (This was a second set of petitions. The first set was filed at the end of 1990, where we the residents along Gordon ln asked to move the road 1800 ft. west of Gordon ln since there was no center line in 1990)

In 1996, ISTHA presented their FEIS in a public forum. This was met with strong opposition with the majority of the attendees against its construction. Once again, the signatures presented were sealed in the dark corners of the IDOT.

In 1996 as the FEIS was approved by the FHWA, ISHTA went for the land grab, and many senior citizens were swindled out of their homes. One of my neighbors, an older woman in her late 70's, was the owner of 5 acres of land. ISTHA paid her the miniscule amount of $160,000 leaving her to be sent to a nursing home which costs her $32,000 per year. This is only one of many incidents. In that same year the project was stopped by a law intervention; the FEIS contained NO BUILD ALTERNATIVE. When creating their supplemental FEIS, ISHTA had taken advantage of the situation by modifying several environmental actions in order to reduce the cost of the road. One of them is to remove some noise barriers in the area by 135 st bridge (previous document have shown a longer barrier and a barrier on the south side of 135 st bridge.)

The problem is Noise pollution

Is ISHTA responsible for the NOISE pollution and harming its neighbors? Should ISHTA remedy the noise pollution produced higher than 67dBA?

The FHWA have set guidelines for new roads to be built and their emission of noise pollution in residential areas. These guidelines and other data are shown in the (filed) amended complaint and on Figure 1. Based on the current facts ISHTA did not follow the guideline from the FHWA. Exhibit A "THREE PART APPROACH TO NOISE ABATEMENT" then Exhibit B "FHWA NOISE ABATEMENT PROCEDUDE" In Exhibit A (table 4) it is shown that heavy trucks generate a noise level of 80 dBA taken at 50 feet from the centerline. In addition, Exhibit C (NOISE BARRIER DESIGN HANDBOOK) section 3.3.1 (Divergence) shows a "line source"meaning multiple points. The reduction of noise from the line is 3 dBA for every doubling of the distance. In essence the noise from the source is 80dBA at 50 feet, and at 160 feet the noise level will be 77 dBA and at 320 feet the noise level will be 73 dBA. Taking into account height, the effect is 1.5 dBA per 3 feet. The design manual, on section 3.5.2, also shows that the length of the barrier should have to be take into account 4 times the distance from the receiving site to the wall. The

Manual or handbook furthermore indicate that if there is more the one source, (i.e. several trucks passing at the same time) there is a logarithmic addition, in other word the noise source might be larger the 80 dBA which, of course, depends on the speed of the trucks .

Taking the data into account, my home is 350 feet from the bridge, Mary Pytlewsky's house is only 120 feet from the open bridge, Boris Nitchkoff's house is located 400 feet from the bridge, and A. Garb's house is about 300 feet from the ramp.

I strongly believe ISHTA has obligations to the FHWA that it needs to follow. Since I-55 and I-80 are federal roads which I-355 leads into, and furthermore crosses navigational waters, ISHTA must oblige to the rules of the FHWA

Revenue from noise generation

ISHTA is the organization that runs the tollway for profit. The agency is accountable to the bond holders. ISHTA provides services at a price for users. ISHTA rents its tollway to users for a fee. The fee is $1.50 for automobiles of 2 axels and $5.00 or more for more than 3 axels, ISHTA states that the I-355 extension is used by 65,000 vehicles per day. Of those vehicles, more than 10% are used by trucks. The revenue is roughly between 2.8 and 3 million dollars per month. Based on the given figures, the additional revenue from trucks over automobiles is between 5.9 and 8 million dollars more per year. It can be seen ISHTA profits more from vehicles which generate higher noise level then 67 decibel.

The following relates to a discussion on noise generation with Mr. Zucchero. Prior to the road being open for service I had several discussions with Mr. Zucchero about the noise coming from the bridge. After the road was opened and put in service Mr. Zucchero and his assistant came into my home. They seemed to be responsive and acknowledged the level of noise came; they've seen my bedroom and further acknowledged it. I made two presentations to the board of directors, one of which shows the noise generated by different vehicles (Fig 1.). The chairman of the board (Mitola) seemed impressed by the noise vehicle chart from Federal Traffic Noise Analysis and the co relationship with my data. His last words were "Let me look into this ". Unfortunately the man has been replaced showing that ISHTA is an organization of revolving doors.

There were a few more meetings with Mr Zucchero and chief Kovacs, one including my neighbors, Nitchkoff. The meetings were not productive. We wanted an abatement wall of 1600 feet long , from the north side of 135 st bridge to Archer av. where the Gorb family lives. In one of the meetings, Mr. Zucchero and I were negotiating a wall of 500 feet and some form of agreement was made. Finally in the last meeting, the quasi agreement of a 500 foot wall, fell apart where Mr. Kovacs left the meeting early seemingly with something better to do then finish a discussion which he himself set up. At this point, Mr Zuccharo was offering a wall only a 240 feet long on the bridge, and went so far as to threaten putting no wall up . As pointed out to him about the noise pollution violation, he expressed, "the FHWA signed off the SEIS, this is their problem" Here once again ISHTA shows its generosity. ISHTA continually is mentioning the 240 feet wall on the bridge to accommodate me, Peter Arendovich, In reality that wall had to be there, for V. Pytlewski's house which is at 150 feet from the centerline where a noise level is close to 80dBA meaning 15 dBA above what the SEIS is quoting it would be after be the road will be in service (64 dBA. See FEIS ,SEIS). ISHTA's generosity is expressed by negating my noise collection data, disregarding the graph of noise level by different vehicles, and the attitude of deputy chief engineer Zuccharo ("FHWA signed off that is their problem"). The Counselor's advice is to go to another bedroom, or question why I built my bedrooms on the west side. Is this an accommodating attitude or is this punishment? The belligerent attitude goes as far as expressing its position towards the Illinois pollution board by stating "The board has no jurisdiction to this case"

WE NEED A SOUND BARRIER

We need a sound barrier on the 135 st bridges to be extended to 16 Feet high and a wall built by The Garb family's home.

I believe that building a barrier is both feasible and economically reasonable. ISHTA has built a 240 foot long wood barrier on the bridge previously. The wooden wall, according to ISHTA, costed $68,000.00. If the wall is completed as it was initially proposed by Mr. Zuccharo, it may cost perhaps $ 70,000 dollars. Doing this as well as the addition of a 250 foot wall by the Garb family's house may bring ISTHA in compliance with the FHWA. Since the financial criteria of the FHWA is $35,000 per receptor, and ISTHA is offering $24,000 the total budgeted finances would be at the least $144,000. Based on this figure, it should have been very simple to fix this, yet for some reason, ISTHA was STILL unable to comply

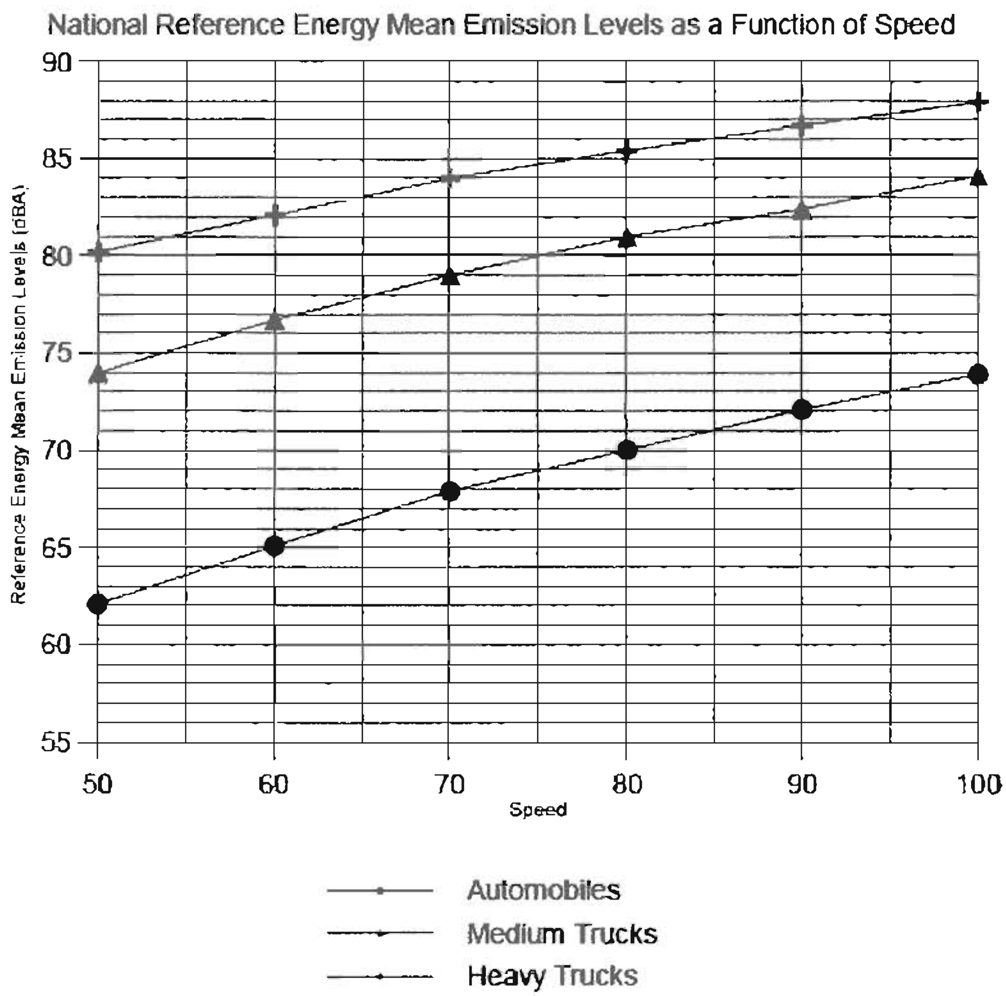
As it was shown previously, the revenue per year from heavy trucks is around $ 4.000.000 higher then from regular automobiles, in essence the total cost would be only about 3% of the first year revenue. In comparison I have spent so far $ 16,000 (or my annual social security) and many hours of labor to improving my house in an effort to eliminate the noise pollution in my bedrooms at no benefit of my own, but for ISHTA profit. It makes us miserable knowing that we once had tranquil homes ruined by the construction and use of the for profit highway. Why should we have to be sacrificed for ISHTA profit.

CONCLUSION

We the people undersigned in this summary are asking the Illinois Pollution Control Board to give a judgment in our favor, so The Illinois State Toll Highway Authority can comply by reducing the noise level generated on its property into our property.

Peter Arendovich	1388 Gordon Ln. Lemont	[illegible]	3/23/2011
Mary Pytlewsky	16119 w 135 st. Lemont	Mary Pytlewski	3/23/2011
Boris Nitchkoff	16055 w 135 st Lemont	[illegible]	
A Garb	13764 S Archer Av. Homer Glen	Albina Garb	3/29
F. Cisneros	1382 Gordon Ln Lemont	Francisco Cisneros	
J. Pytlewsky	16010 W 135 st. Lemont.	Joan Pytlewski	3/20/11
D Nemec	16047 135	[illegible]	3/23/2011

Figure 1: Reference Energy Mean Emission Levels



NOTE: Automobiles: All vehicles with two axles and four wheels
Medium Trucks: All vehicles with two axles and six wheels
Heavy Trucks: All vehicles with three or more axles

Table 5: Noise Abatement Criteria (NAC) **Hourly A-Weighted Sound Level in Decibels (dBA)***			
Activity Category	L_{eq}(h)	L_{10}(h)	Description of Activity Category
A	57 (Exterior)	60 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	--	Undeveloped lands.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

* Either L_{eq}(h) or L_{10}(h) (but not both) may be used on a project.

NOTE: These sound levels are only to be used to determine impact. These are the absolute levels where abatement must be considered. Noise abatement should be designed to achieve a substantial noise reduction - not the noise abatement criteria.

Three-Part Approach to Noise Abatement

Effective control of the undesirable effects of highway traffic noise requires that land use near highways be controlled, that vehicles themselves be quieted, and that mitigation of noise be undertaken on individual highway projects.

The first component is traditionally an area of local responsibility. The other components are the joint responsibility of private industry and of Federal, State, and local governments.

Land Use Planning and Control

The Federal Government has essentially no authority to regulate land use planning or the land development process. The FHWA and other Federal agencies encourage State and local governments to practice land use planning and control in the vicinity of highways. The Federal Government advocates that local governments use their power to regulate land development in such a way that noise-sensitive land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that noise impacts are minimized.

Some State and local governments have enacted legislative statutes for land use planning and control. As an example, the City of San Antonio's subdivision plats' state "For residential development directly adjacent to State right of way, the Developer shall be responsible for adequate set-back and/or sound abatement measures for future noise mitigation." The City of Gilbert, Arizona places on their plat a note stating "This property could experience noise from the freeway."

Although other States and local governments have similar laws, the entire issue of land use is extremely complicated with a vast array of competing considerations entering into any actual land use control decisions. For this reason, it is nearly impossible to measure the progress of using land use to control the effects of noise.

Source Control

The Noise Control Act of 1972 gives the Federal Environmental Protection Agency (EPA) the authority to establish noise regulations to control major sources of noise, including transportation vehicles and construction equipment. In addition, this legislation requires EPA to issue noise emission standards for motor vehicles used in Interstate commerce (vehicles used to transport commodities across State boundaries) and requires the Federal Motor Carrier Safety Administration (FMCSA) to enforce these noise emission standards.

The EPA has established regulations which set emission level standards for newly manufactured medium and heavy trucks that have a gross vehicle weight rating (GVWR) of more than 10,000 pounds and are capable of operating on a highway or street. Table 3 shows the maximum noise emission levels allowed by the EPA noise regulations for these vehicles.

"EXHIBIT A"

Table 3
Maximum Noise Emission Levels
as Required by EPA for Newly Manufactured Trucks
with GVWR Over 10,000 pounds

Effective Date	Maximum Noise Level 50 feet from Centerline of Travel*
January 1, 1988	80 dBA

*Using the Society of Automotive Engineers, Inc. (SAE), test procedure for acceleration under 35 mph

For existing (in-use) medium and heavy trucks with a GVWR of more than 10,000 pounds, the Federal government has authority to regulate the noise emission levels only for those that are engaged in interstate commerce. Regulation of all other in-use vehicles must be done by State or local governments. The EPA emission level standards for in-use medium and heavy trucks engaged in interstate commerce are shown in Table 4 and are enforced by the FMCSA.

Table 4
Maximum Noise Emission Levels
as Required by EPA for In-Use Medium and Heavy Trucks
with GVWR Over 10,000 pounds Engaged in Interstate Commerce

Effective Date	Speed	Maximum Noise Level 50 feet from Centerline of Travel
January 8, 1986	< 35 mph	83 dBA
January 8, 1986	> 35 mph	87 dBA
January 8, 1986	Stationary	85 dBA

Highway Project Noise Mitigation

The National Environmental Policy Act (NEPA) of 1969 provides broad authority and responsibility for evaluating and mitigating adverse environmental effects including highway traffic noise. The NEPA directs the Federal government to use all practical means and measures to promote the general welfare and foster a healthy environment.

A more important Federal legislation which specifically involves abatement of highway traffic noise is the Federal-Aid Highway Act of 1970. This law mandates FHWA to develop noise standards for mitigating highway traffic noise.

The law requires promulgation of traffic noise-level criteria for various land use activities. The law further provides that FHWA not approve the plans and specifications for a federally aided highway project unless the project includes adequate noise abatement measures to comply with the standards. The FHWA has developed and implemented regulations for the mitigation of highway traffic noise in federally-aided highway projects.

The FHWA regulations for mitigation of highway traffic noise in the planning and design of federally aided highways are contained in Title 23 of the United States Code of Federal Regulations Part 772 (attached). The regulations require the following during the planning and design of a highway project: 1) identification of traffic noise impacts; examination of potential mitigation measures; 2) the incorporation of reasonable and feasible noise mitigation measures into the highway project; and 3) coordination with local officials to provide helpful information on compatible land use planning and control. The regulations contain noise abatement criteria which represent the upper limit of acceptable highway traffic noise for different types of land uses and human activities. The regulations do not require that the abatement criteria be met in every instance. Rather, they require that every reasonable and feasible effort be made to provide noise mitigation when the criteria are approached or exceeded. Compliance with the noise regulations is a prerequisite for the granting of Federal-aid highway funds for construction or reconstruction of a highway.

EXHIBIT (B) 3 pages (13)

FHWA Noise Abatement Procedures

The FHWA noise abatement procedures are codified in the Code of Federal Regulations (23 CFR 772). The procedures are described in the following sections.

Noise Descriptors

Noise descriptors are used to describe the time-varying nature of noise. The L_{10} and Leq noise descriptors are used in the abatement procedures. The former is the noise level exceeded 10% of the time in the noisiest hour of the day. The latter is the constant, average sound level, which over a period of time contains the same amount of sound energy as the varying levels of the traffic noise. The L_{10} is a statistical descriptor that is easy for most people to determine and understand. While the Leq descriptor is harder for inexperienced people to understand, it has the advantages over L_{10} of being more reliable for low-volume roadways and of permitting noise levels from different sources to be added directly to one another for inclusion in noise analyses. Leq for typical traffic conditions is usually about 3 dBA less than L_{10} for the same conditions.

Impact Criteria

A traffic noise impact occurs when either of the following conditions exist:

1. The projected traffic noise levels approach or exceed the noise abatement criteria (NAC) shown in Table 9, or (c) page
2. The projected traffic noise levels substantially exceed the existing noise levels in an area.

There is no mandated definition for what constitutes a substantial increase over existing noise levels in an area. Most State highway agencies use either a 10 dBA increase or a 15 dBA increase in noise levels to define a "substantial increase" in existing noise levels. Several State highway agencies use a sliding scale to define substantial increase. The sliding scale combines the increase in noise levels with the absolute values of the noise levels, allowing for a greater increase at lower absolute levels before a substantial increase occurs.

Existing Activities

The location of existing activities in the vicinity of various study alternatives for a highway project are identified by individual land uses, or by broad categories of land use for which a single NAC level may apply. In some cases, lands which are undeveloped at the time of the project may be known to be under consideration for development in the future. If this is the case and definite commitments have been made to develop the land, then, these lands are treated as developed and the highway noise impacts assessed accordingly. Primary consideration for highway traffic noise analysis is normally given to exterior areas where frequent human use occurs.

