Environmental Traffic Noise

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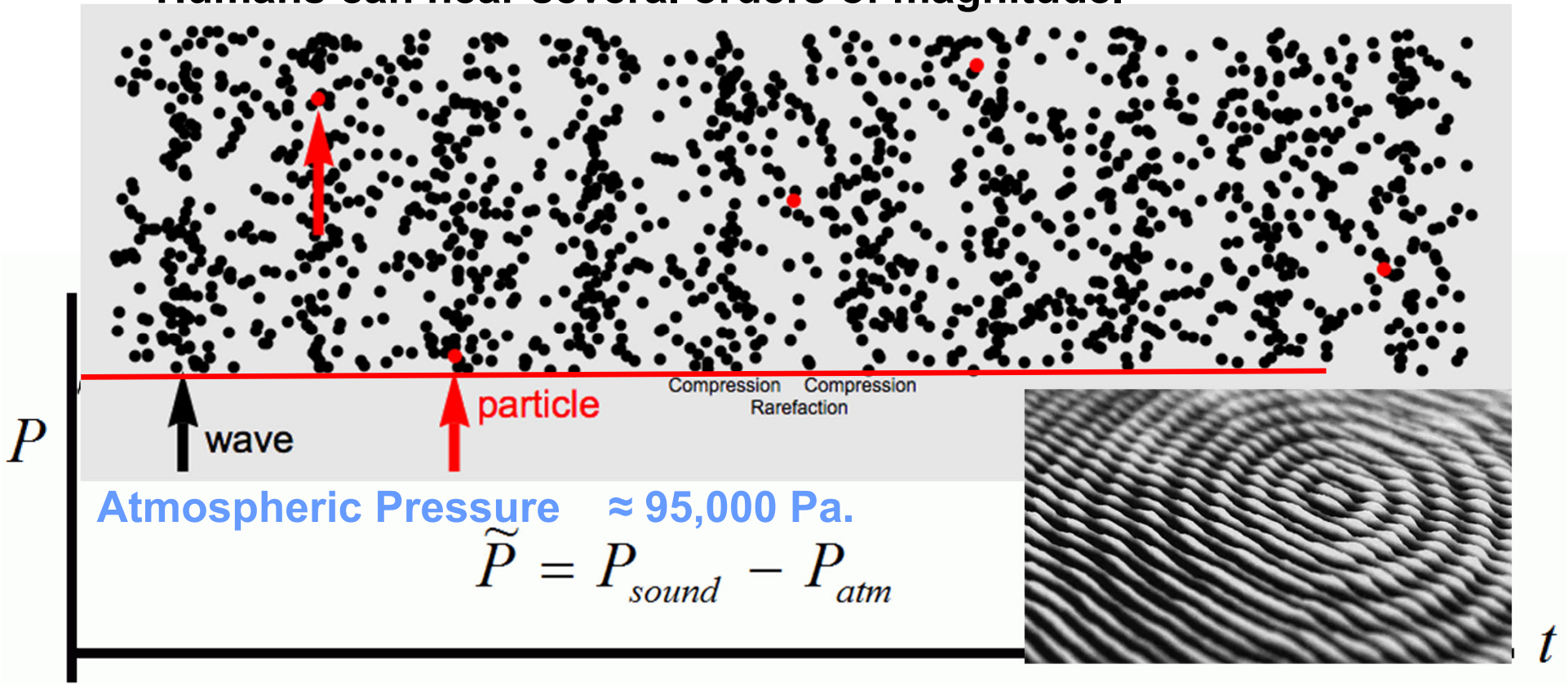
Topics for Discussion

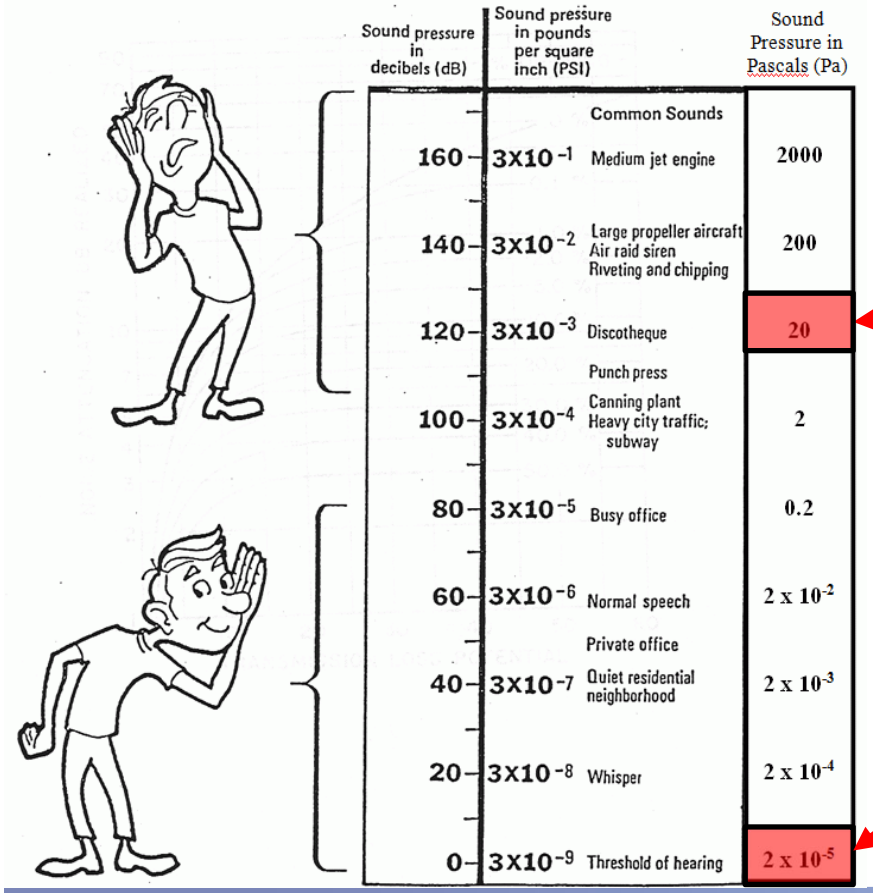
What is Sound? → What is Frequency? → Traffic Noise → Noise Barriers → Criteria

What is Sound?

- Sound requires a medium in which to travel (i.e. air, metal, water).
- Sound propagates as a wave.
- In air, sound is a fluctuation in pressure relative to the mean
- Fluctuations are very small.
- Humans can hear several orders of magnitude.



What is Sound?



Atmospheric Pressure ≈ 95,000 Pa

Factor of 1,000,000

Threshold of Pain

20 Pa

to

Threshold of Hearing

(2×10^{-5} Pa)

Sound Pressure in Pa is not convenient.