Type I/ Type II Projects

"EXHIBIT B"

The FHWA regulation makes a distinction between projects for which noise abatement is considered as a feature in a new or expanded highway and those for which noise abatement is considered as a retrofit feature on an existing highway. The former are defined as Type I projects, the latter as Type II. For Type I projects, the consideration of noise abatement as part of the highway construction project is mandatory if Federal-aid funds are to be used and if a traffic noise impact is expected to occur. Type II projects are, however, completely voluntary on the part of the individual States, and such projects compete for funds with all the other construction needs of the States. It should be noted that the National Highway System Designation Act of 1995 (NHS) restricted Federal participation in Type II noise barriers to those projects that were approved before November 28, 1995 or are proposed along lands where land development or substantial construction predated the existence of any highway.

Noise Analysis

Analysis of the traffic noise impacts expected from construction of a highway involves a number of technical steps. The traffic noise analysis includes the following for each alternative under detailed study:

1. identification of existing activities, developed lands, and undeveloped lands for which development is planned, designed and programmed, which may be affected by traffic noise from the highway;
2. determination of existing noise levels;
3. prediction of traffic noise levels;
4. determination of traffic noise impacts; and
5. examination and evaluation of alternative noise abatement measures for reducing or eliminating the traffic noise impacts.

If potential traffic noise impacts are identified, noise abatement is considered and implemented, if it is found to be both reasonable and feasible. The views of the impacted residents are a major consideration in reaching a decision on the reasonableness of abatement measures to be provided. When noise abatement measures are being considered, every reasonable effort is made to obtain substantial noise reductions. Substantial noise reductions have been defined by State highway agencies to typically range from 5 to 10 dBA.

(C)

Sec. 772.19 Construction Noise.

The following general steps are to be performed for all Types I and II projects:

a. Identify land uses or activities which may be affected by noise from construction of the project. The identification is to be performed during the project development studies.
b. Determine the measures which are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall include a weighing of the benefits achieved and the overall adverse social, economic and environmental effects and the costs of the abatement measures.
c. Incorporate the needed abatement measures in the plans and specifications.

Table 9
Noise Abatement Criteria (NAC)
Hourly A-Weighted Sound Level - decibels (dBA)*

Activity Category	Leq(h)	L_{10}(h)	Description of Activity Category
A	57 (Exterior)	60 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75	Developed lands, properties, or activities not included in Categories A or B above.
D	--	--	Undeveloped lands.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

* Either L_{10}(h) or Leq(h) (but not both) may be used on a project

Updated: 05/20/2010

EXHIBIT (C)

Highway Traffic Noise

Construction Noise
Measurement
Noise Barriers
Abatement
Design/Construction
Inventory
Research
Noise Compatible Planning
Noise Effect on Wildlife
Regulation and Guidance
Tire Pavement Noise
Traffic No
Training
Site Map

Noise Barrier Design Handbook

3. Acoustical Considerations

This section describes the acoustical considerations associated with highway noise barrier design, beginning with a brief general discussion on the fundamentals of highway traffic noise.

Characteristics of Sound

Highway traffic noise originates primarily from three discrete sources: truck exhaust stacks, vehicle engines, and tires interacting with the pavement. These sources each produce sound energy that, in turn, translates into tiny fluctuations in atmospheric pressure as the sources move and vibrate. These sound pressure fluctuations are most commonly expressed as sound pressure and measured in units of micro Newtons per square meter ($\mu N/m^2$), or micro Pascals (μPa). Typical sound pressure amplitudes can range from 20 to 200 million μPa. Because of this wide range, sound pressure is measured on a logarithmic scale known as the decibel (dB) scale. On this scale, a value of 0 dB corresponds to a sound pressure level (SPL) of 20 μPa and corresponds to the threshold of hearing for most humans. A value of 140 dB is equal to an SPL of 200 million μPa, which is the threshold of pain for most humans.

The following figure shows a scale relating various sounds encountered in daily life and their approximate decibel values.

Contacts

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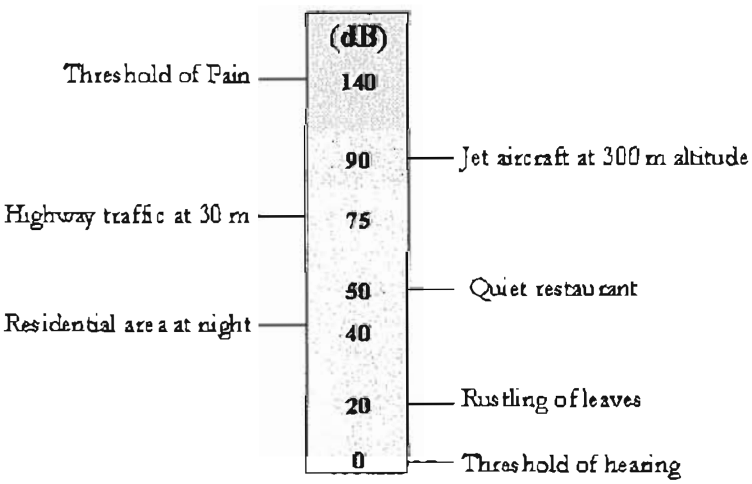

Figure 6. Decibel scale

To express a sound's energy, or sound pressure in terms of SPL, or dB, the following equation is used:

$SPL = 10*\log10(p/p_{ref})^2$ dB

where p is the sound pressure, and

p_{ref} is the reference sound pressure of 20 μPa

Conversely, sound energy is related to SPL as follows:

$(p/p_{ref})^2 = 10^{(SPL/10)}$

The above relationships are important in understanding the way decibel levels are combined, i.e., added or subtracted. That is, because decibels are expressed on a logarithmic scale, they cannot be combined by simple addition. For example, if a single vehicle pass-by produces an SPL of 60 dB at a distance of 15 m (50 ft) from a roadway, two identical vehicle pass-bys would not produce an SPL of 120 dB. They would, in fact, produce an SPL of 63 dB. To combine decibels, they must first be converted to energy, then added or subtracted as appropriate, and reconverted back to decibels. The following tabl

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"EXHIBIT C"

Table approximations are within &#177,1 dB of the exact value)

Table 1. Decibel addition approximation.

When two decibel values differ by (dB)	Add to higher value (dB)	Example
0 to 1	3	50 + 51 = 54
2 to 3	2	62 + 65 = 67
4 to 9	1	65 + 71 = 72
10 or more	0	55 + 65 = 65

The above table can also be used to approximate the sum of more than two decibel values. First, rank the values from low to high, then add the values two at a time. For example:

60 dB + 60 dB + 65 dB + 75 dB	= (60 dB + 60 dB) + 65 dB + 75 dB
	= 63 dB + 65 dB + 75 dB
	= (63 dB + 65 dB) + 75 dB
	= 67 dB + 75 dB
	= 76 dB

In the above example, the exact value would be computed as follows

$60\ dB + 60\ dB + 65\ dB + 75\ dB = 10 * \log_{10} [10^{(60/10)} + 10^{(60/10)} + 10^{(65/10)} + 10^{(75/10)})$

= 75.66 dB

The next characteristic of sound is its *amplitude*, or loudness. As stated earlier, sound sources produce sound energy that, in turn, translates into tiny fluctuations in atmospheric pressure as the sources move and vibrate. As the sources move and vibrate, surrounding atoms, or molecules, are temporarily displaced from their normal configurations thus forming a disturbance that moves away from the sound source in waves that pulsate out at equal intervals. For simplicity, the outward propagating waves can be approximated by the trigonometric sine function (see Figure 6). The "height" of the sine wave from peak to peak is referred to as its amplitude. The length between wave repetitions is referred to as the *wavelength* (&#955,) The amplitude determines the strength, or loudness, of the wave

Finally, another characteristic of sound is its *frequency*, or tonality, measured in Hertz (Hz), or cycles per second. Frequency is defined as the number of cycles of repetition per second, or the number of wavelengths that have passed by a stationary point in one second.

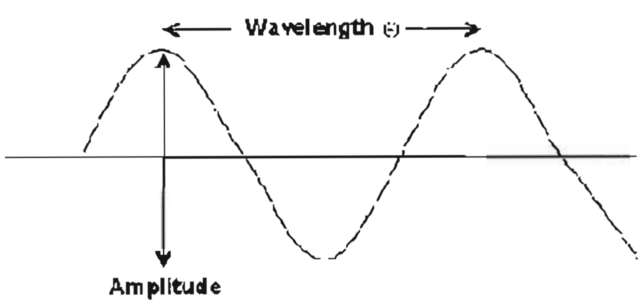

Figure 6. Sound wave amplitude and wavelength

Most humans can hear in a range from 20 Hz to 20,000 Hz. However, the human ear is not equally sensitive to all frequencies. To account for this, most transportation-related noise, including highway traffic noise, is measured using an "*A-weighted*" response network. A-weighting emphasizes sounds between 1,000 Hz and 6,300 Hz, and de-emphasizes sounds above and below that range to simulate the response of the human ear. Figure 7 presents the A-weighting curve as a function of frequency. Table 2 presents the curve in tabular form for one-third octave band frequencies from 20 to 20,000 Hz. Sound levels measured using the A-weighting network are expressed in units of dB(A) [ref 12]

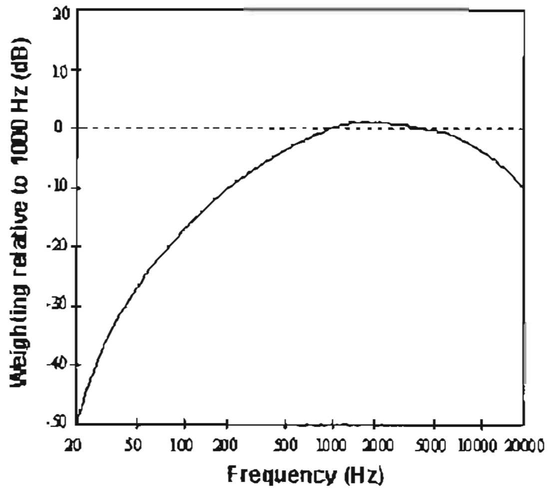

Figure 7. Frequency A-weighting

Table 2. Frequency A-weighting.

One-Third Octave-Band Center Frequency (Hz)	Response, re: 1000 Hz	One-Third Octave-Band Center Frequency (Hz)	Response, re: 1000 Hz
20	-50.5	800	-0.8
25	-44.7	1000	0.0
31.5	-39.4	1250	0.6
40	-34.6	1600	1.0
50	-30.2	2000	1.2
63	-26.2	2500	1.3
80	-22.5	3150	1.2
100	-19.1	4000	1.0
125	-16.1	5000	0.5
160	-13.4	6300	-0.1
200	-10.9	8000	-1.1
250	-8.6	10000	-2.5
315	-6.6	12500	-4.3
400	-4.8	16000	-6.6
500	-3.2	20000	-9.3
630	-1.9	.	.

3.2 Noise Descriptors

Noise descriptors provide a mechanism for describing sound for different applications. As stated previously, sound levels measured for highway traffic noise use an A-weighting filter to more accurately simulate the response of the human ear. An A-weighted sound level is denoted by the symbol, L_A. Other noise descriptors include the maximum sound level (MXFA or MXSA, denoted by the symbol, L_{AFmx} or L_{ASmx}), the equivalent sound level for a one-hour period (1HEQ, denoted by the symbol, L_{Aeq1h}), the sound exposure level (SEL, denoted by the symbol, L_{AE}), the day-night average sound level (DNL, denoted by the symbol, L_{dn}), the community noise equivalent level (CNEL, denoted by the symbol, L_{den}), and the ten-percentile exceeded sound level (denoted by the symbol, L_{10}).

For highway traffic noise, the L_{Aeq1h} are most often used to describe continuous sounds, such as relatively dense highway traffic. The L_{ASmx} and L_{AE} may be used to describe single events, such as an individual vehicle pass-by. Note that the L_{AE} is more commonly used to describe an aircraft overflight. The L_{dn} and the L_{den} may be used to describe long-term noise environments (typically 24 hours or more).

3.3 Sound Propagation

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The sound that reaches a receiver is affected by many factors These factors include:[ref. 18]

- Divergence (Section 3.3.1),
- Ground effect (Section 3.3.2),
- Meteorological effects (Section 3.3.3); and
- Shielding by natural and man-made structures, e.g., trees and buildings (Section 3.3.4). Note. Shielding by man-made noise barriers will be discussed separately in Section 3.4

3.3.1 Divergence.
Divergence is referred to as the spreading of sound waves from a sound source in a *free field* environment. In the case of highway traffic noise, two types of divergence are common, spherical and cylindrical. Spherical divergence is that which would occur for sound emanating from a *point source*, e.g., a single vehicle pass-by. The attenuation of sound over distance due to spherical spreading is illustrated using the following equation.

$L_2 = L_1 + 20*\log_{10}(d_1/d_2)$ dB(A)

where, L_1 is the sound level at distance d_1, and

L_2 is the sound level at distance d_2

Thus, with this equation, it can be shown that sound levels measured from a point source decrease at a rate of 6 dB(A) per doubling of distance For example, if the sound level from a point source at 15 m was 90 dB(A), at 30 m it would be 84 dB(A) due to divergence, i.e., $90 + 20*\log_{10}(15/30)$

Cylindrical divergence is that which would occur for sound emanating from a *line source*, or many point sources sufficiently close to be effectively considered as a line source, e.g., a continuous stream of roadway traffic. The attenuation of sound over distance due to cylindrical spreading is illustrated using the following equation

$L_2 = L_1 + 10*\log_{10}(d_1/d_2)$ dB(A)

With this equation, it can be shown that sound levels measured from a line source decrease at a rate of 3 dB(A) per doubling of distance For example, if the sound level from a line source at 15 m was 90 dB(A), at 30 m it would be 87 dB(A) due to divergence, i.e., $90 + 10*\log_{10}(15/30)$ [ref 19]

3.3.2 Ground Effect.
Ground effect refers to the change in sound level, either positive or negative, due to intervening ground between source and receiver Ground effect is a relatively complex acoustic phenomenon, which is a function of ground characteristics, source-to-receiver geometry, and the spectral characteristics of the source Ground types are typically characterized as acoustically hard or acoustically soft. *Hard ground* refers to any highly reflective surface in which the phase of the sound energy is essentially preserved upon reflection; examples include water, asphalt, and concrete For practical highway applications, measurements have shown a 1 to 2 dBA increase for the first and second row residences adjacent to the highway *Soft ground* refers to any highly absorptive surface in which the phase of the sound energy is changed upon reflection, examples include terrain covered with dense vegetation or freshly fallen snow [ref 19] An acoustically soft ground can cause a significant broadband attenuation (except at low frequencies)

A commonly used rule-of-thumb is that (1) for propagation over hard ground, the ground effect is neglected; and (2) for propagation over acoustically soft ground, for each doubling of distance the soft ground effect attenuates the sound pressure level at the receiver by an additional 1.5 dB(A). This extra attenuation applies to only incident angles of 20 degrees or less For greater angles, the ground becomes a good reflector and can be considered acoustically hard Keep in mind that these relationships are quite empirical but tend to break down for distances greater than about 30.5 to 61 m (100 to 200 ft). For a more detailed discussion of ground effects, the reader is directed to References 20 and 21.

3.3.3 Atmospheric Effects.
Atmospheric effects refer to (1) atmospheric absorption, i.e., the sound absorption by air and water vapor, (2) atmospheric refraction, i.e., the sound refraction caused by temperature and wind gradients, and (3) air turbulence.[ref 18] It is recommended that when atmospherics are of potential concern, high-precision meteorological measurement equipment should be used to record continuous temperature, relative humidity, and wind data

- Atmospheric absorption Atmospheric absorption is a function of the frequency of the sound, the temperature, the humidity, and the atmospheric pressure between the source and the receiver [ref.22] and [ref.23] Over distances greater than 30 m (100 ft), the attenuation due to atmospheric absorption can substantially reduce sound levels, especially at high frequencies (above 5000 Hz)

- Atmospheric refraction: Atmospheric refraction is the bending of sound waves due to wind and temperature gradients Near-ground wind effects are, typically, the most substantial contributor to sound refraction Upwind conditions tend to refract sound waves away from the ground resulting in a decrease in sound levels at a receiver Conversely, downwind conditions tend to refract sound waves towards the ground resulting in an increase in sound levels at a receiver Studies have shown measured sound levels to be affected by up to 7 dB(A) as a result of wind refraction within just 100 m from the centerline of the roadway.[ref.24] and [ref 25] It is generally recommended that highway traffic noise measurements be performed when the recorded wind speed is no greater than 5 m/s (11 mph) to minimize the effects of wind Further, measurements should not be performed in conditions where strong winds with small vector components exist in the direction of propagation. Readers may refer to Reference 18 for mor

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Temperature effects can also contribute to sound refraction. During daytime weather conditions, when the air is warmer closer to the ground (temperature decreases with height), sound waves tend to refract upward away from the ground (temperature lapse). This may result in a decrease in sound levels at a receiver. Conversely, when the air close to the ground cools during nighttime weather conditions (temperature increases with height), sound waves tend to refract downward towards the ground (temperature inversion). This may result in an increase in sound levels at a receiver [ref 26]. Generally, refraction effects due to temperature do not exert a substantial influence on sound levels within 61 m (200 ft) of the roadway [ref 24].

- Air turbulence: Although, its effects on sound levels are more unpredictable than other atmospheric effects, in certain cases air turbulence has shown an even greater effect on noise levels than atmospheric refraction within 122 m (400 ft) from a roadway [ref 25]. As stated earlier, it is generally recommended that highway traffic noise measurements be performed when the recorded wind speed is no greater than 5 m/s to insure minimal effects of wind. Further, measurements should not be performed in conditions where strong winds with small vector components exist in the direction of propagation. Readers may refer to Reference 18 for more information on performing highway-related noise measurements.

3.3.4 Shielding by Natural and Man-Made Structures.
In this section, shielding by structures, such as trees and buildings, will be discussed. The amount of attenuation provided by these structures is determined by their size and density, and the frequencies of the sound levels. Note that shielding by noise barriers will be discussed separately in *Section 3.4*.

Shielding by trees and other such vegetation typically only have an "out of sight, out of mind" effect. That is, the perception of highway traffic noise impact tends to decrease when vegetation blocks the *line-of-sight* to nearby residents (i.e., "out of sight, out of mind"). However, for vegetation to provide a substantial, or even noticeable, noise reduction, the vegetation area must be at least 5 m (15 ft) in height, 30 m (100 ft) wide and dense enough to completely obstruct the line-of-sight between the source and the receiver. This size of vegetation area may provide up to 5 dB(A) of noise reduction. Taller, wider, and denser areas of vegetation may provide even greater noise reduction. The maximum reduction that can be achieved is approximately 10 dB(A) [ref 5] and ref 23.

Shielding by a building is similar to the shielding effects of a short (lengthwise) barrier. Building rows can act as longer barriers keeping in mind that the gaps between buildings will leak sound through to the receiver. Generally, assuming an at-*grade* building row with a building-to-gap ratio of 40 percent to 60 percent, the noise reduction due to this row is approximately 3 dB(A). Further, for each additional building row, another 1.5 dB(A) noise reduction may be considered typical [ref.3] and ref.27. For situations where the buildings in a building row occupy less than 20 percent of the row area, unless the receiver is directly behind a building, minimal, or no, attenuation should be assumed. For situations where the buildings in a building row occupy greater than 80 percent of the row area, it may be assumed that the leakage of sound due to gaps is minimal. In this case, noise attenuation may be determined by treating the building row as a noise barrier, which is discussed in *Section 3.4*.

3.4 Noise Barrier Basics

As shown in Figure 8, noise barriers reduce the sound which enters a community from a busy highway by either absorbing it (see *Section 3.4.1*), transmitting it (see *Section 3.4.2*), reflecting it back across the highway (see *Section 3.5.4*), or forcing it to take a longer path. This longer path is referred to as the *diffracted* path.

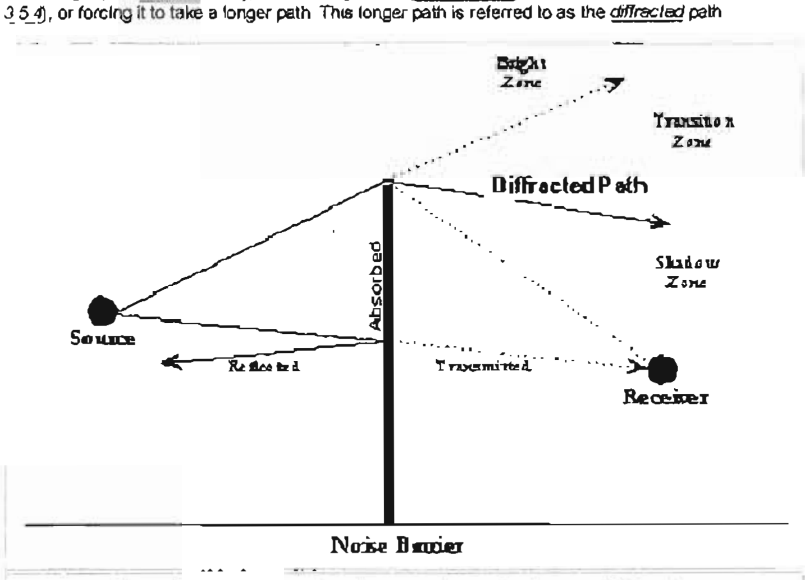

Figure 8. Barrier absorption, transmission, reflection, and diffraction

Diffraction, or the bending of sound waves around an obstacle, can occur both at the top of the barrier and around the ends. This bending occurs much like other wave phenomena, such as light and water waves. Due to the nature of sound waves, diffraction does not bend all frequencies uniformly. Higher frequencies (shorter wavelengths) are diffracted to a lesser degree, while lower frequencies (longer wavelengths) are diffracted deeper into the "shadow" zone behind the barrier. As a result, a barrier is,

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number and, thus, barrier attenuation increases. If the frequency increases, barrier attenuation increases as well. Figure 11 shows the relationship between barrier attenuation and Fresnel Number for a frequency of 550 Hz. A 550 Hz frequency is considered fairly representative for computing barrier attenuation of highway traffic noise.[ref 29]

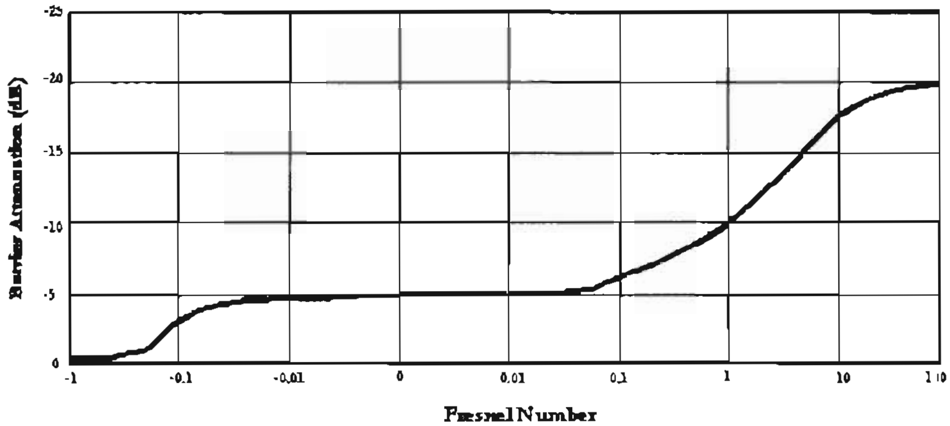

Figure 11. Barrier attenuation versus Fresnel Number

3.4.1 Barrier Absorption.
The amount of incident sound that a barrier absorbs is typically expressed in terms of its *Noise Reduction Coefficient* (NRC). NRC is defined as the arithmetic average of the *Sabine absorption coefficients*, αsab, at 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz

NRC = ¼ × (α250 + α500 + α1000 + α2000)

NRC values can range from zero to one; where zero indicates the barrier will reflect all the sound incident upon it (see also *Section 3.5.4.*), and one indicates the barrier will absorb all the sound incident upon it. A typical NRC for an absorptive barrier ranges from 0.6 to 0.9.[ref 19]

Measurements to determine the αsab of a barrier facade should be made in accordance with the ASTM Recommended Practice C384 (Impedance Tube Method) or C423 (Reverberation Room Method). The Impedance Tube Method can be used to measure the sound absorption of *normal incident sound* on a small sample of a material.[ref 15] and *ref 30* The Reverberation Room Method (see Figure 12)[note 2] is used to measure the sound absorption of *random incident sound* on a larger sample of a material. Most barrier manufacturers prefer to use the Reverberation Room Method because of its lack of constraints on sample size. However, for this Method, the sample size chosen and method and angle of mounting may have substantial effects on the determined absorption coefficients. These concerns are further addressed in Reference 31.

Figure 12.
Barrier absorption: Reverberation Room Method
photo #2553

3.4.2 Barrier Sound Transmission.
The amount of incident sound that a barrier transmits can be described by its sound *Transmission Loss* (TL). Measurements to determine a barrier's TL should be made in accordance with ASTM Recommended Practice E413-87.[ref 16] TL is determined as follows.

$$TL = 10\log_{10}[10^{(SPL_s/10)} / 10^{(SPL_r/10)}]$$

dB(A)

where: SPL_s is the sound pressure level (see *Section 3.1*) on the source side of the barrier; and

SPL_r is the sound pressure level on the receiver

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For highway noise barriers, any sound that is transmitted through the barrier can be effectively neglected since it will be at such a low level relative to the diffracted sound, i e , the sound transmitted will typically be at least 20 dB(A) below that which is diffracted That is, if a sound level of 100 dB(A) is incident upon a barrier and only 1 dB(A) is transmitted, i e, 1 percent of the incident sound's energy, then a TL of 20 dB(A) is achieved

As a rule of thumb, any material weighing 20 kg/m^2 (4 lbs/ft^2) or more has a transmission loss of at least 20 dB(A) Such material would be adequate for a noise reduction of at least 10 dB(A) due to diffraction. Note that a weight of 20 kg/m^2 (4 lbs/ft^2) can be attained by lighter and thicker, or heavier and thinner materials The greater the density of the material, the thinner the material may be TL also depends on the stiffness of the barrier material and frequency of the source [ref 18]

In most cases, the maximum noise reduction that can be achieved by a barrier is 20 dB(A) for thin walls and 23 dB(A) for berms Therefore, a material that has a TL of at least 25 dB(A) or greater is desired and would always be adequate for a noise barrier The following table gives approximate TL values for some common materials, tested for typical A-weighted highway traffic frequency spectra. They may be used as a rough guide in acoustical design of noise barriers For accurate values, consult material test reports by accredited laboratories

Table 3. Approximate sound transmission loss values for common materials.

Material	Thickness mm (Inches)	Weight kg/m^2 (lbs/ft^2)	Transmission Loss (dB(A))
Concrete Block, 200mm x 200mm x 405 (8" x 8" x 16") light weight	200mm (8")	151 (31)	34
Dense Concrete	100mm (4")	244 (50)	40
Light Concrete	150mm (6")	244 (50)	39
Light Concrete	100mm (4")	161 (33)	36
Steel, 18 ga	1 27mm (.0 050")	10 (2 00)	25
Steel, 20 ga	0.95mm (0.0375")	7 3 (1 50)	22
Steel, 22 ga	0 79mm (0 0312")	6 1 (1 25)	20
Steel, 24 ga	0 64mm (0 025")	4 9 (1 00)	18
Aluminum, Sheet	1 59mm (0 0625")	4.4 (0 9)	23
Aluminum, Sheet	3.18mm (0.125")	8 8 (1 8)	25
Aluminum, Sheet	6 35mm (0 25")	17.1(3 5)	27
Wood, Fir	12mm (O 5")	8 3 (1 7)	18
Wood, Fir	25mm (1 0")	16 1(3 3)	21
Wood, Fir	50mm (2 0")	32.7 (6 7)	24
Plywood	12mm (0 5")	8 3 (1.7)	20
Plywood	25mm (1.0")	16.1 (3 3)	23
Glass, Safety	3 18mm (0.125")	7.8 (1 6)	22
Plexiglass	6mm (0 25")	7.3 (1 5)	22

The above table assumes no openings or gaps in the barrier material Some materials, such as wood, however, are prone to develop openings or gaps due to shrinkage, warping, splitting, or weathering. Treatments to reduce/eliminate noise leakage for wood barrier systems are discussed in *Section 5 4 1* Noise leakage due to possible gaps in the horizontal joints between *panels* in a post and panel "stacked panel" barrier system (see *Section 4 1 2.1*) should also be given careful consideration Finally some barrier systems are designed with small openings at the base of the barrier to carry water, which would otherwise pond on one side of the barrier, through the barrier Two important consideration associated with these openings are (1) Ensure that the opening is small (the effect of a continuous gap of up to 20 cm (7.8 in) at the base of a noise barrier is usually within 1 dB(A)), [ref 32] and (2) Ensure that proper protection in the form of grates or bars is provided to restrict entry by small animals (cats, small dogs, etc) Drainage considerations are also discussed in ... tion 7.

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It should be noted that there are other ratings used to express a material's sound transmission characteristics. One rating in common use is the *Sound Transmission Class* (STC). STC is a single-number rating derived by fitting a reference rating curve to the TL values measured for the one-third octave frequency bands between 125 Hz and 4000 Hz. The reference rating curve is fitted to the TL values such that the sum of deficiencies (TL values less than the reference rating curve), does not exceed 32 dB, and no single deficiency is greater than 8 dB. The STC value is the TL value of the reference *contour* at 500 Hz. The disadvantage to using the STC rating scheme is that it is designed to rate noise reductions in frequencies of normal speech and office areas, and not for the lower frequencies of highway traffic noise. For frequencies of traffic noise, the STC is typically 5 to 10 dB(A) greater than the TL and, thus, should only be used as rough guide.

3.5 Barrier-Design Acoustical Considerations

This section describes the various acoustical considerations involved in actual noise barrier design. Non- acoustical design considerations will be discussed in Sections 4 to 13). The acoustical considerations include:

Barrier design goals and insertion loss(*Section 3.5.1*);

Barrier length (*Section 3.5.2*),

Wall versus berm (*Section 3.5.3*),

Reflective versus absorptive (*Section 3.5.4*);

Other miscellaneous design considerations (*Section 3.5.5*).

3.5.1 Barrier Design Goals and Insertion Loss.

The first step in barrier design is to establish the design goals. Design goals may not be limited simply to noise reduction at receivers, but may also include other considerations of safety and maintenance as well. These other considerations are discussed later in Sections 4 through 13.

In this section, the acoustical design goals of noise reduction will be discussed. Acoustical design goals are usually referred to in terms of barrier *Insertion Loss* (IL). IL is defined as the sound level at a given receiver before the construction of a barrier minus the sound level at the same receiver after the construction of the barrier. The construction of a noise barrier usually results in a partial loss of soft-ground attenuation. This is due to the barrier forcing the sound to take a higher path relative to the ground plane. Therefore, barrier IL is the net effect of barrier diffraction, combined with this partial loss of soft-ground attenuation.

Typically, a 5-dB(A) IL can be expected for receivers whose line-of-sight to the roadway is just blocked by the barrier. A general rule-of-thumb is that each additional 1 m of barrier height above line-of-sight blockage will provide about 1.5 dB(A) of additional attenuation (see Figure 13).

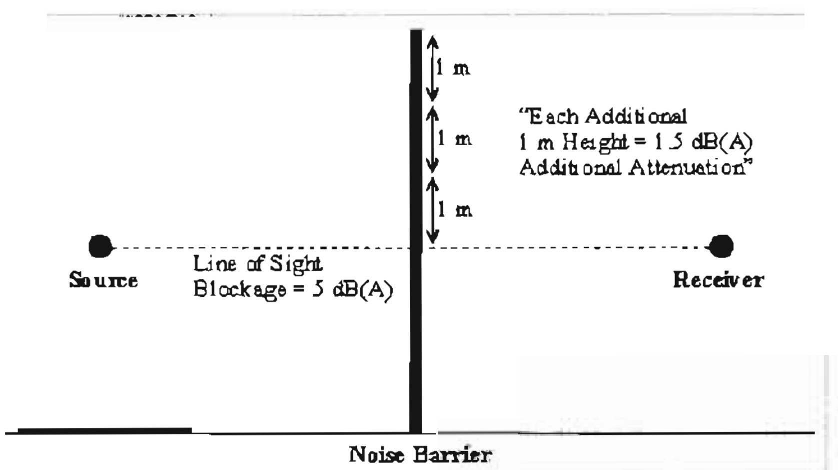

Figure 13. Line-of-sight

Properly-designed noise barriers should attain an IL approaching 10 dB(A), which is equivalent to a perceived halving in loudness for the first row of homes directly behind the barrier. For those residents not directly behind the barrier, a noise reduction of 3 to 5 dB(A) can typically be provided, which is just slightly perceptible to the human ear. Table 4 shows the relationship between barrier IL and design feasibility. ref 1

Table 4. Relationship between barrier insertion loss and design feasibility.

Barrier Insertion Loss	Design Feasibility	Reduction in Sound Energy	Relative Reduction in Loudness
5 dB(A)	Simple	68%	Readily perceptible
10 dB(A)	Attainable	90%	Half as loud

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compared with the lower frequencies (see Figure 9).ref. 18

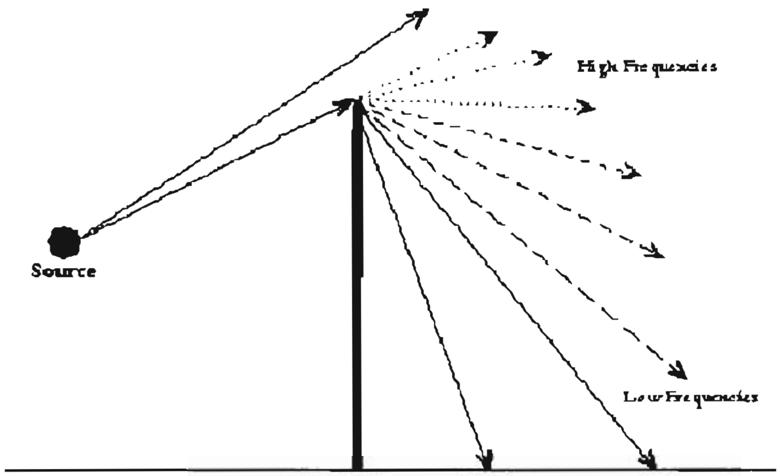

Figure 9. Barrier diffraction

An important aspect of diffraction is the path length difference (δ) between the diffracted path from source over the top of the barrier to the receiver, and the direct path from source to receiver as if the barrier were not present (see Figure 10)

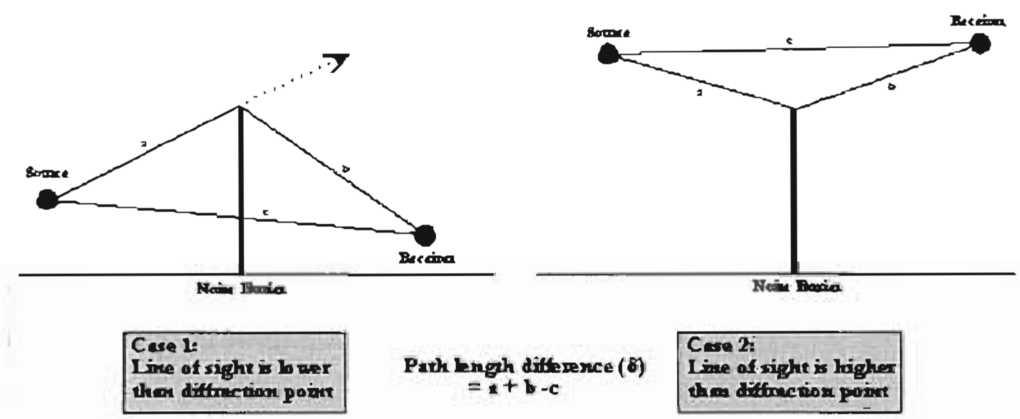

Figure 10. Path length difference

The path length difference is used to compute the *Fresnel Number* (N0), which is a dimensionless value used in predicting the attenuation provided by a noise barrier positioned between a source and a receiver. The Fresnel Number is computed as follows:

N0 = ±2(δ0/λ) = ±2(f δ0 /c)

where: N0 is the Fresnel Number determined along the path defined by a particular source-barrier-receiver geometry;

± is positive in the case where the line of sight between the source and receiver is lower than the diffraction point and negative when the line of sight is higher than the diffraction point (see Figure 10),ref 28

δ0 is the path length difference determined along the path defined by a particular source-barrier-receiver geometry;

λ is the wavelength of the sound radiated by the source;

f is the frequency of the sound radiated by the source; and

c is the speed of sound.