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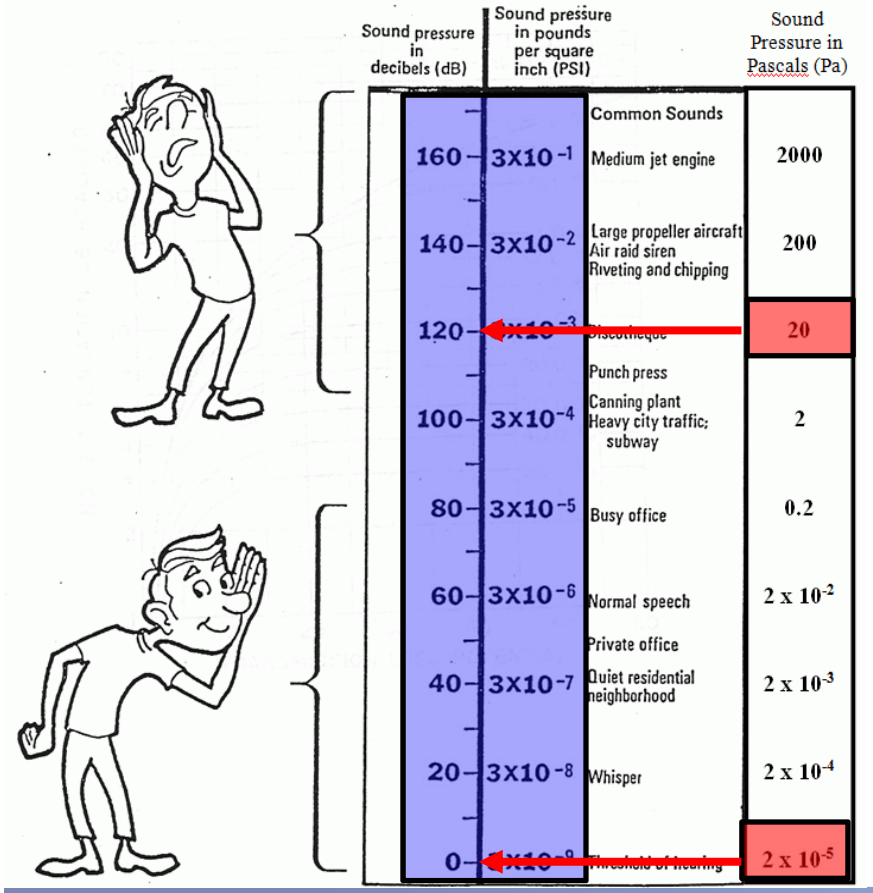
What is Sound?



- So a more "convenient" scale was devised
- Decibel scale (dB) named after Alexander Graham Bell
- Reference sound pressure level is the threshold for "typical" human hearing
- Allows for easier comparison of SPL

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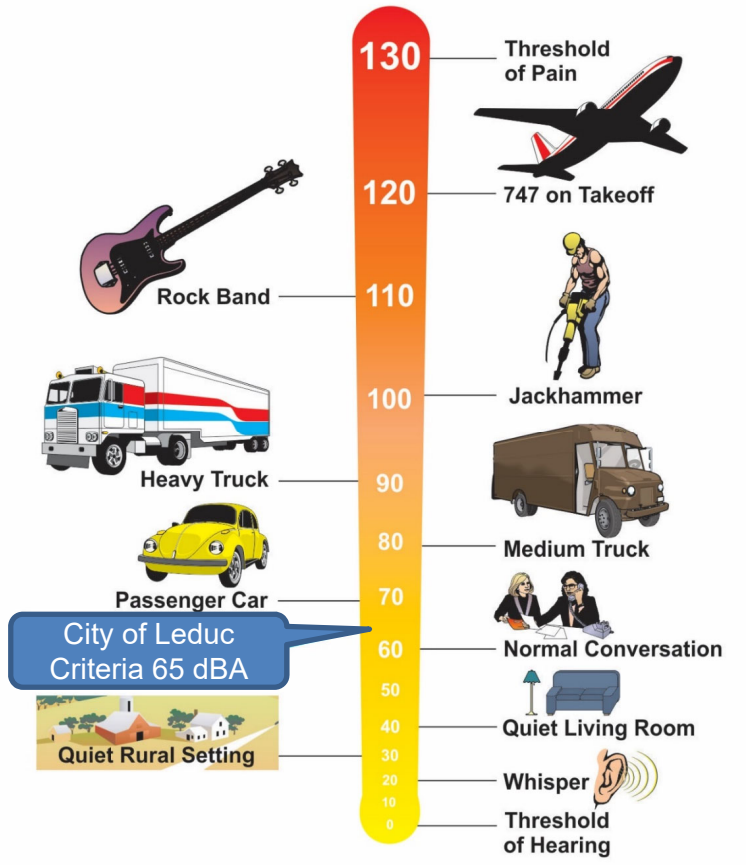
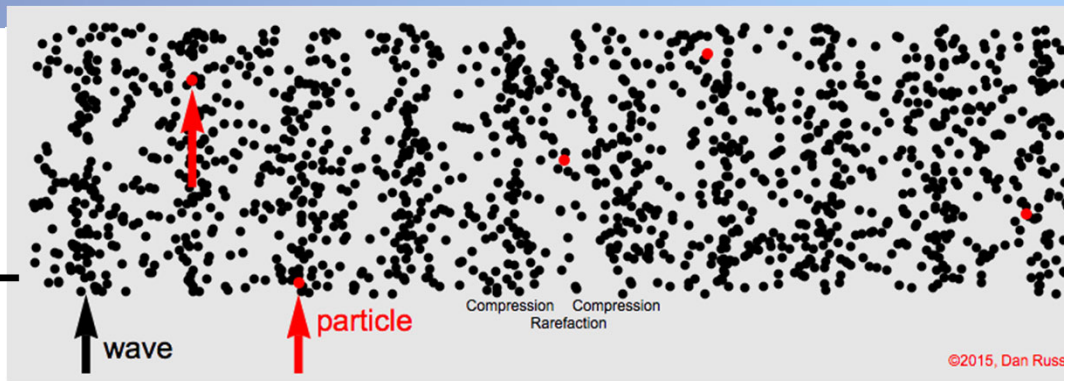
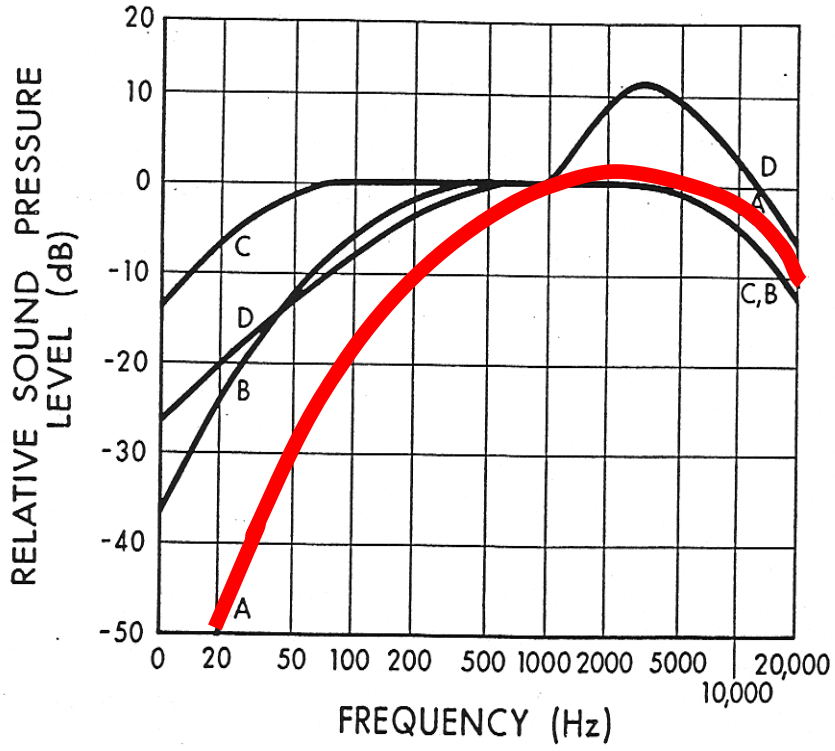
What is Sound?



Frequency



- Frequency ≈ Pitch
- Humans can typically hear 20 Hz – 20,000 Hz
- We do not hear all frequencies the same.



- Human hearing reduces low frequency noises and very high frequency noises
- A-Weight the measured sound ‘dBA’ ‘dB(A)’

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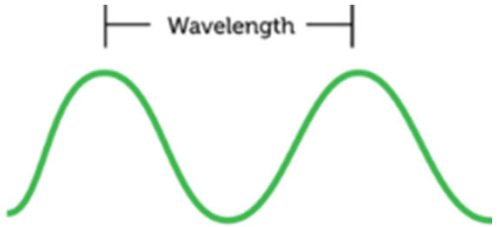
Frequency / Wavelength

- Frequency and Wavelength are related by the speed of sound.
- $\lambda = \frac{C}{f}$ Where: λ = wavelength (m), C = Speed of Sound (m/s), f = frequency (Hz)
- Low frequencies can be a problem.

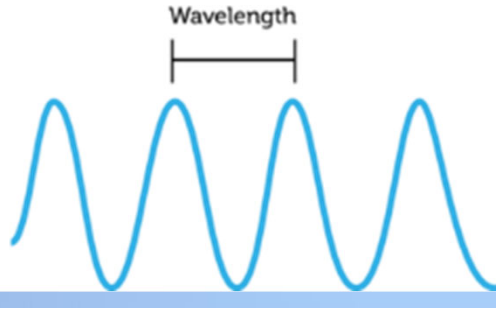
$$\lambda = \frac{340\ m/s}{f}$$

Frequency (Hz)	Wavelength (m)
20	17
100	3.4 (approximately 10 ft)
1000	0.34 (approximately 1 ft
5000	0.068
10000	0.034
20000	0.017

Lower f = Longer Wavelength



Higher f = Shorter Wavelength



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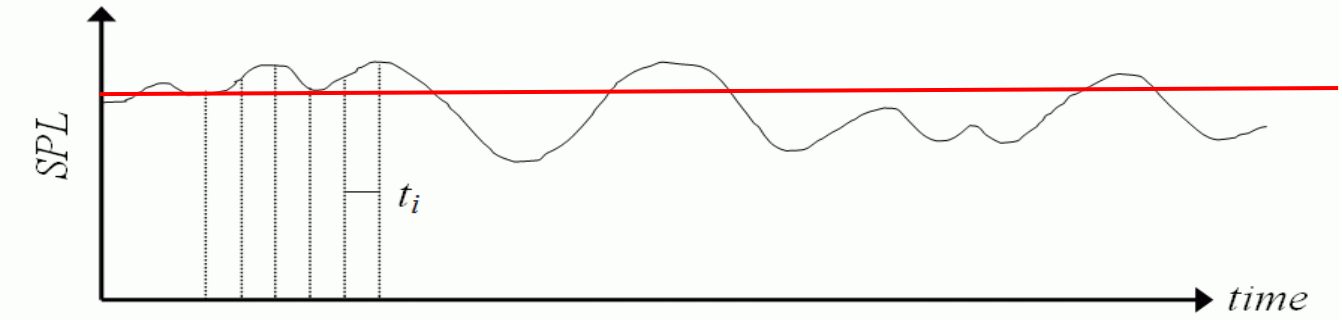
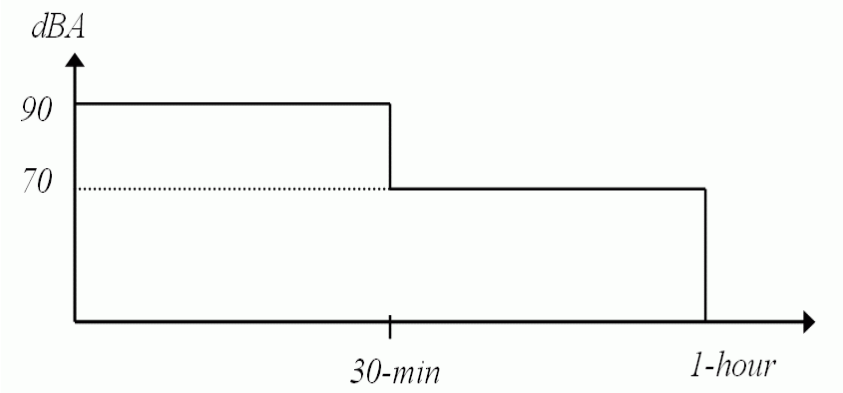
Fluctuating Sounds

- **How do we account for fluctuating sounds?**



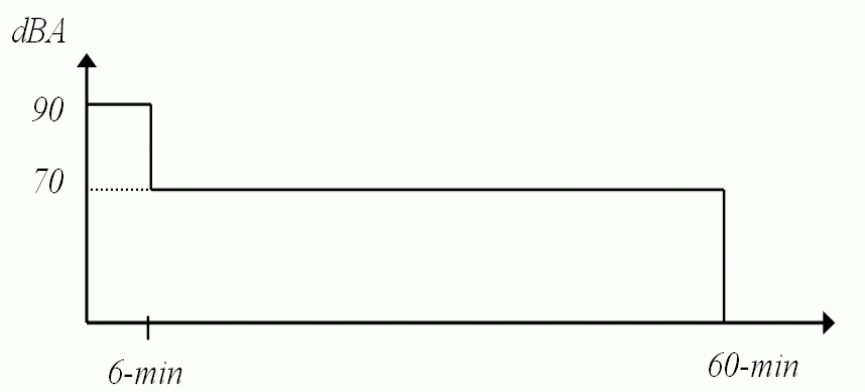
- **Energy Equivalent Sound Level (L_{eq})**
- **Logarithmic Average of sound (not arithmetic)**
- **Devised in the US (1970's) to characterize noise near US Air Force Bases**
- **The same amount of annoyance occurs from a sound having a high level for a short period of time as a sound at a lower level for a longer period of time**

Fluctuating Sounds



$$L_{eq} = 10\log_{10}\left[\tfrac{1}{2}10^{\frac{90}{10}} + \tfrac{1}{2}10^{\frac{70}{10}}\right] = 87\,dBA$$