Note the relationship between the variables in th

15 dB(A)	Very difficult	97%	One-third as loud
20 dB(A)	Nearly impossible	99%	One-fourth as loud

3.5.2 Barrier Length.
Noise barriers should be tall enough and long enough so that only a small portion of sound diffracts around the edges. If a barrier is not long enough, degradations in barrier performance of up to 5 dB(A) less than the barrier's design noise reduction may be seen for those receivers near the barrier ends. A rule-of-thumb is that a barrier should be long enough such that the distance between a receiver and a barrier end is at least four times the perpendicular distance from the receiver to the barrier along a line drawn between the receiver and the roadway (see Figure 14). Another way of looking at this rule is that the angle subtended from the receiver to a barrier end should be at least 80 degrees, as measured from the perpendicular line from the receiver to the roadway.

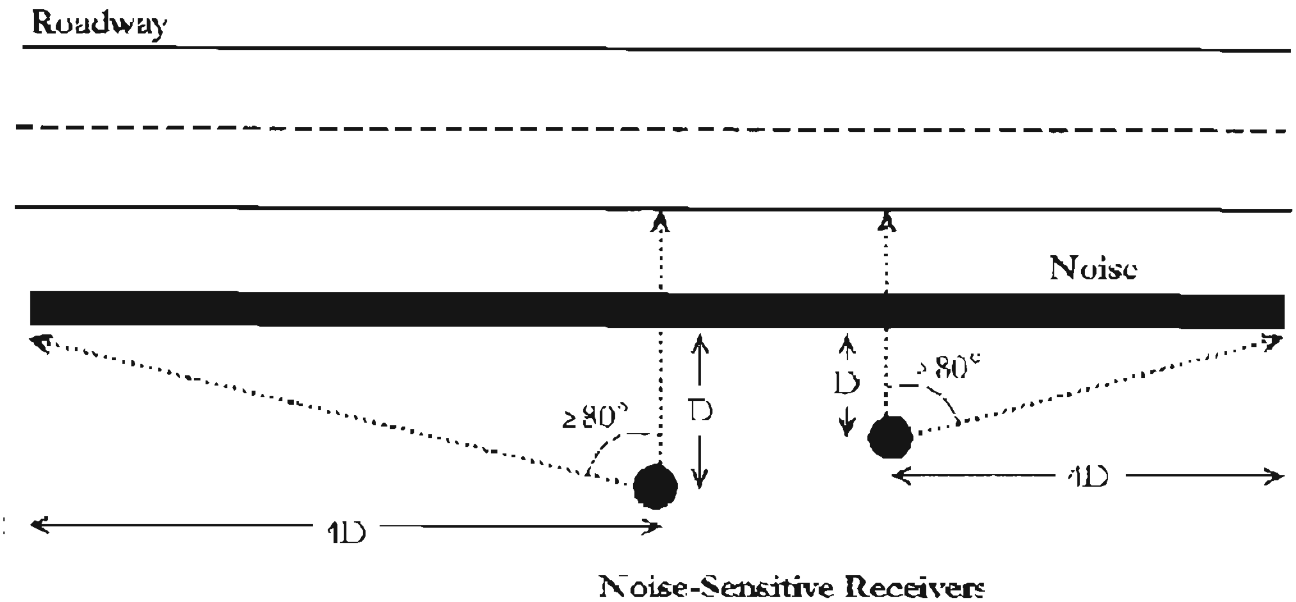

Figure 14. Barrier length

Sometimes due to the community and roadway geometry, there is not enough available area to ensure a proper-length barrier. In those cases, highway barrier designers may decide to construct the barrier with the ends curved inward towards the community (see Figure 15).

Figure 15.
Barrier curved inward towards the community
photo #2617

3.5.3 Wall Versus Berm.
Highway noise barriers are typically characterized as a wall, a berm, or a combination of the two (see Figure 16). There are advantages and disadvantages to each type. The considerations that are examined in deciding whether to build a wall or a berm, include available area, materials, costs, aesthetics, and community concerns. Acoustically, for a given site geometry and comparable barrier height and length, a berm barrier will typically provide an extra 1 to 3 dB(A) of attenuation. Several factors contribute to this increase. First, the flat top of a berm diffracts the sound waves twice, resulting in a longer path-length difference, a larger Fresnel number, and, thus, more attenuation. Second, the surface of a berm is, essentially, grass-covered acoustically soft earth with side slopes closer to the sound path, which provides additional attenuation. However, because a berm is wider than a wall (thus, requiring more land than a wall when constructed) and because the 1 to 3 dB(A) additional attenuation is, at best, only barely perceptible to the human ear, a berm's acoustical advantage does

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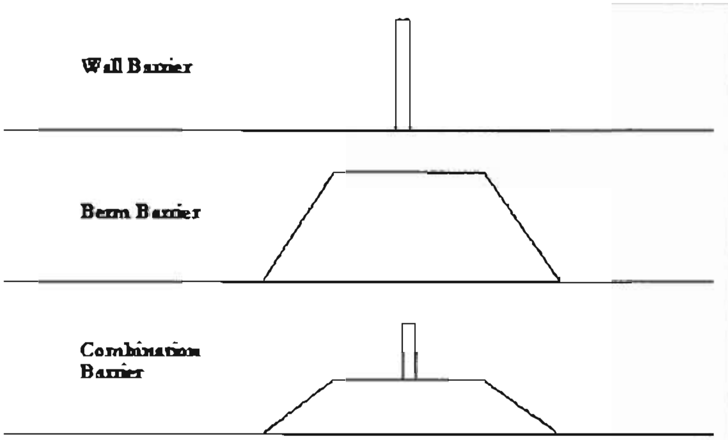

Figure 16. Wall, berm and combination noise barriers

3.5.4 Reflective Versus Absorptive.
A barrier without any added absorptive treatment is by default reflective (see also Section 3.4.1). A reflective barrier on one side of the roadway can result in some sound energy being reflected back across the roadway to receivers on the opposite side (see Figure 17).

It is a common phenomenon for residents to perceive a difference in sound after a barrier is installed on the opposite side of a roadway. Although theory indicates greater increases for a single reflection, practical highway measurements commonly show not greater than a 1 to 2 dB(A) increase in sound levels due to the sound reflected off the opposing barrier. While this increase may not be readily perceptible, residents on the opposite side of the roadway may perceive a change in the quality of the sound; the signature of the reflected sound may differ from that of the source due to a change in frequency content upon reflection.

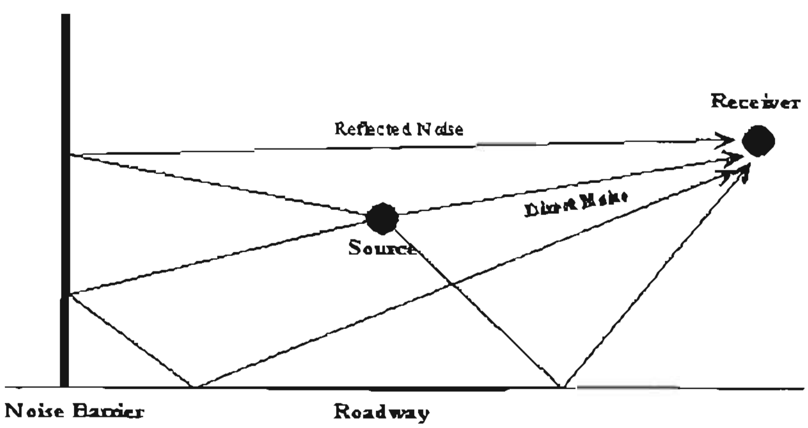

Figure 17. Reflective noise paths due to a single barrier

Parallel barriers are two barriers which face each other on opposite sides of a roadway (see Figure 18). Sound reflected between reflective parallel barriers may cause degradations in each barrier's performance due to multiple reflections that diffract over the individual barriers. These degradations may be from 2 to as much as 6 dB(A) (see Figure 19).[ref.19] That is, a single barrier with an insertion loss of 10 dB(A) may only realize an effective reduction of 4 to 8 dB(A) if another barrier is placed parallel to it on the opposite side of the highway.

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Figure 18.
Parallel noise barriers
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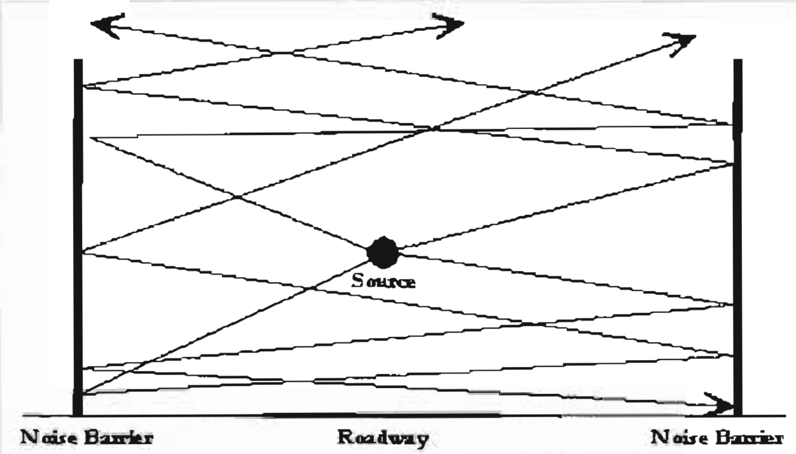

Figure 19. Reflective noise paths due to a parallel barrier

The problems caused by both single and parallel barriers can be minimized using one or a combination of the following three methods [ref 19]

- For parallel barriers, ensure that the distance between the two barriers is at least 10 times their average height. A 10:1 width-to-height (w/h) ratio will result in an imperceptible degradation in performance. In recent studies, it was determined that as the w/h ratio increases, the insertion loss degradation decreases [ref 24] and ref 33 This decrease can be attributed to: (1) the decrease in the number of reflections between the barriers, and (2) the weakening of the reflections due to geometrical spreading and atmospheric absorption. Table 5 provides a guideline of three, general w/h ratio ranges and the corresponding barrier insertion-loss degradation (ΔIL) that can be expected

Table 5. Guideline for categorizing parallel barrier sites based on the w/h ratio.

w/h Ratio	Maximum ΔIL in dB(A)	Recommendation
Less than 10:1	3 or greater	Action required to minimize degradation
10:1 to 20:1	0 to 3	At most, degradation barely perceptible, no action required in most instances.
Greater than 20:1	No measurable degradation	No action required.

- Apply sound absorptive material on either one or both barrier facades. See also *Section 3.4.1* The decision to add a sound absorptive surface should be determined by weighing benefit versus cost. That is, what noise abatement benefits can be achieved for how many residents versus the costs of the application and maintenance of the absorptive treatments?

  The answer is most important since the typical costs of noise absorptive material, whether integrated with the noise barrier at the time of barrier construction, or as a retrofit later on after the barrier is constructed, is usually \$75 to \$118/m^2 (\$7 to \$11/ft^2). Using an average cost of \$97/m^2 (\$9/ft^2) for example, for a 3.6-m (12 ft) high barrier, this would translate into an additional \$0.4 million/km (\$0.6 million/mi) in costs. [ref 24], ref 34, ref 35, ref 36 and ref 37

- Tilt one or both of the barriers outward away from the road. Previous research has shown that an angle as small as 7 degrees is effective at minimizing degradations [ref 33] This solution, however, must consider locations higher than the opposite barrier because they may be adversely affected by the reflected sound.

3.5.6 Other Unique Design Considerations.

3.5.6.1 Overlapping Barriers.

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Barriers which overlap each other (see Figure 20) are usually constructed to allow access gaps for maintenance, safety, and pedestrian purposes (see Section 9.4.1). A general rule-of-thumb is that the ratio between overlap distance and gap width should be at least 4:1 to ensure negligible degradation of barrier performance (see Figures 21). If a 4:1 ratio is not feasible, then consideration should be given to the application of absorptive material (see Section 3.4.1) on the barrier surfaces within the gap area.

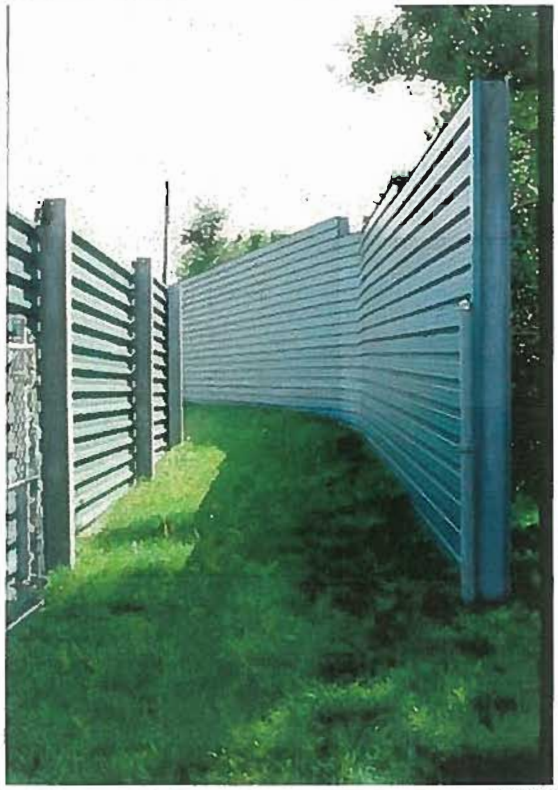

Figure 20.
Example of overlapping barriers
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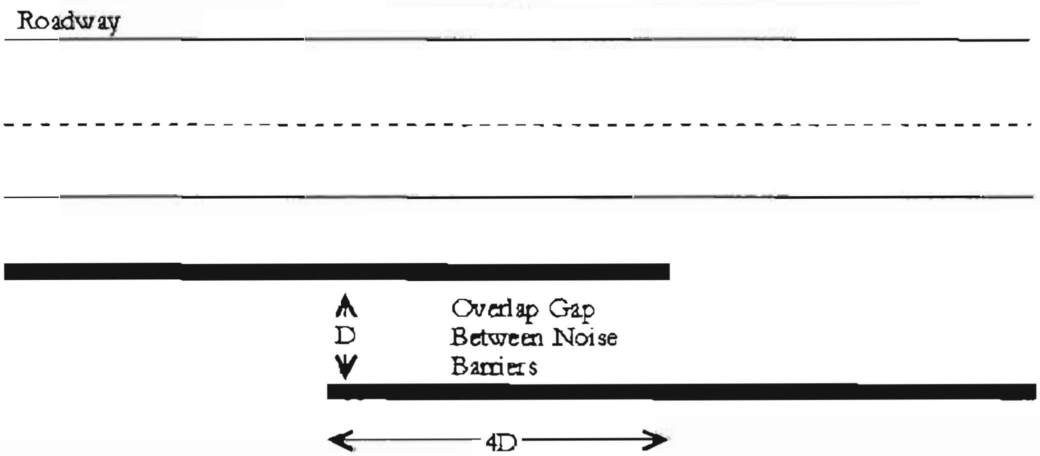

Figure 21. Overlapping barriers

3.5.5.2 "Zig-zag" Barriers.

A barrier using concrete panels arranged in a "zig-zag-like" or "trapezoidal" configuration (see Section 4.1.2.3.1) is advantageous because it is structurally sound without the use of a foundation. This type of barrier can also be visually pleasing to motorists because it provides variation in form (see Figure 22). It does not, however, have any substantial additional sound attenuation benefits.

Figure 22.
"Zig-zag" barrier
photo #8057

3.6.6.3 Tops of Barriers.

There has been limited research into varying the shape of the top of a barrier (see Figure 23 and 24) for the purpose of shortening barrier heights and possibly attaining the attenuation characteristic of a taller barrier. The technical rationale is that additional attenuation can be attained by increasing the number of diffractions occurring at the top of the barrier. Shorter barrier heights could improve the aesthetic impact on communities and motorists by preserving more of the view.[ref 18] and [ref 38]

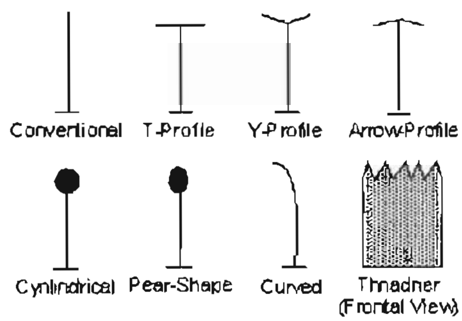

Figure 23.
Special acoustical considerations:
tops of barriers

Studies have shown that a T-profile top barrier (see Figure 25) provides insertion losses comparable to a conventional top barrier when the difference in their heights is equal to the width of the T-profile top. When the two barriers are the same height, the T-profile top barrier has been shown to provide an additional 2.5 dB(A) insertion loss over the conventional top barrier. Y- and arrow-profile tops also performed better than conventional tops, however, to a lesser degree than the T- profile tops.[ref 39] and [ref 40] Cylindrical, pear-shape, curved, and Thnadner top barriers have not shown substantial benefits, unless an absorptive treatment was incorporated into the barrier tops.[ref 41] and [ref 42]

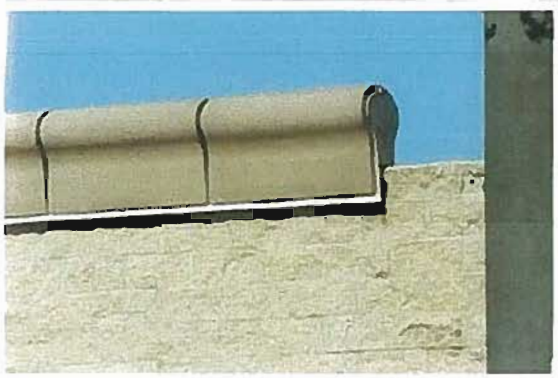

Figure 24. Special top of barrier
photo #2395

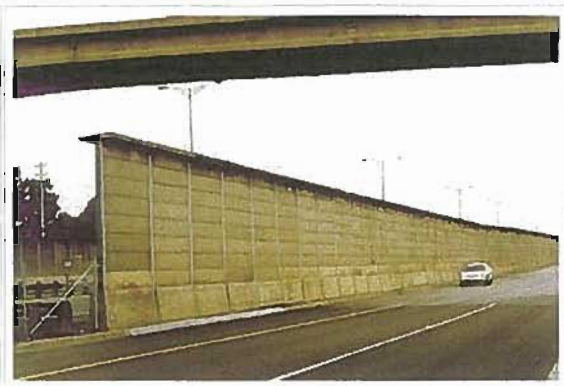

Figure 25. T-profile top barrier
photo #1312

Although there are some acoustical and aesthetic benefits associated with special barrier tops, the cost of constructing these shapes typically outweigh the cost of simply increasing the barrier's height to accomplish the same acoustic benefit.[ref 43]

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Section Summary

Acoustical considerations for all noise barriers.

Item#	Main Topic	Sub-Topic	Consideration	See Also Section
3-1	Atmospheric Effects	Atmospheric Absorption, Refraction, Turbulence	Field measurements should not be performed when wind speeds are greater than 5 m/s, or when strong winds with small vector components exist in the direction of propagation.	3.3.1 14.1.2.1 15.1.2
3-2	Barrier Design Goals	Barrier Sound Transmission	Barrier panel materials should weigh 20 kg/m^2 or more for a transmission loss of at least 20 dB(A).	3.4.2
		Barrier Length	Ensure barrier height and length are such that only a small portion of sound diffracts around the edges	3.5.2
		Wall vs. Berm	A berm requires more surface area, but provides 1 to 3 dB(A) additional attenuation versus a wall.	3.5.3
		Reflective vs. Absorptive	Communities may perceive sound level increases due to reflections. Sound reflected between parallel barriers may cause degradations in each barrier's performance from 2 to as much as 6 dB(A), but in most practical situations, the degradation is smaller.	3.5.4
		Overlapping Barriers	Ensure the ratio between overlap distance and gap width (between barriers) is at least 4:1.	3.5.5.1
		Special Tops for Barriers	The cost of constructing these special shapes typically outweigh the cost of simply increasing the barrier's height to accomplish the same acoustic benefit.	3.5.5.3

Updated: 05/20/2010

ISTHA. June 1, 2010

2700 Ogden Av.

Downers Grove Ill. 60515-1703

Re: Arendovich v. ISTHA, 2009-102

Dear Mr. Lane

In reference to the interrogatory which you did not find it satisfactory. I am writing a second version , I hope it will satisfy you . As I said in the previous letter most of the information you have asked it is in the amended complain.

Question #12 Each graph provides you with the data ,hour, location and a beautiful chart which shows your noise level .

Question #13 To isolate tollway noise versus no tollway , please , go to the EIS signed by FHA and by your organization , you will find the noise level in DB is 41 and no DB 72.

Many of your inquire like # 14 to #17 have no answer, since we have complain about noise pollution , and not about personal injury.

Question # 18 , a) It repeats it self . see your question # 12 no movie , but noise charts. b) this repeat itself , you have asked for resume , it is given to you in question # 20 . c) the answer to this question was provided to you previously but let me repeat : Mr. Lane of ISTHA, IPB, and Peter Arendovich.

Question #19 See answers in the amended answers to the Interrogatory.

Question # 20 a) two resume are provided. b) Noise pollution at 135 st. at I-355 extension . c) this is a mouthful, some possible answers you will find at the amended answers to your interrogatory . d) Please see the filled amended complain. e) I am the witness that complained , and you have my opinion in my so called resume.

I hope this satisfy your interrogatory.

Mr. Lane in regard to your third paragraph of the letter of May 7 2010. You are a lawyer for the Tollway you are supposed to know the rules on noise pollution and how NOISE pollution affects life were previously the noise level was not higher then 41 DB see EIS, so please don't ask my . Should I make the research for you ? Please adhere to the law and don't fight the law, you are supposed to be part of the government of the people to protect the wellbeing of the citizen , not harm them , have you forgotten the basic human rights ?

Thank you

Sincerely

P. Arendovich (630 257-8753)

Cc: Mr. Brad Halloran
Pollution Control Board Hearing Officer

ILLINOIS POLLUTION CONTROL BOARD

PETER ARENDOVICH	]	
COMPLAINANT	]	
VS	]	PCB - 2009 – 102
ILLINOIS STATE TOLL HIGHWAY	]	(ENFORCEMENT – NOISE POLLUTION)
AUTHORITY	]	
RESPONDENT	]	

ANSWER TO THE INTERROGATATION BY THE RESPONDANT

1 I, Peter Arendovich, due to noise pollution, have been unable to sleep, and as a result have had increased hypertension.

2

Peter Arendovich	1388 Gordon Ln Lemont IL, 60439	(630)257-8753
Mary Pytllewsky	16119 w 135th st Lemont IL, 60439	(630)257-5075
Boris Nitchkoff	16055 W 135th st Lemont IL, 60439	(630)257-9705
A. Garb	13764 S Archer Ave Homer Glen IL, 60439	(630)257-2562
Fransisco Cisneros	1382 Gordon Ln Lemont IL, 60439	(773)744-1747 (Cellular)

3 The lot was purchased in 1987

4 The property was fully constructed in 1990

5 The appraisal can be found through the cook county Assessor's office or through the home insurance agency

6 Noise was detected on November 11, 2008

7 The complaint was submitted to Rocko Zuckero the day after the road was opened which was about the same week as the ISTHA board meeting. I also contacted the FHA several times with regards to my problem.

8 The complaint was first to the ISTHA followed by the FHA. The Township of Lemont was contacted as well.

9 See line (7). I intended to deal with the ISTHA directly expecting them to be a responsible agency, but realized they were leading me on for several months. I found myself helpless so I looked for another means.

10 There has been no other legal actions taken

11 Every time a vehicle crosses the bridge from either direction, a significant amount of noise is created. As a car passes, a noise is created. As larger vehicles pass, a louder noise is created. As semis pass, an even louder noise is created. When combinations of all the above vehicles cross, such as times of the early morning, the noise becomes absolutely unbearable. My bedroom faces the bridge, and what used to be peace and tranquility, has been turned into the sound of many vehicles traveling across a highway. The noise has made me resort to stuffing my ears with cotton if I desire to stay or sleep in my bedroom.

12 Please see charts in the amended complain on each chart there is a date, location and noise chart for each day taken

Chart	Date:
074	06/05/08
075	06/05/08
077	06/06/08
078	06/06/08
078	06/06/08
079	06/06/08
090	06/12/08
089	06/12/08
087	06/11/08
088	06/11/08

Description of location and methodology and equipment you find it in the exhibit " C "

in the filed amended complain received on Sept 5 2009 by the Illinois Pollution Board and one copy was submitted to you (R.T. Lane)

13 The method, equipment, and calibration was handled by Mr. Larsen (acoustic engineer). The baseline was determined when low levels of passenger cars were using the tollroad and the sensor was set for long time data acquisition. The comparison was obtained between high traffic and low traffic concentrations.

14. None other to my knowledge , I don't ask for their health problem.

15. I don't ask people (neighbors) about their health condition.

16 I don't ask Neighbors abouth their health condition

17 David A. Larson27707 Moose Range Rd. Sycamore Il. 60178

18 a) All that information is in you possession

b) David Larson or I Peter Arendovich

c) ISTHA and IBP have copy of the graphs (Robert T. Lang) attached to the amended complain

19 Yes there were reading take on the out side of my balcony. This is a repetition of previous questions .

a. The answer is on the charts submitted in the amended complain
b. The answer is in the submitted amended complain
c. David A. Larson calibrated his equipment
d. Answer is submitted in the amended complain
e. David A. Larson have the data as stated in the submitted complain
f. David A. Larson 27707 Moose Range Sycamore Il. 60178

20. a. Resume is given as exhibit # " B "

b. The subject matter is Noise produced by the tollway I-355 extension by 135 st.

c. A report Issued by David Larson to Peter Arendovich June 13 2009 , This report was included as exhibit " C " in the amended complain presented to the Tollway and to the Illinois Pollution Board

This report contains the conclusion and the opinion of the expert witness .

The Tollway have in its own possession

Final environmental Impact statement

Supplement of the final environmental impact statement on disc.

Letters send to Municipality mayors , property of the Tollway in regard to abatement.is your possession .

Highway traffic noise analysis and abatement policy and guidance

U.S. Department of Transportation
Federal Highway Administration
Office of Environment and Planning
Noise and Air Quality Branch
Washington, D.C.
June 1995

You should get it from your engineering library, That should have been you Bible.

APENDIX A VEHICLE NOISE EMISSION

From the Fed Dep. Of transportation. This should have been you guidance prior building the road. (You failed is because you did not follow Federal guidelines.)

d. There is a written report in the filled amended complain.

e. I am the controlled witness and the Tollway I had correspondence with ISTHA, please check with Kovaks , Zuckero and the former chairman of the board Mitola.

MY description or resume

I, Peter Arendovich, am retired graduated Chemist and have worked in research for over 20 years and in product development for other 20 years . I lived in Cicero and Lyons for 31 years. I purchased a property in Lemont in a rural area and built my house as a general contractor so I could enjoy my retirement. A year later after I moved into my retirement home, IDOT showed an attempt to build a freeway. We the resident in the area signed a petition, asking IDOT the road be moved to a less developed area about 1800 ft. west of the preliminary alignment. For some mysterious reason, IDOT did not oblige our petition. Later in time IDOT granted the project to ISTHA. From here on several scandals came to be due to impropriety by the agency. As our interests were in pollution, our big concern was water pollution and those concerns have not gone away. This is the issue of the polluting of our aquifers by the water runoff from the road discharges as well as the salt dumps during winter time. It was during Governor Jim Edgars administration, that I have sent a letter to the governor. The response was on document # which surprisingly mentioned about noise pollution even though at that time I did not express concern of it. I obtained a letter from Mark Kazich (project coordinator # that a noise barrier of 3000 feet north from 135 St. bridge was part of the project , In my subsequent discussion of pollution. The Chief engineer provided me with construction plans in the area between 127 St. and Archer Av. were on the drawing it shows a proposed noise barrier to be constructed between the South end of 135 th St. bridge and Archer Av. #

All those mentioned documents were part of the Final Environmental Statement.

The project was stopped because no alternative alignment was not mentioned in the FEIS. Since the time was a factor , otherwise a new study would have to be made therefore a Supplement EIS was made in a hurry and no physical environmental study were made in our area . So it was expected the project plans should be the same , ButThe new administration violated the FEIS and made changes favoring their own interest. Apparently ISTHAs previous engineers during Edgars administration were concern about noise and water pollution as shown in governors Edgar response . See exhibit " D "

Respectfully Submitted,

Peter Arendovich

1388 Gordon Ln.

Lemont Il. 60439

162 - 2.6/mi
239 - 4.0/mi
243 - 4.0/mi
291 - 5.0/mi
303 - 5.0/mi

March 2010; Weekday Average Toll Transaction by Hour - 3, 4, 5 or more axle trucks

	Plaza 93		Plaza 95		Plaza 97		Plaza 99		Plaza 101	
Hour	North	South	North	South	North	South	North	South	North	South
0:00	1	5	0	0	0	0	33	29	0	0
1:00	1	3	1	0	0	0	30	27	0	1
2:00	1	3	0	0	0	1	32	27	0	1
3:00	1	4	0	2	1	1	40	36	0	0
4:00	1	4	1	1	1	2	56	46	0	1
5:00	3	7	5	1	2	4	101	62	0	1
6:00	5	9	7	3	5	7	140	99	2	1
7:00	5	11	8	6	9	7	149	114	6	4
8:00	6	13	8	6	8	7	154	137	6	5
9:00	6	13	10	7	7	7	160	153	6	5
10:00	5	12	9	8	7	7	156	157	5	4
11:00	6	13	10	8	8	8	153	168	5	6
12:00	5	14	8	7	7	8	155	167	5	4
13:00	5	12	7	7	8	6	144	165	4	4
14:00	5	8	7	7	6	6	132	162	4	3
15:00	4	8	5	6	6	5	121	141	2	2
16:00	3	7	4	5	4	4	102	125	1	1
17:00	3	7	4	3	4	4	89	100	1	1
18:00	3	7	2	3	3	3	75	84	1	1
19:00	1	7	2	2	2	2	63	60	1	0
20:00	1	7	2	1	1	1	55	54	1	1
21:00	1	7	1	1	1	1	47	42	0	0
22:00	1	6	1	1	1	1	47	44	0	0
23:00	1	5	1	1	1	1	39	38	0	0

3. State the income collected from I-355 extension (between I-55 and I80) in the months mentioned in the paragraphs #1 and # 2.

Item 3 Response:

New Monthly Revenue Report, Adjusted Collected Revenue; before toll collection, maintenance, operating, and debt expenses.

Collected Revenue for Entire I-355 S. Extension

Month	Total
Nov-2009	$ 2,981,458
Feb-2010	$ 2,409,884
Mar-2010	$ 2,833,271

65000
30
0000
195000
1950000

March 2010; Weekday Average Toll Transactions by Hour

Hour	Plaza 93 North	Plaza 93 South (122 ST)	Plaza 95 North	Plaza 95 South (ARCHER)	Plaza 97 North (I 595)	Plaza 97 South	Plaza 99 North (SPRING CREEK)	Plaza 99 South	Plaza 101 North (US 6)	Plaza 101 South
0:00	9	29	17	35	22	57	137	166	16	5
1:00	7	15	10	18	17	30	96	100	10	4
2:00	7	10	9	12	21	19	92	84	6	3
3:00	10	10	17	8	33	17	125	98	6	7
4:00	27	13	54	12	128	21	343	172	8	27
5:00	116	48	213	27	445	50	1151	525	19	87
6:00	262	116	454	83	796	168	2073	1298	121	179
7:00	365	147	552	151	914	245	2498	1743	89	259
8:00	284	155	385	159	612	267	1805	1477	70	146
9:00	214	128	244	135	394	222	1268	1171	59	95
10:00	174	134	201	134	312	226	1084	1056	57	73
11:00	176	165	191	153	298	266	1094	1063	59	68
12:00	171	183	182	174	301	286	1107	1132	67	65
13:00	150	201	176	194	295	318	1130	1237	71	61
14:00	159	230	179	247	304	432	1279	1495	104	85
15:00	199	308	190	371	325	606	1616	2046	163	135
16:00	191	374	204	504	349	778	1634	2389	174	102
17:00	199	397	228	516	384	873	1696	2303	173	117
18:00	176	294	185	350	328	612	1220	1565	130	78
19:00	116	202	131	215	228	402	812	1010	90	49
20:00	83	161	97	171	194	312	654	779	78	35
21:00	69	135	96	153	165	260	578	678	68	28
22:00	41	89	62	99	99	182	400	473	46	22
23:00	22	51	38	62	54	124	255	309	28	12

2. State the number of trucks with 3 and 4 axels on daily bases in a given month (November and March) and separate the hourly counts in the same manner as asked in the paragraph # 1.

Item 2 Response:

Average weekday three, four, five and more axle truck transactions by hour by toll plaza incorporating the requested months are provided:

TRUKS 25600 / WEEK

$ 5

128 000

52

$ 6,8 54,000

ATTESTATION

STATE OF ILINOIS)
) SS.
COUNTY OF DUPAGE)

Rocco Zucchero, being first duly sworn on oath, deposes and states that I am the Respondent's Deputy Chief of Engineering for Planning; that I have read the foregoing document, and that the answers made herein are true, correct and complete to the best of my knowledge and belief.

SUBSCRIBED and SWORN to before me
this ~~1st~~ 2nd day of June, 2010.

NOTARY PUBLIC

OFFICIAL SEAL
MARIA WIDLAK
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES:05/22/13

ROBERT T. LANE
Assistant Attorney General
Illinois Toll Highway Authority
2700 Ogden Avenue
Downers Grove, IL 60515
(630) 241-6800 (ex. 1530)

LISA MADIGAN,
Attorney General of Illinois

CERTIFICATE OF SERVICE

The undersigned, being first duly sworn upon oath, deposes and states that a copy of this Notice **of Filing and ILLINOIS STATE TOLL HIGHWAY AUTHORITY'S RESPONSES TO COMPLAINANT'S FIRST SET OF INTERROGATORIES** were served upon Peter Arendovich at 1388 Gordon Lane, Lemont, IL 60439 by depositing the same in the United States Mail at 2700 West Ogden Avenue, Downers Grove, IL 60515 on the ~~1st~~ 2nd day of June, 2010 with proper postage prepaid.

ROBERT T. LANE
Senior Assistant Attorney General

4. State the riders fee for different vehicles on I-355 between I-55 and I-80.

Item 4 Response.

Illinois Tollway toll rates:

Plaza Name	Plaza No.	Autos		Trucks					
		All Times (I-PASS)	All Times (Cash)	Daytime (Cash & I-PASS)			Overnight (Cash & I-PASS)		
				Small	Medium	Large	Small	Medium	Large
127th Street	93	$0.50	$1.00	$1.50	$2.25	$4.00	$1.00	$1.75	$3.00
Archer Ave / 143rd Street	95	$0.65	$1.25	$1.95	$3.00	$5.20	$1.30	$2.30	$3.90
IL 7 (159th Street)	97	$0.75	$1.50	$2.25	$3.45	$6.00	$1.50	$2.70	$4.50
Spring Creek	99	$1.00	$2.00	$3.00	$4.50	$8.00	$2.00	$3.50	$6.00
US 6	101	$0.25	$0.50	$0.75	$1.15	$2.00	$0.50	$0.90	$1.00

Daytime and Overnight Hours
Daytime = 6:00 AM - 10:00 PM
Overnight = 10:00 PM - 6:00 AM

5. State the speed limit on I-355 and the margin tolerable above speed limit, by enforcement police.

Item 5 Response:

The current speed limit on I-355 is 55 miles per hour. The Tollway is unaware of any margin of speed limit tolerance that may be permitted by the State Police.

6. State the number of State police trooper employed by the Tollway.

Item 6 Response: NO CONTROL

The Tollway does not employ any State Troopers. State Troopers are employed by the Illinois State Police.

7. State and show data documents if the Federal Highway Authority have verified Physically, if Illinois State Highway Authority have complied with the Final Environmental Impact Statement if regard to noise pollution.

Item 7 Response:

The Tollway does not have any responsive documents in its possession.

8. State the rational and show documents as why the Illinois Tollway Authority spent money to build and 18 foot wall for one mile long, along I-55 which is not a part of the Tollway system, but neglected to build a wall between 135 st. and Archer Ave.

Item 8 Response:

The sound wall constructed on I-55 near I-355 was justified based on sound studies performed as part of the Supplemental Environmental Impact study. However, the wall constructed along Interstate 55 is the financial responsibility of the Illinois Department of Transportation, not the Illinois Tollway.

9. Show documents how much money Illinois toll way Authority saved, between the initial proposed to build the extension and the final build of the I-355 extension.

Item 9 Response:

The project was initially proposed to be constructed in the late 1990's. As of April 17, 2000, the estimated construction cost of the I-355 extension was $431,000,000. While the I-355 project is substantially complete, there are still some on-going construction contracts. The final cost of construction is currently estimated at $622,322,815. LIE

10. Give the name of the Chief Engineer who modified the implementation from Final Environmental Impact Statement to the Supplement Environmental Impact Statement.