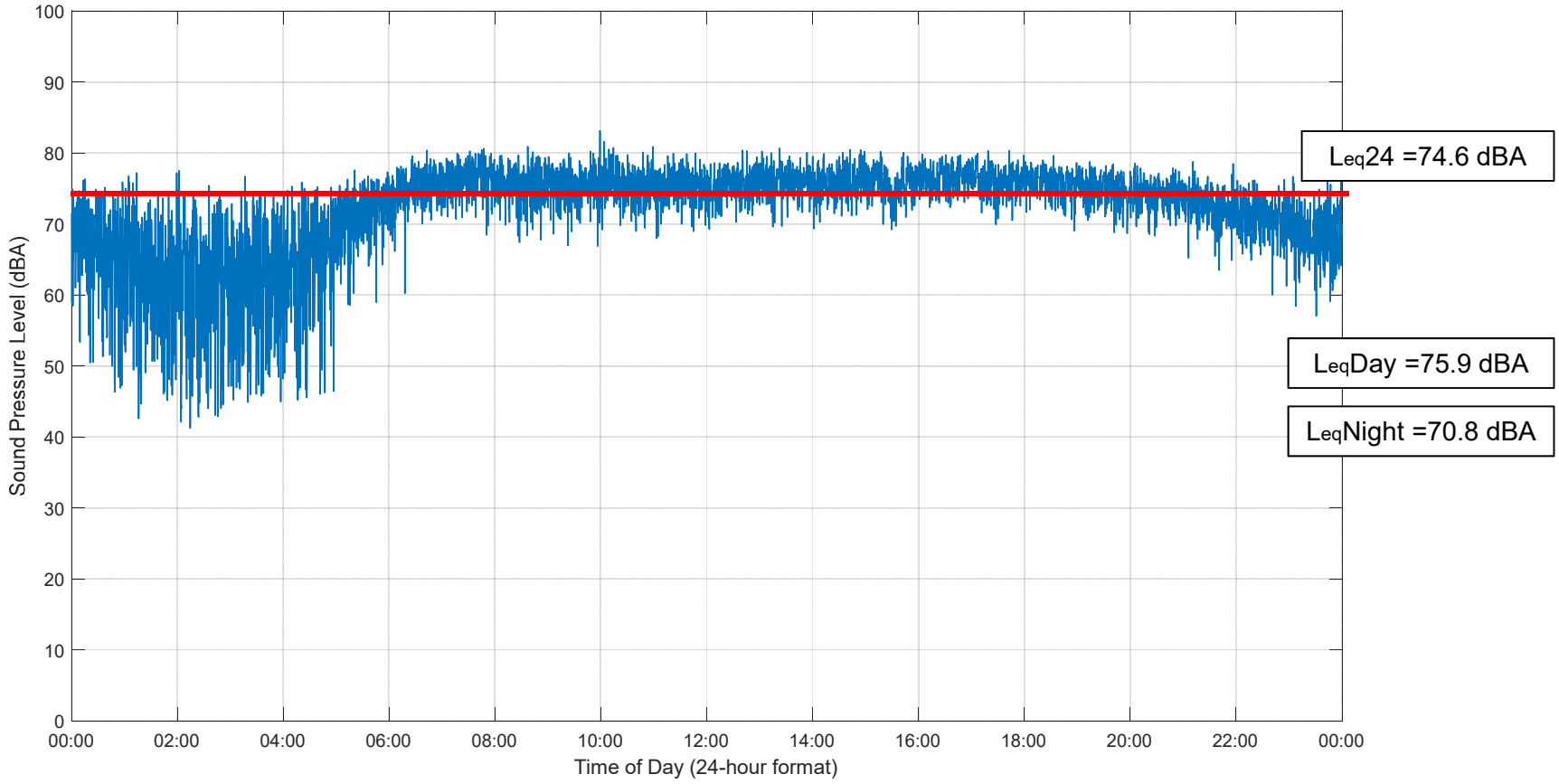
$$note: \ average = 80\,dBA$$



$$L_{eq} = 10\log_{10}\left[\tfrac{1}{10}10^{9} + \tfrac{9}{10}10^{7}\right] = 80.4\,dBA$$

$$note: \ average = 72\,dBA$$

Fluctuating Sound



Example of Broadband15-Second Leq Sound Levels from 2016 Leduc Noise Monitoring Study

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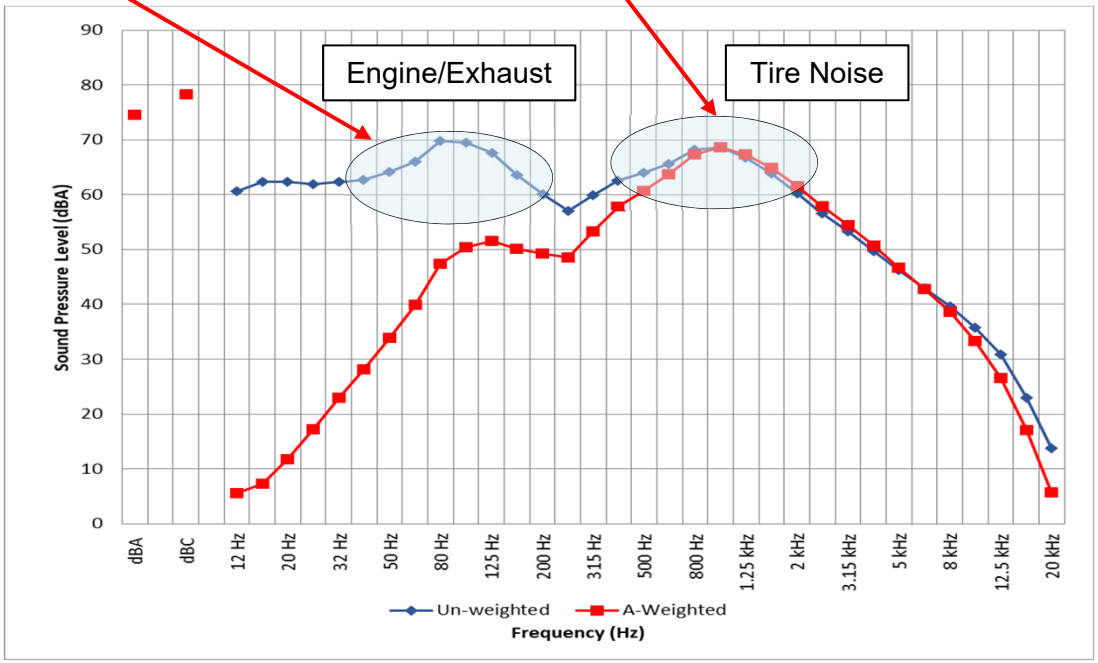
Traffic Noise

- **Dominated by tire noise at speeds greater than about 50 km/hr**
- **Engine noise (from front grill and reflections off road)**
- **Exhaust noise (higher up for large trucks, busses)**

Dependent On:

- **Road surface type and condition**
- **Vehicle type and condition (passenger vehicles, trucks, buses, motorcycles)**
- **Tire configuration**
- **Number of vehicles, vehicle speeds**



Example of 1/3 Octave Leq Sound Levels from 2016 Leduc Noise Monitoring Study

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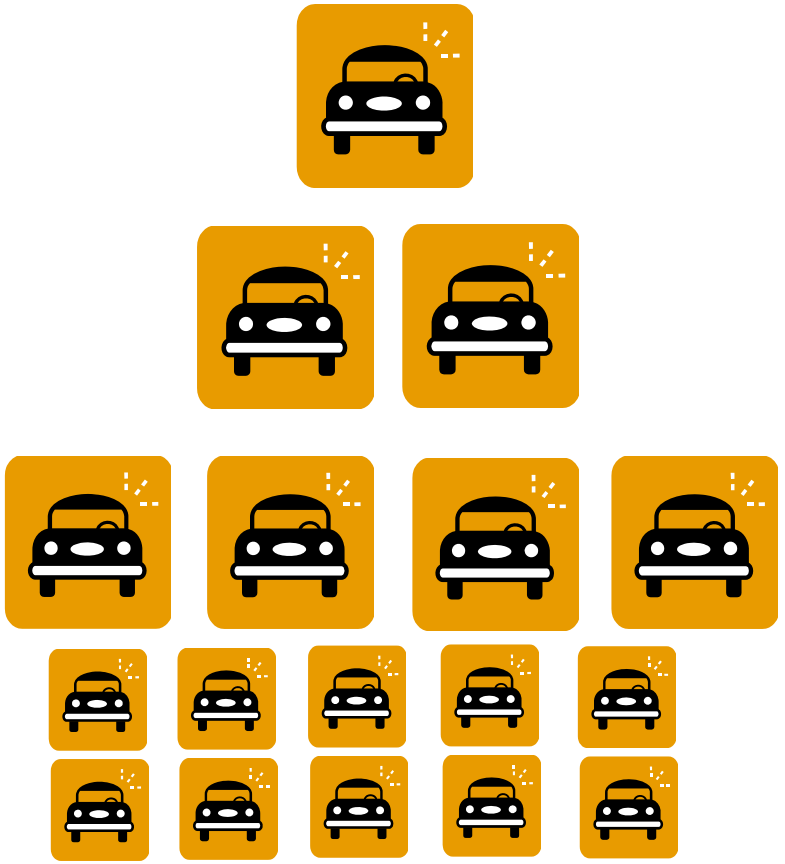
Subjective Response to Changes in Sound Level

- **A change of 1 – 2 dB = Threshold for subjective change**
- **A change of 3 dB = Barely perceptible subjective change**
- **A change of 5 dB = Strongly perceptible subjective change**
- **A change of 10 dB = Approximately ½ as quiet or twice as loud**

Traffic Noise



Traffic (20,000 vehicles/day) at 100 m away = 55 dBA

x2 Traffic (40,000 vehicles/day) at 100 m away = 58 dBA

x4 Traffic (80,000 vehicles/day) at 100 m away = 61 dBA

x10 Traffic (200k vehicles/day) at 100 m away = 65 dBA

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Traffic Noise

Traffic noise levels decrease by 3 dBA per doubling of distance

100 m

60 dBA

200 m

57 dBA

400 m

54 dBA

Noise Mitigation Options

Noise Barriers

Myth:

“Just put up a wall/fence and the noise levels will be reduced.”

Reality:

There are many factors which impact the performance of a noise barrier.

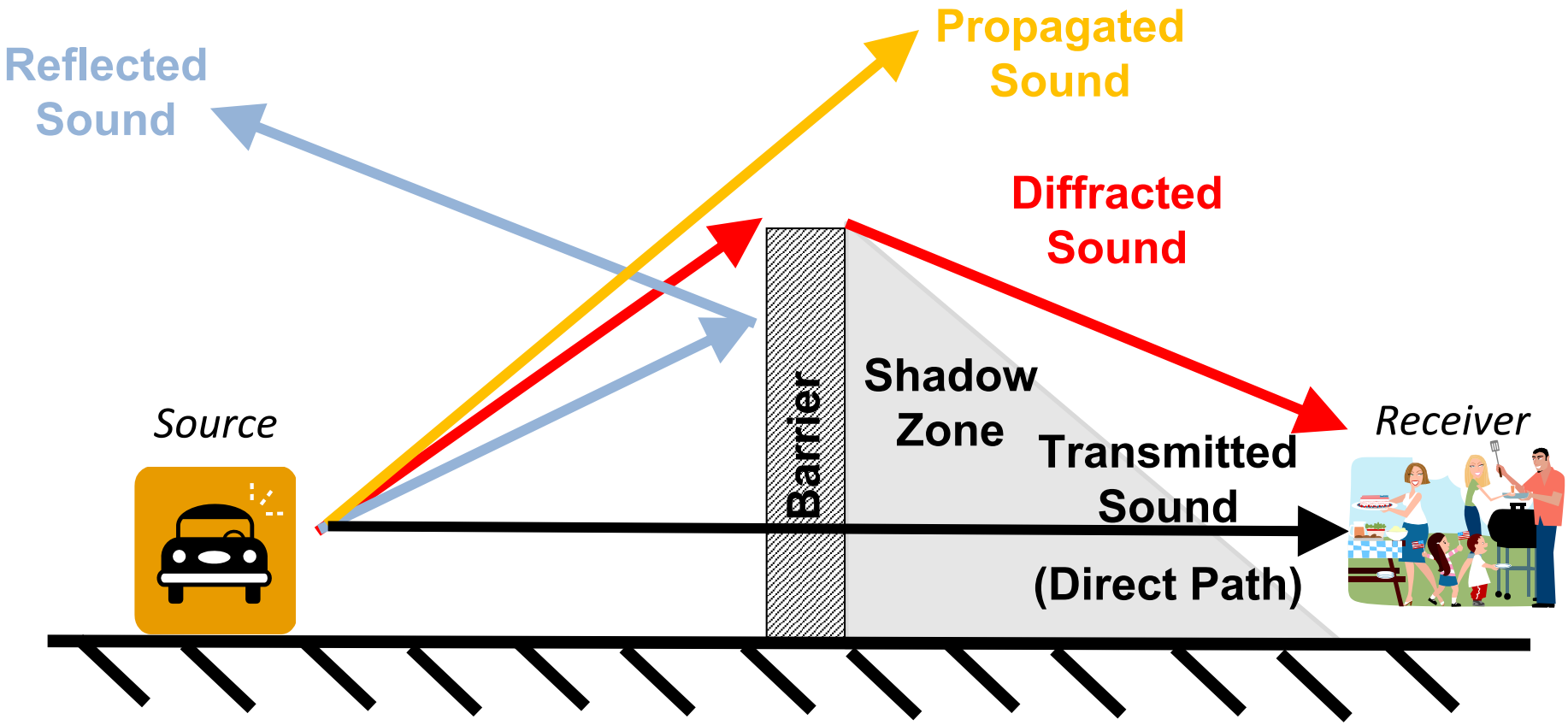
All need to be considered prior to implementation.

Noise Barriers

Factors to consider:

- **Frequency of sound - low frequencies "step over" barriers**
- **Path length difference – the larger the better**
- **Construction materials (need mass)**
- **Reflections**
- **Topography**