Item 10 Response:

The Final Environmental Impact Statement and Supplemental Environmental Impact Statement were prepared by the Illinois Department of Transportation and Federal Highway Administration. The Tollway did not prepare or modify the implementation of the Final Environmental Impact Statement or the Supplemental Environmental Impact Statement.

Illinois State Toll Highway Authority
By: Rocco Zucchero, Deputy Chief of Engineering for Planning

STATE OF ILLINOIS
POLLUTION CONTROL BOARD
JAMES R. THOMPSON CENTER
100 W. RANDOLPH ST, SUITE 11-500
CHICAGO, IL. 60601

RECEIVED
CLERK'S OFFICE
SEP 09 2009
STATE OF ILLINOIS
Pollution Control Board

PETER ARENDOVICH,	)	
	)	
Complainant,	)	
	)	
v.	)	PCB 29009-102
	)	
ILLINOIS STATE TOLL HIGHWAY AUTHORITY,	)	
	)	
Respondent.	)	

MOTION FOR THE FILING OF THE COMPLAINANT'S FIRST AMENDED COMPLAINT

NOW COMES the Complainant, Peter Arendovich and moves this Board for an order granting the filing of the Complainant's First Amended Complaint. In support of this motion, the Complainant states as follows:

1. The Respondent has filed a motion on July 15, 2009, to strike and dismiss the original Complaint as frivolous.
2. The Complainant has corrected the legal deficiencies of the Complaint in answer to the Respondent's Motion to Strike and Dismiss
3. A copy of the First Amended Complaint is attached to this motion and made a part thereof.

WHEREFORE, the Complainant prays this board to grant an order allowing the filing of the First Amended Complaint.

Respectfully submitted,

P. Arendovich

Peter Arendovich
1388 Gordon Lane
Lemont, IL.60439
630-257-8753

STATE OF ILLINOIS
POLLUTION CONTROL BOARD
JAMES R. THOMPSON CENTER
100 W. RANDOLPH ST, SUITE 11-500
CHICAGO, IL. 60601

PETER ARENDOVICH,	)	
	)	
Complainant,	)	
	)	
v.	)	PCB 29009-102
	)	
ILLINOIS STATE TOLL HIGHWAY AUTHORITY,	)	
	)	
Respondent.	)	

FIRST AMENDED COMPLAINT

NOW COMES the Complainant, Peter Arendovich, pursuant to 415 ILCS 5/31(d) (1) and 35 Ill. Admn. Code 900.102 et seq. and complains of the Respondent, the Illinois State Toll Highway Authority as follows:

1. The Illinois State Toll Highway Authority, (ISTHA), has violated 23 CFR Part 772.13(c) and 23 USC 109(h) and 35 Ill. Adm. Code, Subtitle H, Chapter I, Section 900.102 by failing to provide the required noise abatement policies and procedures required under the provisions of both federal and state law.

2. ISTHA co-operated with the Federal Highway Administration in the planning and construction of I-355 through Cook and Will Counties.

3. A required Environmental Impact Statement, (EIS), was prepared by the Respondent and included the required noise abatement studies. The EIS indicates the location of the Complainant's residence as section 25 shown on the EIS exhibit

2-16. A Copy of the exhibit is attached hereto as Complainant's Ex A.

4. Table 4-15 of the EIS details the Results of the Noise Abatement Analysis and section 25, including the Complainant's residence as well as 23 other residences, states that a noise reduction barrier is likely to be implemented and that the potential noise reduction is to be 9 dB(A). (A copy is attached hereto as Exhibit B). The EIS establishes that heavy trucks generate 86dBA and the reduction of 9 dBA fails to comply with state and federal noise levels as is shown on charts 74 through 79 of Exhibit C.

5. The Complainant has consistently complained to ISTHA regarding the excessive noise levels of the constructed Tollway. ISHTA has failed to properly address the Complainants concerns. The Complainant hired the acoustical engineering firm, S&V Solutions to conduct detailed scientific studies in accordance with the measurement procedures set forth under the provisions of 35 Ill. Admn. Code Section 900.103. A detailed scientific study of the noise levels experienced at the Complainant's residence has been conducted and a copy of the detailed analysis and report is attached hereto as Exhibit C. The study's conclusions states as follows:

"The data shows that from Tuesdays through Fridays the noise generated by the highway is above the noise level indicated on Title 23
Chart (A) shows heavy trucks generate 86 db at a distance of 50 feet from the source.
Your property is about 150 feet from the source and the bedroom wall is 350 feet from the source.
Taking into account Chart (A), the generated noise by heavy trucks at 60 MPH is about 86 dB. Based on the

acoustic distance law, where the amount of decibels decrease by 5 every time distance is doubled(inverse square law}, it is very unlikely the noise will dissipate to legal levels 150 feet away, nor at 350 ft. by your bedroom where the readings were taken. This is shown on charts from #74 through #89.
On charts #74 through #79 the high point which is above 65 db correlates with heavy truck noise decibels (db) and heavy truck traveling frequencies, passing at a given point."

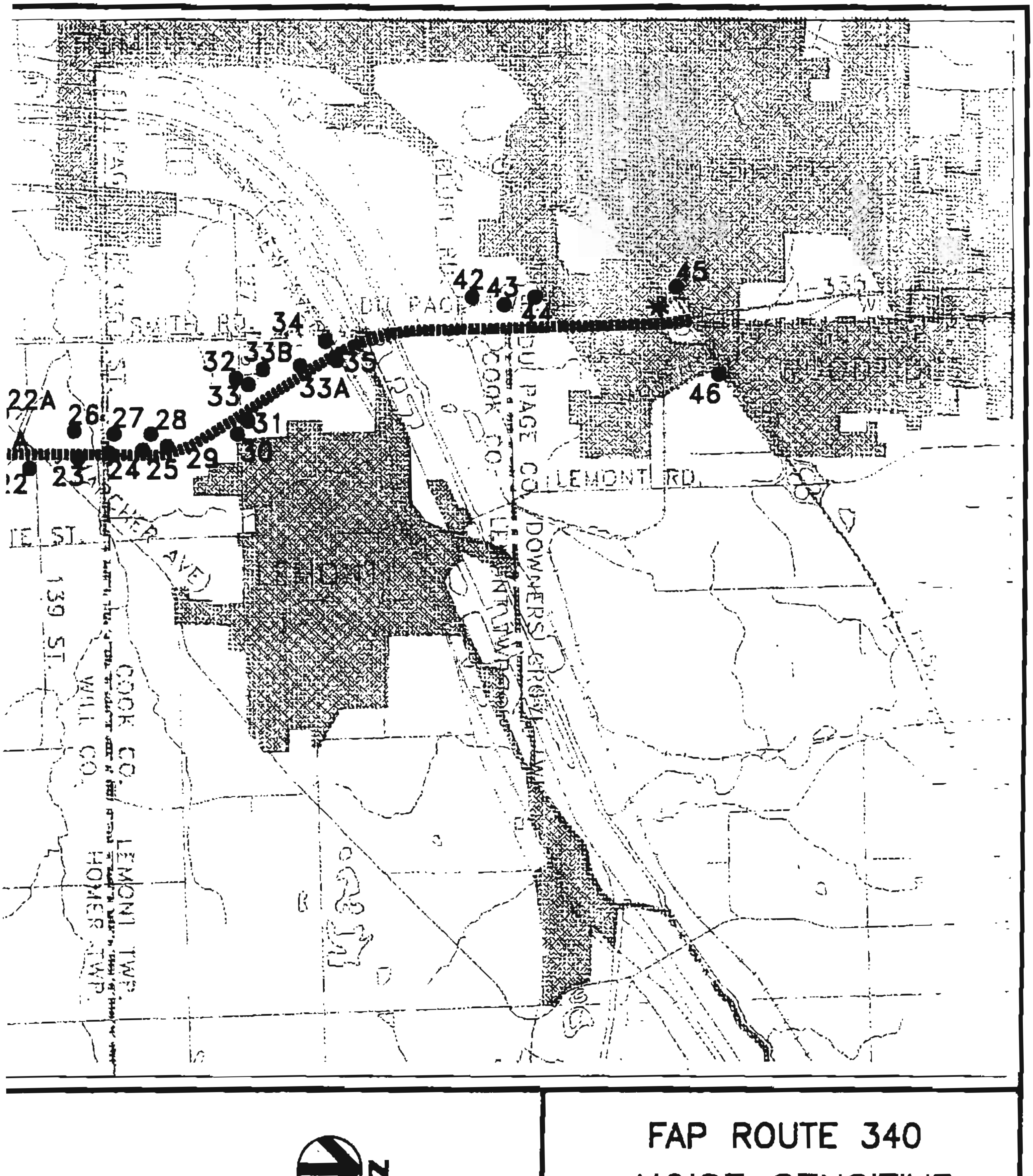
6. The noise levels recorded in the detailed scientific study are in excess of the required maximums established by federal and state regulations. FHWA regulations contained in IDOT's Traffic Noise Assessment Manual at 2-2 indicate that the maximum dBA for residential areas is 67 dBA. A copy of IDOT's FHWA NOISE ABATEMENT CRITERIA is attached hereto as Exhibit D.

7. All of the graphs included in the attached study show that the noise levels generated by the Tollway are consistently above the maximums established under state and federal regulations.

WHEREFORE the Complainant prays this Board to find ISTHA in violation of 35 Ill. Adm. Code, Subtitle H, Chapter I, Section 900.102 and to order the Respondent to construct proper noise abatement barriers as originally proposed in the Environmental Impact Study and in accordance with federal and state laws.

Respectfully submitted,

Peter Arendovich
1388 Gordon Lane
Lemont, IL.60439
630-257-8753



FAP ROUTE 340

NOISE SENSITIVE RECEPTORS

EXHIBIT "A"

0
LAZA

Table 4-15
Results of Noise Abatement Analysis

Receptor	No. of Structures Represented	Barrier Height In Feet	Barrier Length In Feet	Cost* ($25/Sq. Ft.)	Reduction Potential dB(A)	Likely To Be Implimented	If I Reas Wh
SOUTHERN SECTION							
1 (R)	20	15	1200	$450,000	7	YES	-
2 (R)	18	15	1000	$375,000	6	YES	-
5(R)	16	15	6800	$2,550,000	1	NO	2
11(R)	13	25	7680	$4,800,000	2	NO	2
14A (P)	70	25	8800	$5,500,000	4-6	NO	1
15 (R)	1	25	1600	$1,000,000	7-8	NO	1
15A (R)	8	25	1000	$625,000	7-8	YES	-
MIDDLE SECTION							
15B(R)	9	15	1500	$562,500	2-3	NO	2
16(R)	16	15	1500	$562,500	2-3	NO	2
16A (R)	22	25	4700	$2,937,500	4	NO	2
17 (R)	12	-	-	-	-	NO	2
17A (R)	4	25	2200	$1,375,000	13	NO	1
18 (R)	17	25	10200	$6,375,000	2	NO	1,2
19 (R)	17	25	10200	$6,375,000	2	NO	1,2
21A (R)	2	25	5400	$3,375,000	8-9	NO	1,2
21B(R)	17	25	10200	$6,375,000	2	NO	1,2
25 (R)	22	25	3700	$1,400,000	9	YES	
28 (R)	1	25	2200	$1,375,000	9	NO	1,2
29 (R)	3	25	2600	$1,625,000	9	NO	1,2
30(R)	2	15	1700	$637,500	2	NO	1,2
31(R)	3	15	1300	$487,500	2	NO	1,2
32(R)	5	15	2300	$862,500	2	NO	1,2
NORTHERN SECTION							
33 (R)	3	15	3500	$1,312,500	4-6	NO	1
33A (P)	88	25	3000	$1,875,000	4	NO	2
33B (R)	1	25	11200	$7,000,000	2	NO	1,2
34(R)	6	15	3400	$1,275,000	4-6	NO	1,2
35(R)	4	15	3400	$1,275,000	4-6	NO	1
42 (R)	3	25	1400	$875,000	6-8	NO	1
43 (R)	2	25	2600	$1,625,000	6-8	NO	1
44 (R)	2	25	2200	$1,375,000	4-6	NO	1
45 (R)	20	25	1400	$875,000	5	YES	-
46 (R)	25	15	5000	$1,875,000	6-7	YES	-

Notes:

Receptors 16A and 17 share a common noise abatement barrier.

P) - Represents proposed residential developments

R) - Represents existing residence

* The cost includes preliminary analysis design, final design and related construction costs.

1 - Not economically reasonable or feasible based on cost compared to benefit.

2 - Does not provide substantial noise abatement.

EXHIBIT "B"

S & V Solutions
consultants in applied acoustics
and vibration technologies

27707 Moose Range Rd.
Sycamore, IL 60178
815 / 899-2021
815 / 899-2115 FAX

Date: June 13, 2009

To: Peter Arendovich, Lemont Resident

From: David Larson, Acoustical Consultant

Ref: I-355 Traffic Noise Level

Dear Peter:

I am writing to share the results of the noise monitoring I did it your residence for traffic noise coming from I-355. The equipment used is listed below:

1. Bruel & Kjaer type 2144 acoustics analyzer and data collector.
2. Bruel & Kjaer type 2639 microphone preamplifier.
3. Bruel & Kjaer type 4155 condenser microphone.
4. Bruel & Kjaer type 4231 portable acoustic calibrator.

This data analyzer/collector was placed on your premises with a microphone located in two positions:

Position 1: The microphone was placed at a distance of 340 ft from the bridge to your home's balcony tripod that held the mic 5 ft above the ground. The total height from the ground to the microphone was 14 feet. Wind speed and direction was taken from weather reports.

Position 2 was taken at a distance of 120 ft from the bridge onto your lot. The microphone was placed on a tripod 5 ft from the ground. Wind speed and direction was taken from weather reports.

The calibration was based on the standard portable B&K calibrator which was applied to the microphone at the beginning and end of the measurement session.

Data was taken at each position over several different periods of time during the day and night.
The analyzer was set up to measure A-weighted sound level in intervals of one measurement every second or one measurement every 10 seconds.

The data was recorded on a floppy disk. This data from the disk was then analyzed and converted to an MS-Excel spreadsheet chart to be studied and to be compared to the value based on which the EIS was approved.

The following data was collected on a test made for 4 hours in length with 10 seconds intervals.
Notice the noise generated in decibels in weighed scale A (dBA) at different times:

Chart 81	June 7 2008 Saturday	from 13.55 pm to 18.31 pm
Chart 83	June 10 2008 Tuesday	from 10.00 am to 14.36 am
Chart 85	June 10 2008 Tuesday	from 15.00 pm to 19.30 pm
Chart 87	June 11 2008 Wednesday	from 6 .00 am to 10.36 am
Chart 88	June 11 2008 Wednesday	from 13.30 pm to 18.06 pm

EXHIBIT "C"

Chart 90 June 12 2008 Thursday from 13.30 pm to 19.06 pm
Chart 89 June 12 2008 Thursday from 6.00 am to 19.38 am

You can see a fluctuation in the noise at different times during rush hours (in the morning from 5.30 am to about 8.00 am, and again in the afternoon from about 3.00 pm to about 7.00 pm).

Data was also collected during a test made for 27 minutes at an interval length of 1 second. Notice the noise generated in decibels weighed scale a (dBA) at different times

Chart 74 June 5 2008 Thursday from 7.00 am to 7.27 am
Chart 75 June 5 2008 Thursday from 6.00 pm to 6.27 pm
Chart 77 June 6 2008 Friday from 6.00 am to 6.27 am
Chart 78 June 6 2008 Friday from 6.30 am to 6.57 am
Chart 79 June 6 2008 Friday from 7.20 am to 7.47 am

In this set of charts it shows that even on Fridays the noise level measured on the A weighed scale is above the level indicated in the Title 23.

Chart (A) Is a chart provided by the FHA, This chart shows different size vehicles traveling at different speed and the noise level generated in decibel weighed scale A

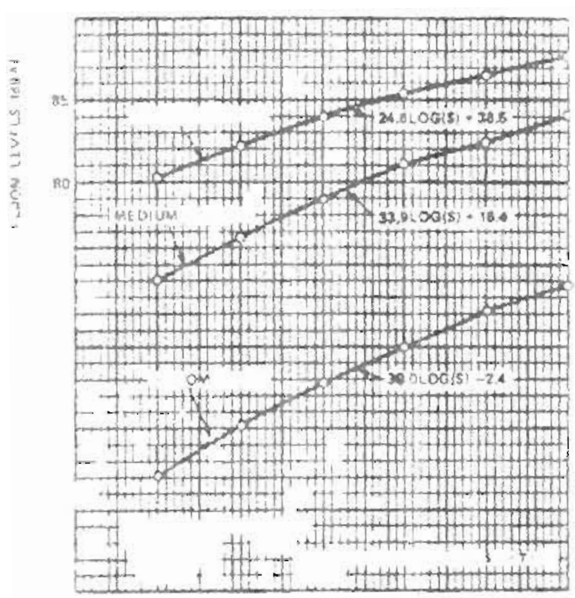


Chart A

Conclusions

1. The data shows that from Tuesdays through Fridays the noise generated by the highway is above the noise level indicated on Title 23.

2. Chart (A) shows heavy trucks generate 86 db at a distance of 50 ft from the source.

3. Your property is about 150 ft. from the source and the bedroom wall is 350 ft from the source.

4. Taking into account Chart (A), the generated noise by heavy trucks at 60 mph is about 86 dB. Based on the acoustic distance law, where the amount of decibels decrease by 5 every time the distance is doubled (the inverse square law), it is very unlikely the noise will dissipate to legal levels 150 ft. away, nor at 350 ft. by your bedroom where the reading were taken. This is shown on charts from # 74 though #89.

5. On charts # 74 through #79 the high point which is above 65 db correlates with heavy trucks noise decibels (db) and heavy truck traveling frequencies, passing by at a given point.

Best Regards,

David A. Larson, S&V Solutions, Inc.

815-899-2021 office, 815-899-2115 FAX, 815-762-5333 cellular

email: techinfo@svsolutions.com

Appendix 1: inverse square law

When sound propagates freely in space the level of sound decays with one over the square of diatance. This is commonly called the inverse square law and can be written as follows:

$$L_2 = L_1 - 20 \times LOG\ (X_2/X_1)$$

Where L_2 is the level of sound a distance X_2, and L_1 is the level of sound at distance X_1.