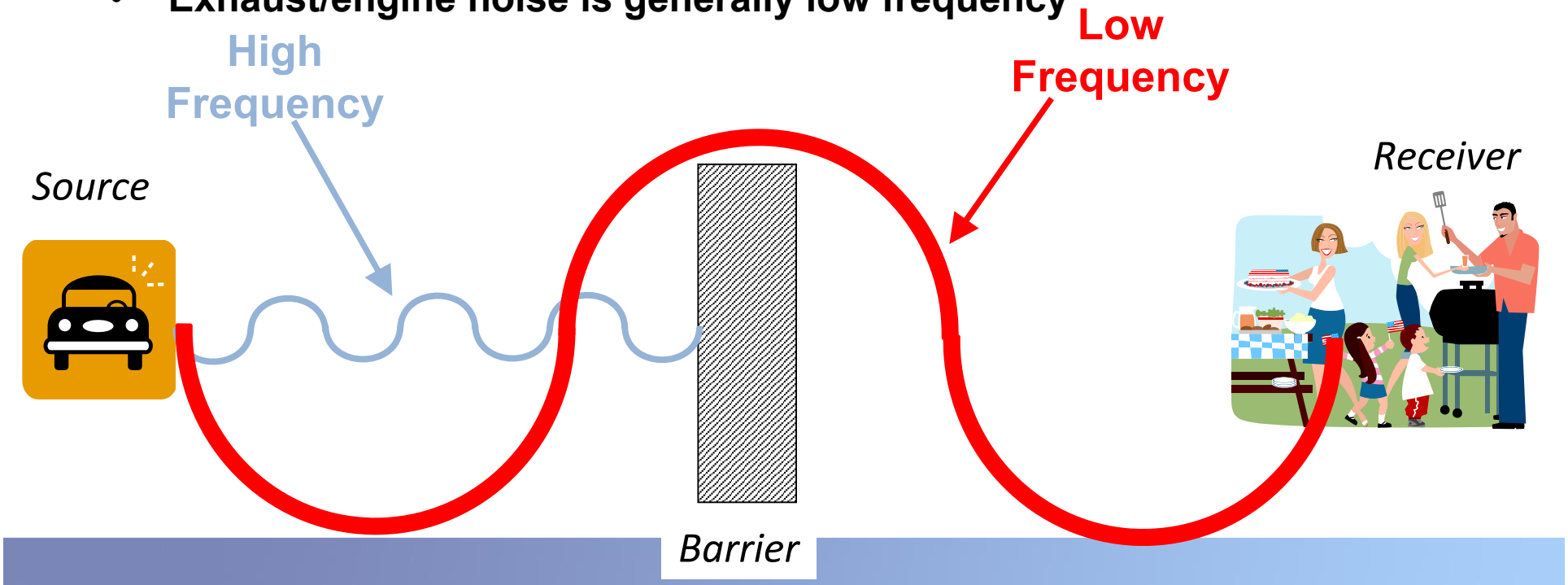
Noise Barriers



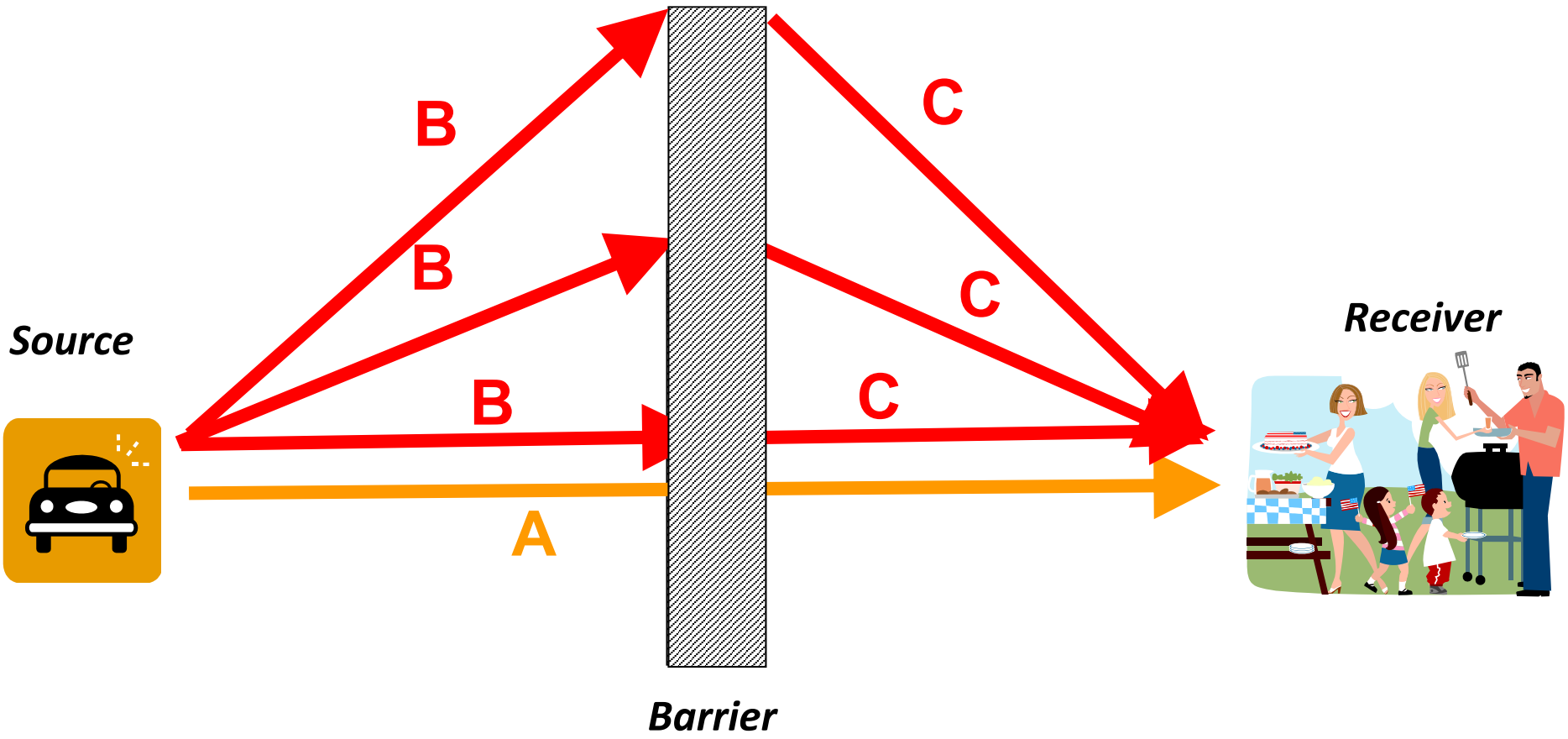
Noise Barriers

- **High frequencies blocked quite well**
  - **Tire noise is generally mid-high frequency**

- **Low frequencies travel less-impeded**
  - **Exhaust/engine noise is generally low frequency**

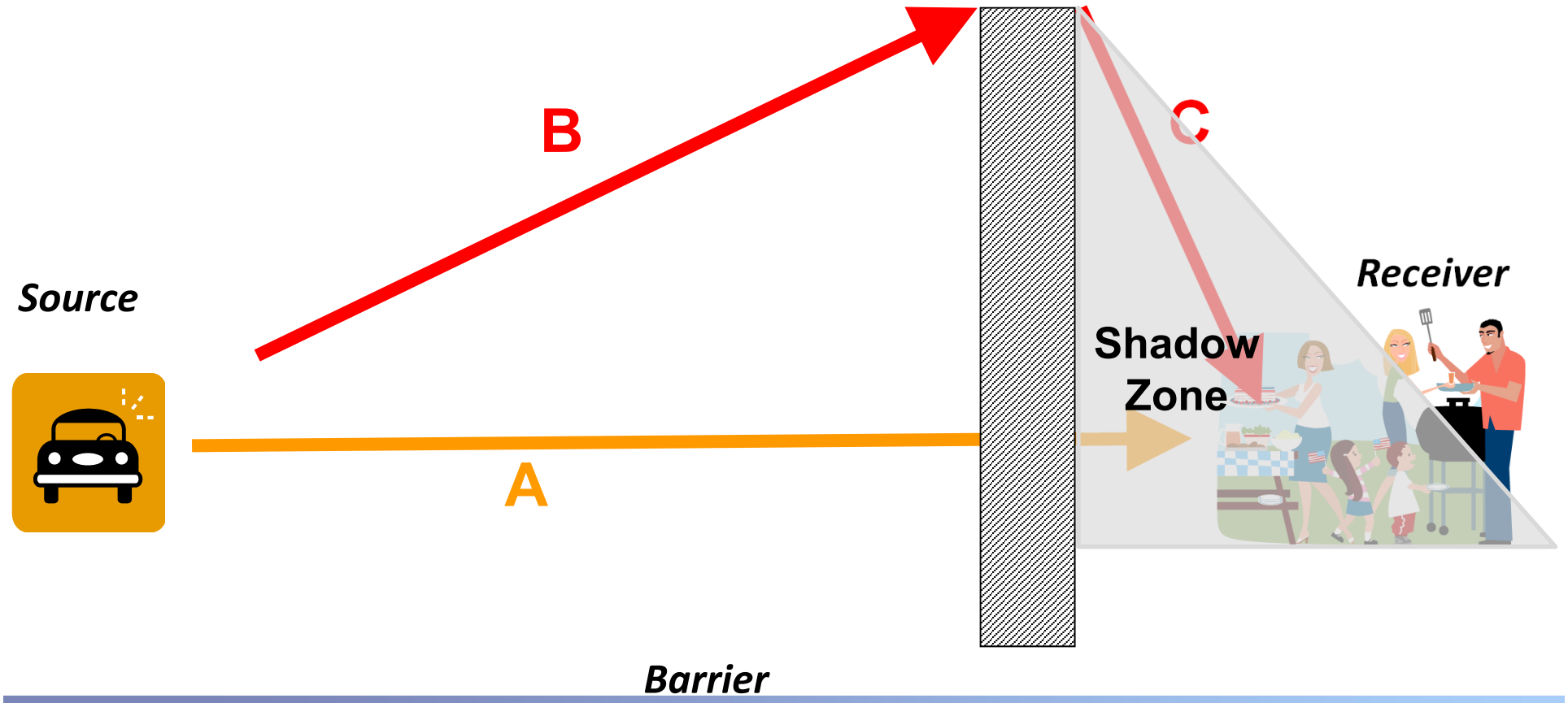


Path Length Difference



$$PLD = (B + C) - A \geq 0$$

Path Length Difference



Now (B + C) - A >>> 0!