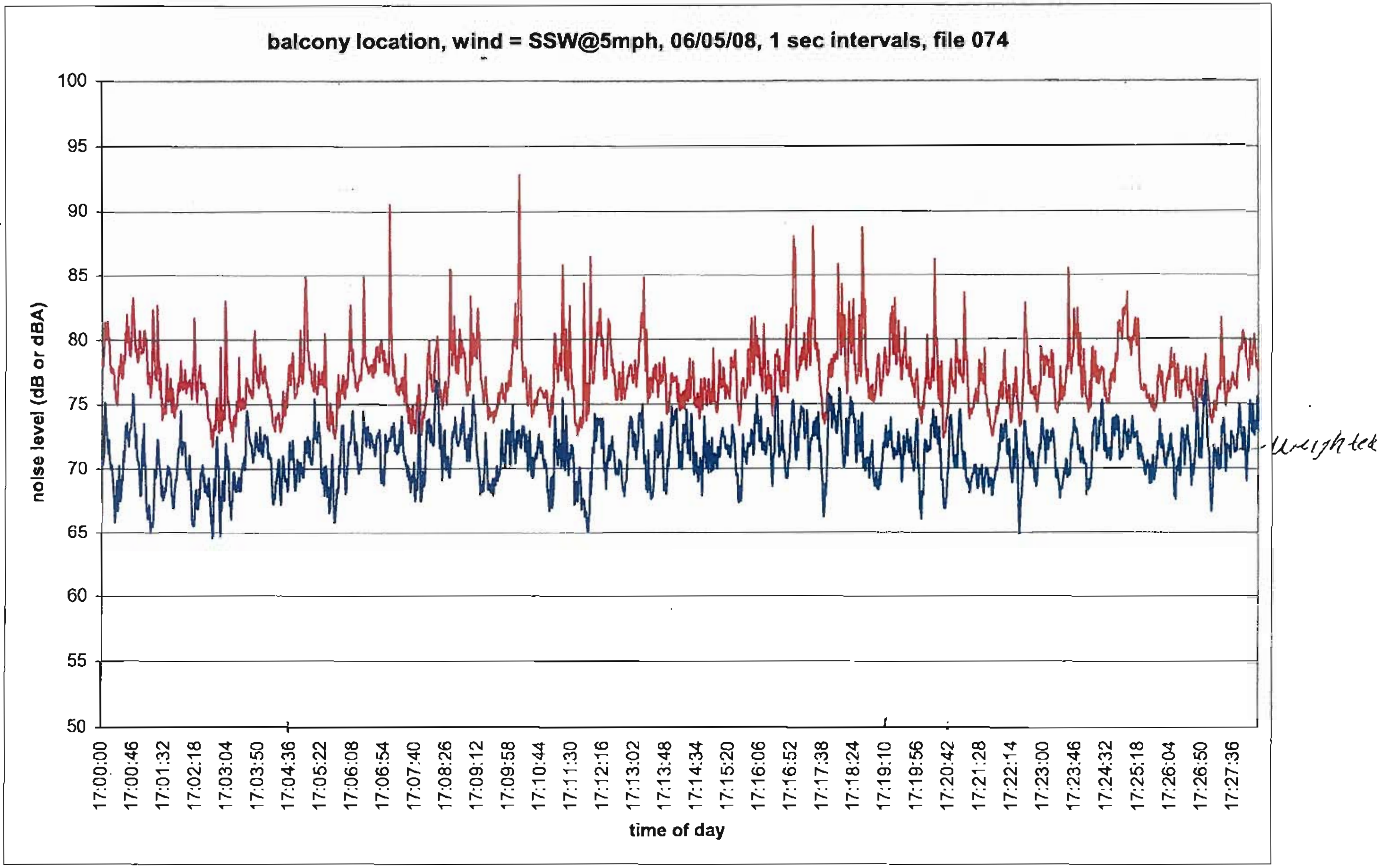
Please remember this law applies on to purely free field radiation. Across a grassy field, or a paved parking lot, or down a gravel road (as examples) one will see less decay with distance.

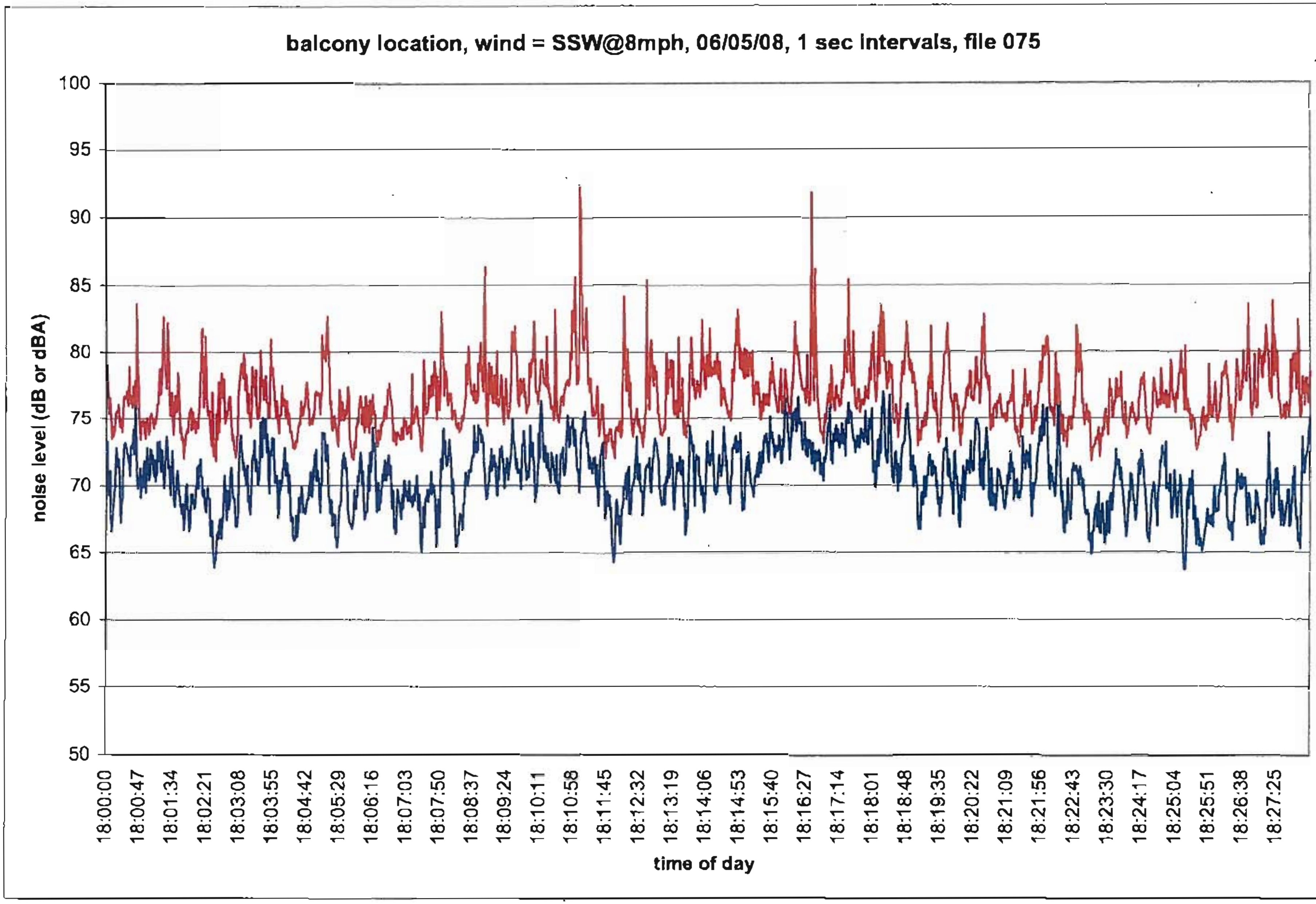
Appendix 2: multiple sources

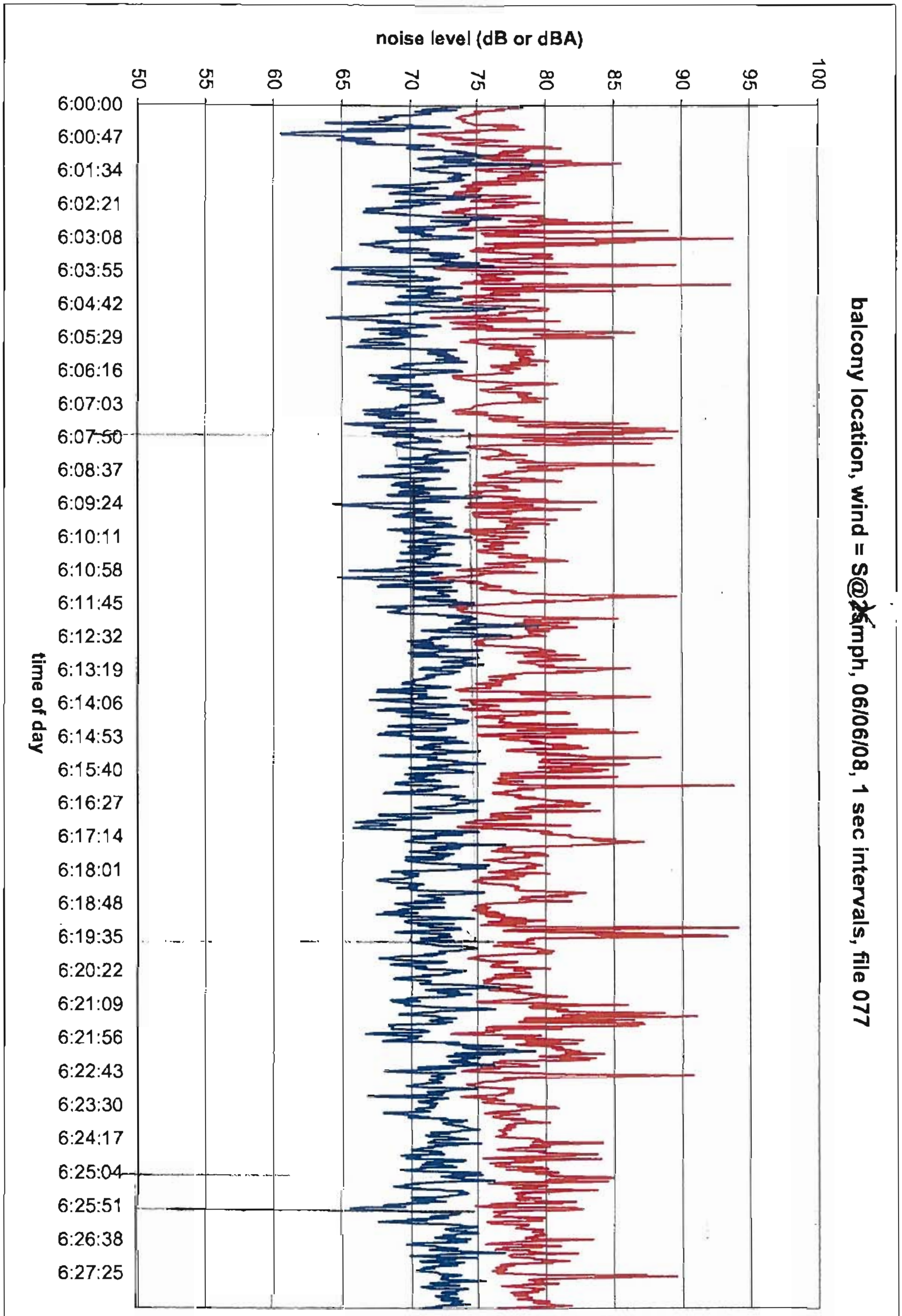
If two noise sources of equal strength and uncorrelated with each other (such at two trucks on a highway) are added, such as they would if passing the same point at about the same time, then the total level would be 3 dB higher than one truck:

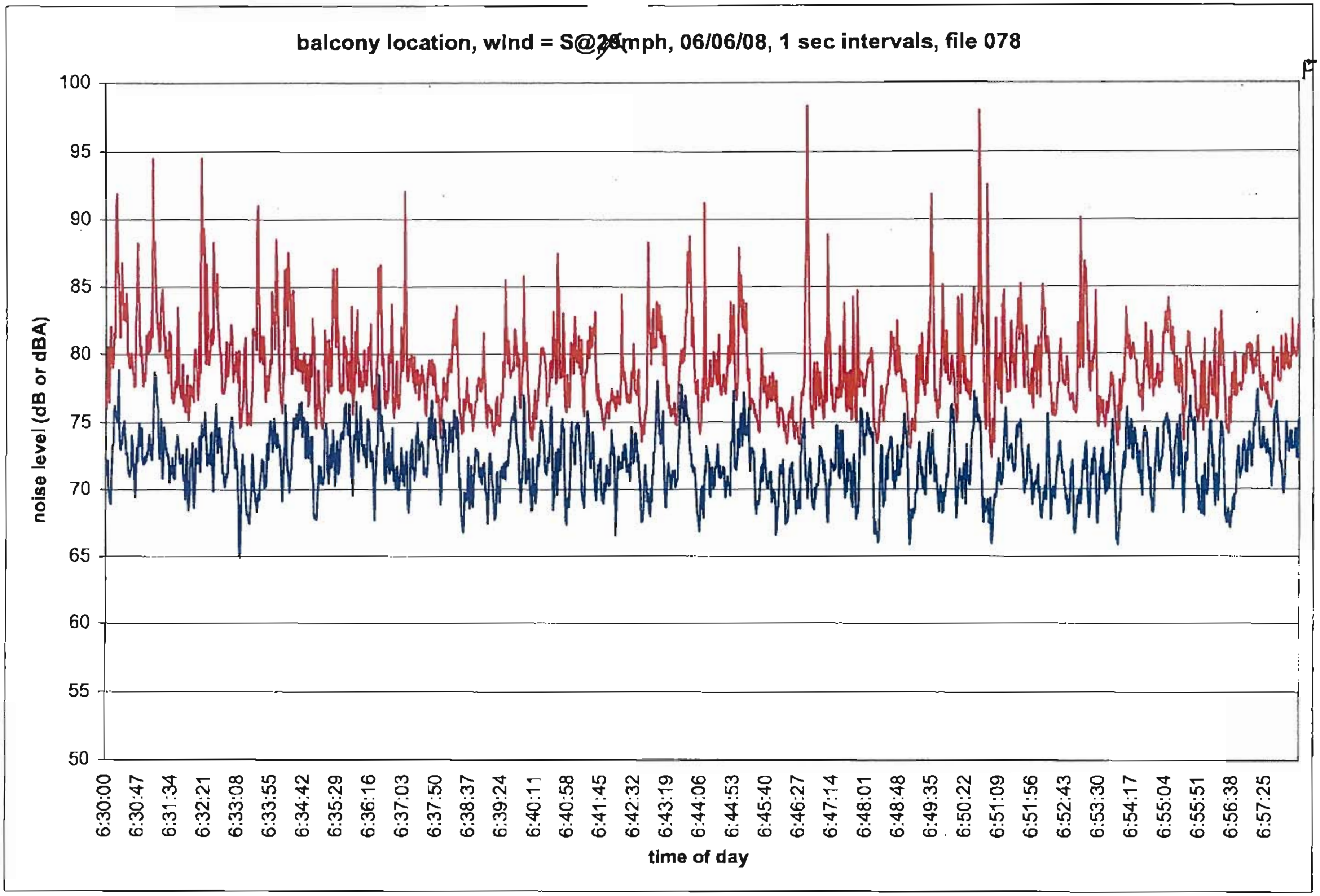
Lets us say that a fleet of trucks are all rated to produce 80 dBA total noise at 100 feet.

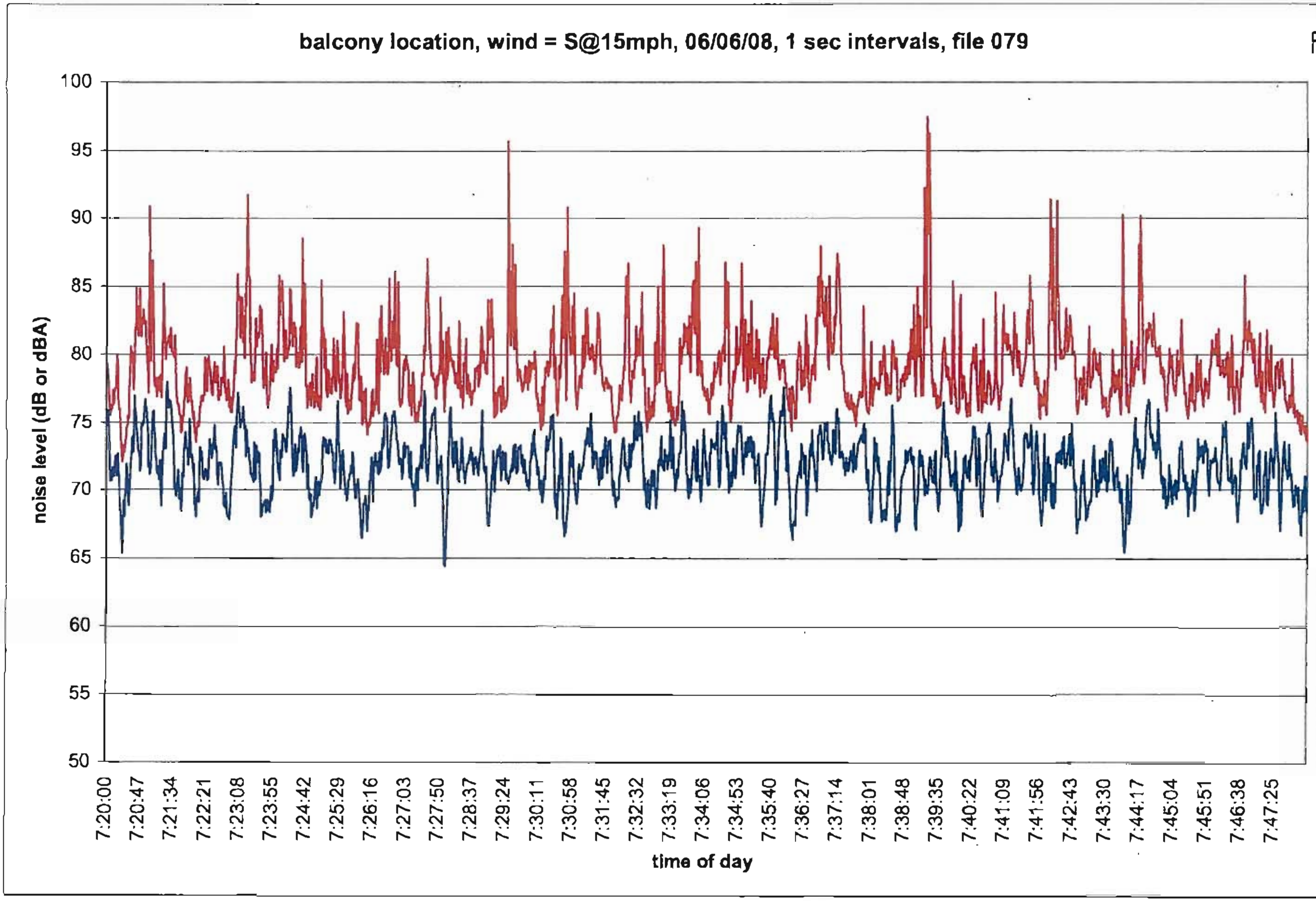
Two trucks passing at 100 feet = 83 dBA
Four trucks passing at 100 feet = 86 dBA
Eight trucks passing at 100 feet = 89 dBA