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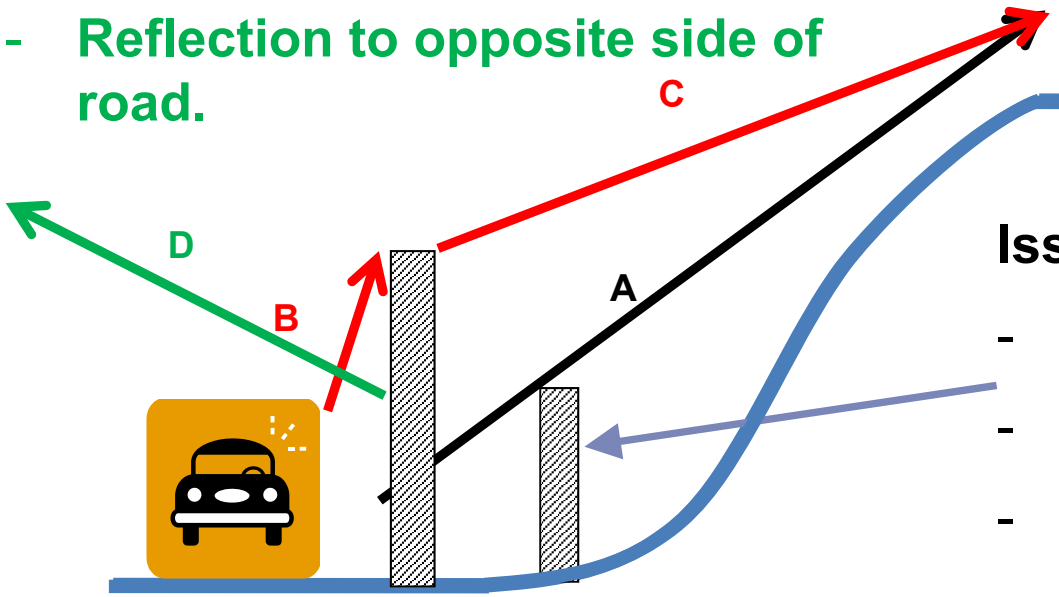
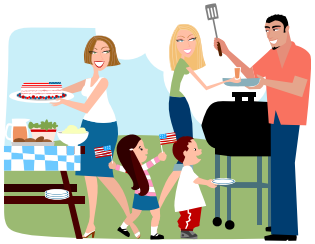
Noise Barriers

- **Residents higher than the site need special consideration.**

Improvements:

- **No direct sight-lines**
- **(B + C) – A >>> 0.**
- **Reflection to opposite side of road.**





Issues with this barrier:

- **Direct line-of-sight.**
- **Not tall enough.**
- **Not close enough to source.**

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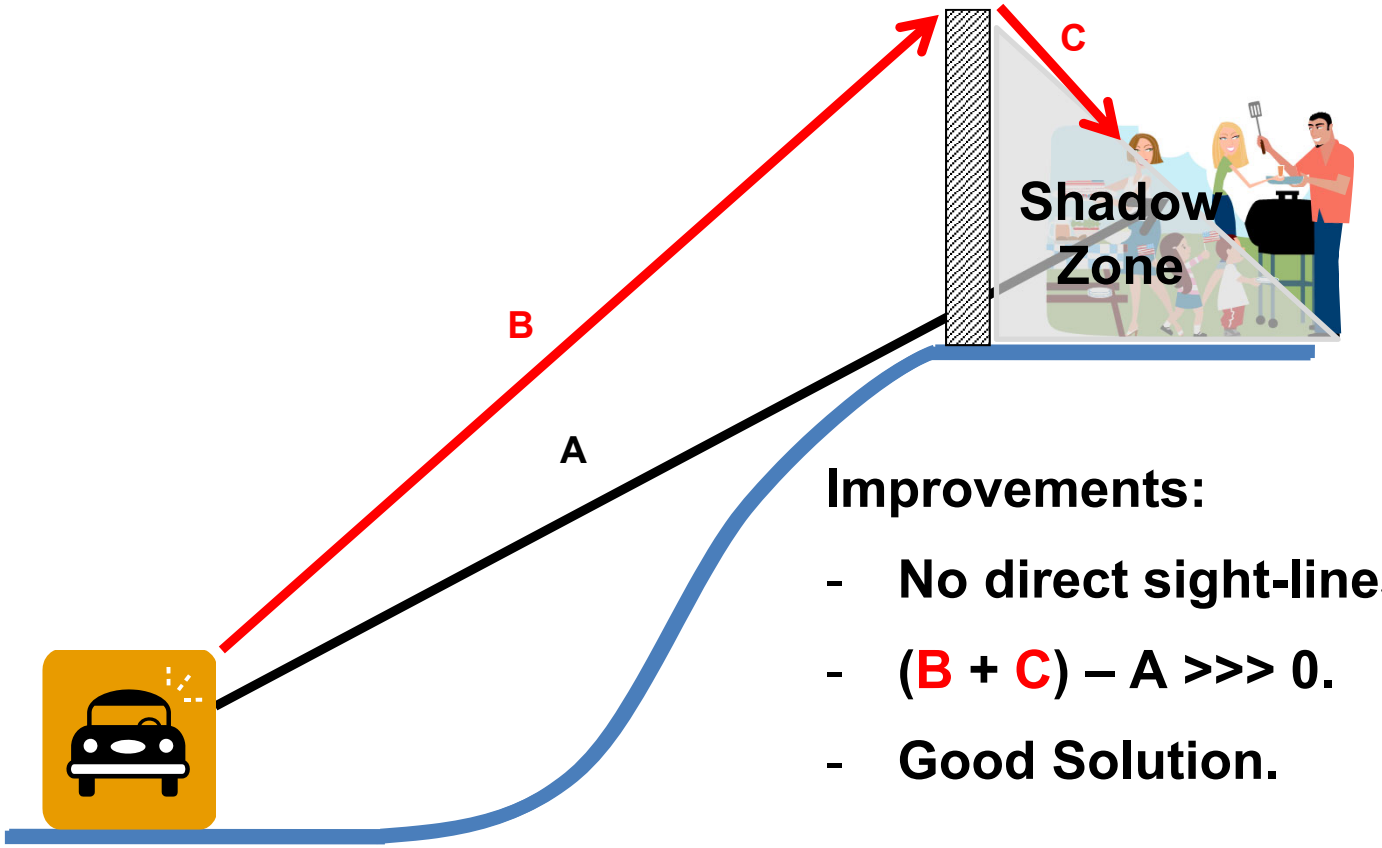
Noise Barriers



Improvements:

- **No direct sight-lines**
- **(B + C) – A >>> 0.**
- **Good Solution.**

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Noise Barriers

- **Sound transmitted through barrier must be at least 10 dBA less than sound diffracted over barrier**
- **Mass, Mass, MASS**
- **At least 20 kg/m^2 (minimum double board fence)**
- **No gaps in between or at bottom**
- **Double Boarded Wood or Masonry materials are preferred**
- **Need to consider maintenance, longevity, visual appeal**
- **There is such a thing as "overkill"**