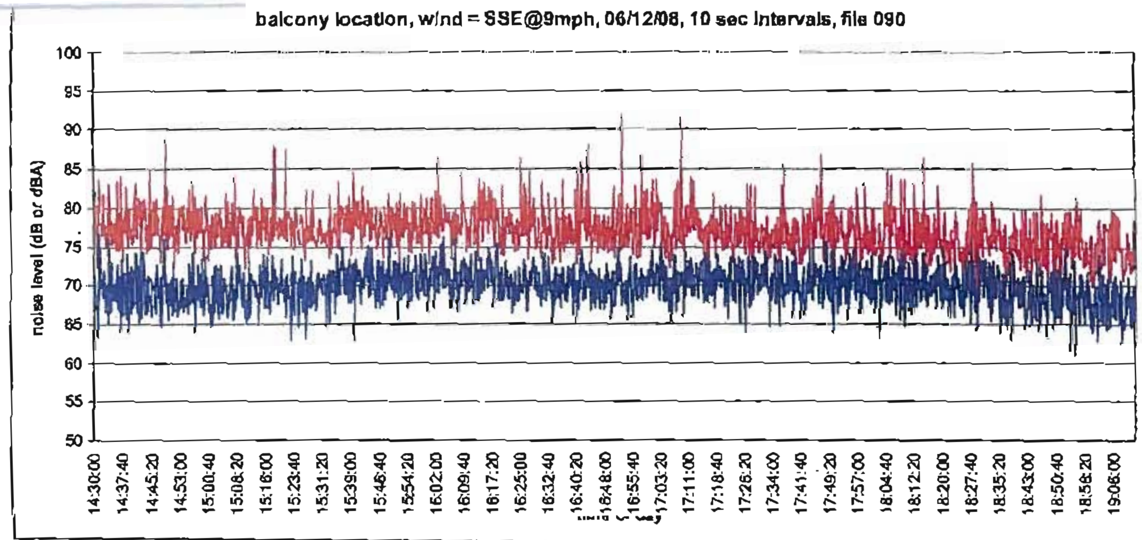

balcony location, wind = SSW@5mph, 06/05/08, 1 sec intervals, file 074
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
17:00:00
17:00:46
17:01:32
17:02:18
17:03:04
17:03:50
17:04:36
17:05:22
17:06:08
17:06:54
17:07:40
17:08:26
17:09:12
17:09:58
17:10:44
17:11:30
17:12:16
17:13:02
17:13:48
17:14:34
17:15:20
17:16:06
17:16:52
17:17:38
17:18:24
17:19:10
17:19:56
17:20:42
17:21:28
17:22:14
17:23:00
17:23:46
17:24:32
17:25:18
17:26:04
17:26:50
17:27:36
time of day

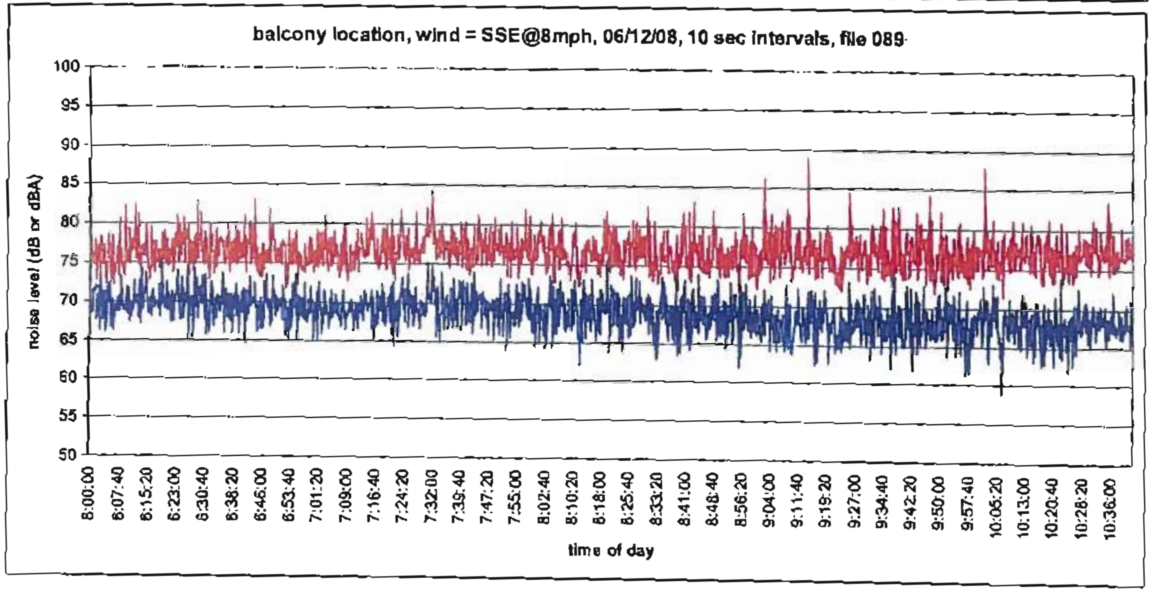

balcony location, wind = SSW@8mph, 06/05/08, 1 sec intervals, file 075
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
18:00:00
18:00:47
18:01:34
18:02:21
18:03:08
18:03:55
18:04:42
18:05:29
18:06:16
18:07:03
18:07:50
18:08:37
18:09:24
18:10:11
18:10:58
18:11:45
18:12:32
18:13:19
18:14:06
18:14:53
18:15:40
18:16:27
18:17:14
18:18:01
18:18:48
18:19:35
18:20:22
18:21:09
18:21:56
18:22:43
18:23:30
18:24:17
18:25:04
18:25:51
18:26:38
18:27:25
time of day


balcony location, wind = S@ mph, 06/06/08, 1 sec intervals, file 077
noise level (dB or dBA)
50
55
60
65
70
75
80
85
90
95
100
6:00:00
6:00:47
6:01:34
6:02:21
6:03:08
6:03:55
6:04:42
6:05:29
6:06:16
6:07:03
6:07:50
6:08:37
6:09:24
6:10:11
6:10:58
6:11:45
6:12:32
6:13:19
6:14:06
6:14:53
6:15:40
6:16:27
6:17:14
6:18:01
6:18:48
6:19:35
6:20:22
6:21:09
6:21:56
6:22:43
6:23:30
6:24:17
6:25:04
6:25:51
6:26:38
6:27:25
time of day


balcony location, wind = S@ mph, 06/06/08, 1 sec intervals, file 078
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
6:30:00
6:30:47
6:31:34
6:32:21
6:33:08
6:33:55
6:34:42
6:35:29
6:36:16
6:37:03
6:37:50
6:38:37
6:39:24
6:40:11
6:40:58
6:41:45
6:42:32
6:43:19
6:44:06
6:44:53
6:45:40
6:46:27
6:47:14
6:48:01
6:48:48
6:49:35
6:50:22
6:51:09
6:51:56
6:52:43
6:53:30
6:54:17
6:55:04
6:55:51
6:56:38
6:57:25
time of day


balcony location, wind = S@15mph, 06/06/08, 1 sec intervals, file 079
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
7:20:00
7:20:47
7:21:34
7:22:21
7:23:08
7:23:55
7:24:42
7:25:29
7:26:16
7:27:03
7:27:50
7:28:37
7:29:24
7:30:11
7:30:58
7:31:45
7:32:32
7:33:19
7:34:06
7:34:53
7:35:40
7:36:27
7:37:14
7:38:01
7:38:48
7:39:35
7:40:22
7:41:09
7:41:56
7:42:43
7:43:30
7:44:17
7:45:04
7:45:51
7:46:38
7:47:25
time of day


balcony location, wind = SSE@9mph, 06/12/08, 10 sec intervals, file 090
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
14:30:00
14:37:40
14:45:20
14:53:00
15:00:40
15:08:20
15:16:00
15:23:40
15:31:20
15:39:00
15:46:40
15:54:20
16:02:00
16:09:40
16:17:20
16:25:00
16:32:40
16:40:20
16:48:00
16:55:40
17:03:20
17:11:00
17:18:40
17:26:20
17:34:00
17:41:40
17:49:20
17:57:00
18:04:40
18:12:20
18:20:00
18:27:40
18:35:20
18:43:00
18:50:40
18:58:20
19:06:00


balcony location, wind = SSE@8mph, 06/12/08, 10 sec intervals, file 089
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
6:00:00
6:07:40
6:15:20
6:23:00
6:30:40
6:38:20
6:46:00
6:53:40
7:01:20
7:09:00
7:16:40
7:24:20
7:32:00
7:39:40
7:47:20
7:55:00
8:02:40
8:10:20
8:18:00
8:25:40
8:33:20
8:41:00
8:48:40
8:56:20
9:04:00
9:11:40
9:19:20
9:27:00
9:34:40
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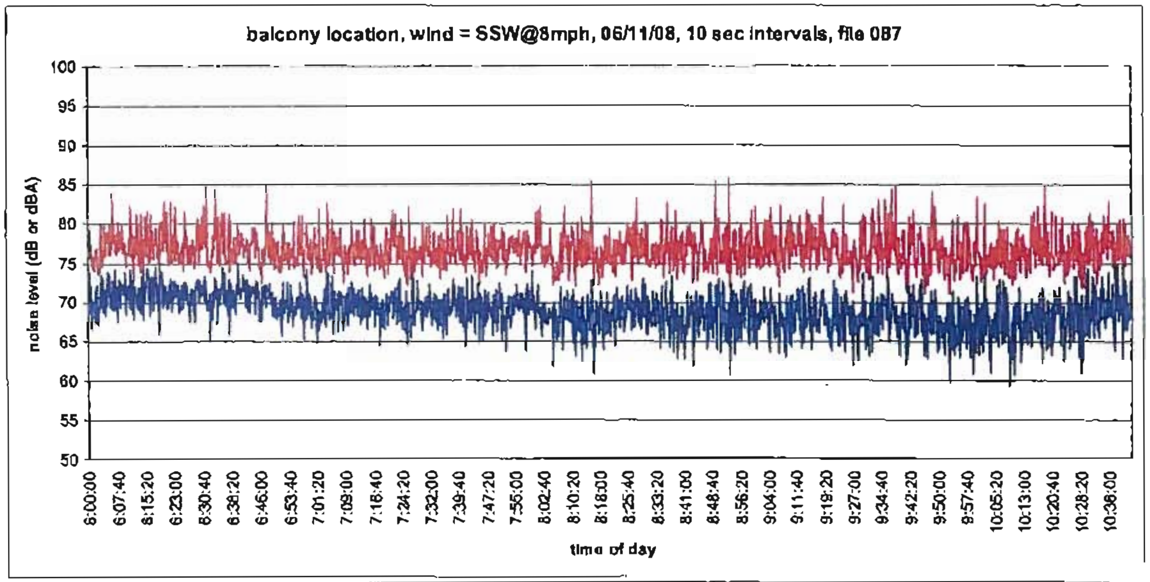
10:28:20
10:36:00
time of day


balcony location, wind = SSW@8mph, 06/11/08, 10 sec intervals, file 087
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
6:00:00
6:07:40
6:15:20
6:23:00
6:30:40
6:38:20
6:46:00
6:53:40
7:01:20
7:09:00
7:16:40
7:24:20
7:32:00
7:39:40
7:47:20
7:55:00
8:02:40
8:10:20
8:18:00
8:25:40
8:33:20
8:41:00
8:48:40
8:56:20
9:04:00
9:11:40
9:19:20
9:27:00
9:34:40
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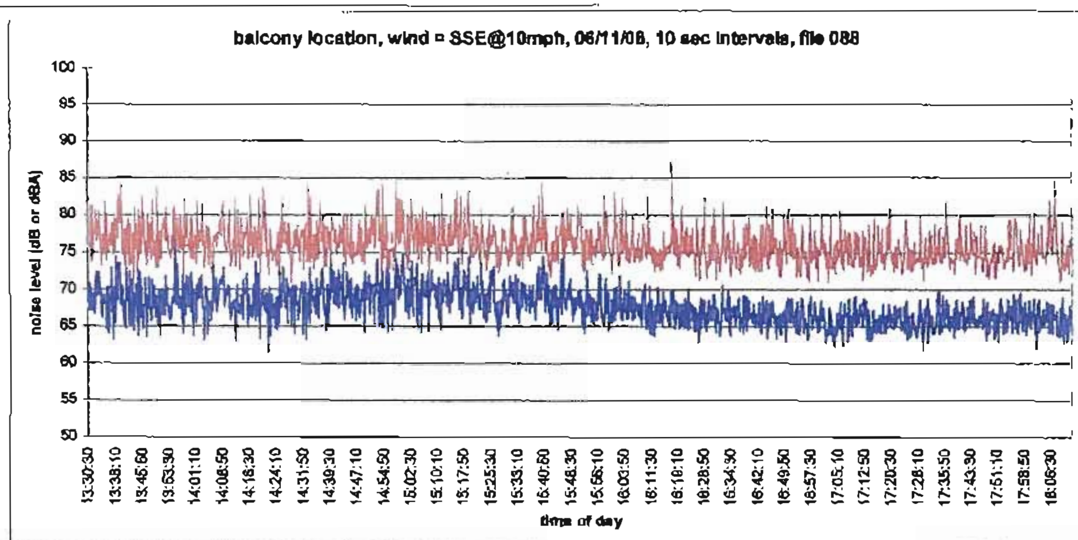
10:36:00
time of day


balcony location, wind = SSE@10mph, 06/11/08, 10 sec intervals, file 088
noise level (dB or dBA)
100
95
90
85
80
75
70
65
60
55
50
13:30:30
13:38:10
13:45:50
13:53:30
14:01:10
14:08:50
14:16:30
14:24:10
14:31:50
14:39:30
14:47:10
14:54:50
15:02:30
15:10:10
15:17:50
15:25:30
15:33:10
15:40:50
15:48:30
15:56:10
16:03:50
16:11:30
16:19:10
16:26:50
16:34:30
16:42:10
16:49:50
16:57:30
17:05:10
17:12:50
17:20:30
17:28:10
17:35:50
17:43:30
17:51:10
17:58:50
18:06:30
time of day

"Special efforts shall be made in the development of a project to comply with Federal, State, and local requirements for noise control; to consult with the appropriate officials to obtain the views of the affected community regarding noise impacts and abatement measures; and to mitigate highway-related noise impacts, where feasible and reasonable."

This policy statement sets forth the intent of the traffic noise analyses, the identification of traffic noise impacts, and the need to offer mitigation where reasonable and feasible criteria have been achieved.

2.3 Traffic Noise Impacts and Applicability

2.3.1 FHWA Regulations

Five separate ***Noise Abatement Criteria (NAC),*** based on land use, are used by FHWA to assess potential noise impacts as defined by 23 CFR 772. The FHWA considered several approaches to define impact levels, but generally based the criteria on noise levels associated with the interference of speech communication. The NAC are therefore a balance of what is desirable and what is generally achievable.[2]

A traffic noise impact occurs when noise levels approach, meet or exceed the NAC criteria listed in the following table or when the predicted noise levels are substantially higher than the ***existing noise level***.

TABLE 2-1
***FHWA NOISE ABATEMENT CRITERIA* - HOURLY WEIGHTED SOUND LEVEL**

Activity Category	$L_{eq}(h)$, *dBA*	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	Residences, picnic areas, recreation areas, playgrounds, active sports areas, parks, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	---	Undeveloped lands.
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums.

FHWA has deferred to the State agencies to define the noise level that "approaches" the NAC and to define a substantial increase in traffic noise levels. It should be noted that the NAC are not used as goals for noise attenuation design criteria or design targets. Instead, the NAC are noise impact thresholds for considering abatement when they are approached, met, or exceeded. Noise abatement measures are required to be considered as part of the project if impacts are identified.

EXHIBIT "D"

Examples of Activity Category A include a monastery, an outdoor prayer area and an ampitheater. Activity Category B lists specific examples, but other land uses not specifically listed include cemeteries, campgrounds, and trails. Activity Category C examples include commercial and industrial land uses.

The NAC and noise procedure regulations apply to Type I and Type II (retrofit) projects only; however, the implementation of a Type II program is optional. ***Type I*** and ***Type II projects*** are defined as follows:

> *Type I projects.* A proposed Federal or Federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes. Noise abatement is financed with funds appropriated for the proposed project.
>
> *Type II or Retrofit projects.* A proposed noise abatement project on an existing ***fully controlled-access State highway*** or Interstate in an urban area.

2.3.2 IDOT Noise Policy

The IDOT *Noise Policy* establishes the traffic noise analyses requirements for all Type I or Type II projects whether they are federally funded or State-only funded, which includes cost-sharing projects with local funds. The traffic noise impact determination is based on the FHWA NAC as set forth in IDOT's policy found in Chapter 26-6.05(c) (Analysis and Reporting) of the BDE Manual. IDOT has established the following criteria to define the occurrence of a traffic noise impact.

- ***Design year*** (typically 20 years into the future) traffic noise levels are predicted to approach, meet, or exceed the NAC, with approach defined as 1 ***dBA*** less than NAC

  Or,

- Design year (typically 20 years into the future) traffic noise levels are predicted to substantially increase (greater than 14 dBA) over existing traffic-generated noise levels

Based on the approach definition determined by IDOT, Table 2-2 provides the noise levels at which a traffic noise impact would occur and would require consideration of traffic noise abatement for the design year.

TABLE 2-2
IDOT TRAFFIC NOISE LEVELS WARRANTING ABATEMENT EVALUATION

Activity Category	L_{eq}(h), *dBA*
A	56 (Exterior)
B	66 (Exterior)
C	71 (Exterior)
D	- - -
E	51 (Interior)