Noise Barriers

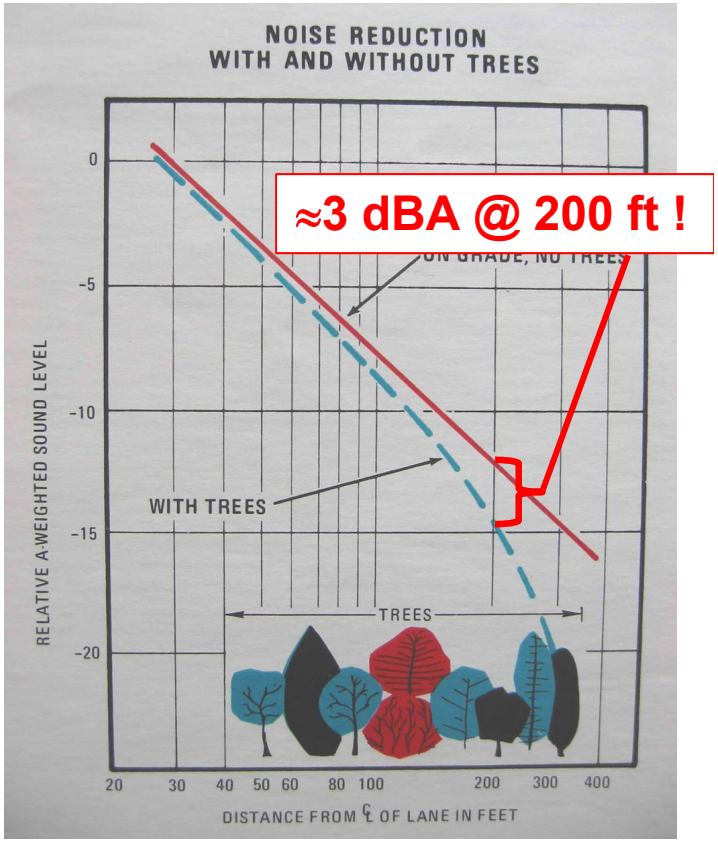
- **Need at least 2 – 3 dBA for a perceptible difference**
- **Rule of thumb is at least 5 dBA reduction to be considered "worth the cost"**
- **10 dBA attenuation is very good**
- **Practical attenuation limit of 10 – 15 dBA**
- **Can it be effective for loud mufflers, motorcycles, sirens, etc?**

Trees

Myth: "Let's just put in some trees to block the noise."

Reality: Trees/bushes are a very ineffective means of noise mitigation.

Trees act as an acoustical placebo: 'out of sight – out of mind'



Assessment Criteria

City of Leduc
Surface Transportation Noise Guideline

Criteria

New Projects

*"*In the case of existing development areas where the residential dwellings are adjacent to an existing major transportation facility the outdoor criterion sound level is 65 dBA. When a measured noise level exceeds 65 dBA the City will consider, on a priority and availability of funds basis, the construction of noise attenuation measures that are determined by administration to have the desired attenuating effect where technically and economically feasible.

Criteria

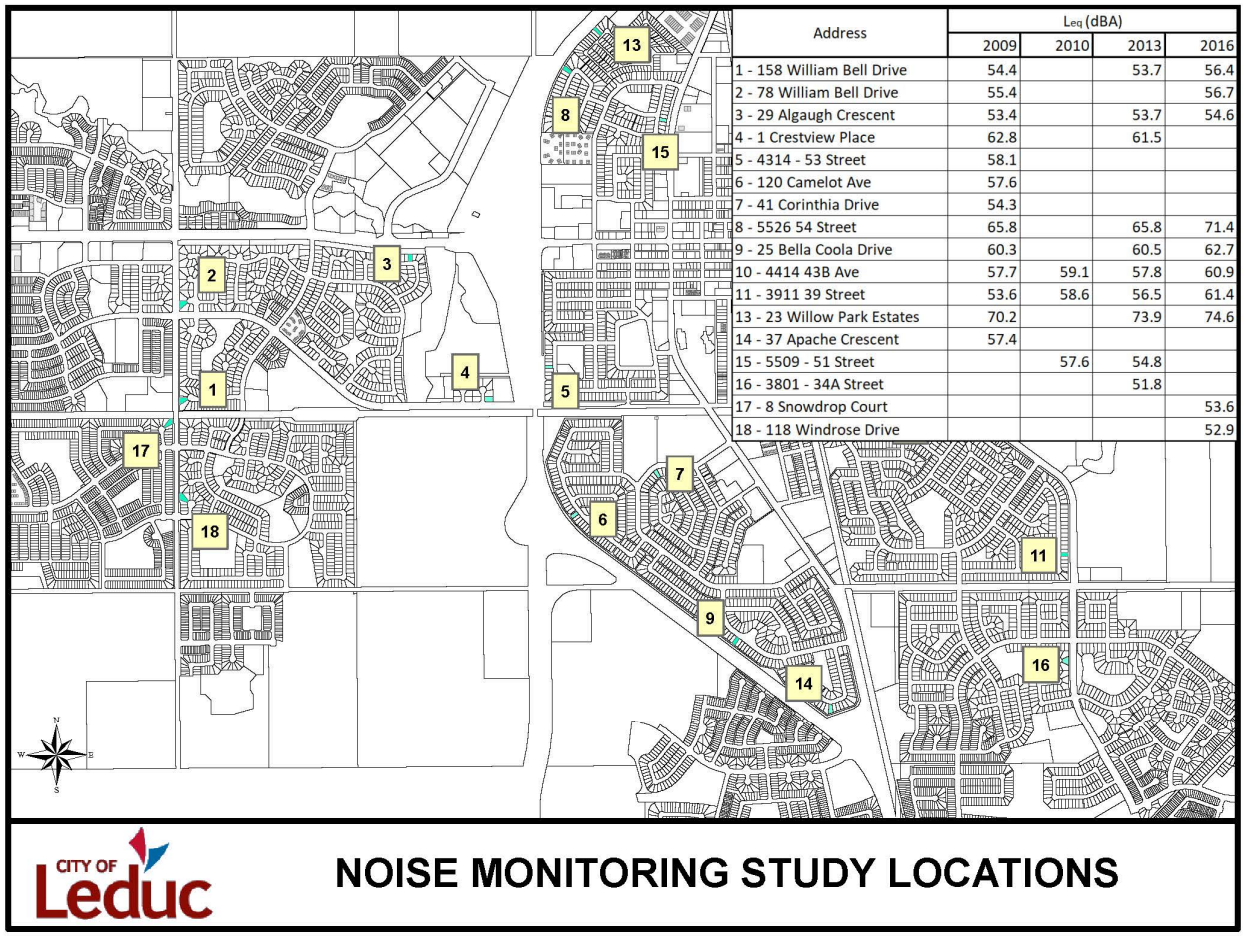
The STNG accounts for "background" transportation noise only and does not deal with non-typical events such as loud mufflers, stereos, etc.

Primary reasons:

- **Non-typical, cannot predict the amount of pass-by's in a 24-hour period.**
- **Noise mitigation is ineffective to reduce "annoyance".**
- **Put resources that will reduce noise 24/7/365.**

Results of Previous Noise Studies

Results



Address	Leq (dBA)			
	2009	2010	2013	2016
1 - 158 William Bell Drive	54.4		53.7	56.4
2 - 78 William Bell Drive	55.4			56.7
3 - 29 Algaugh Crescent	53.4		53.7	54.6
4 - 1 Crestview Place	62.8		61.5	
5 - 4314 - 53 Street	58.1			
6 - 120 Camelot Ave	57.6			
7 - 41 Corinthia Drive	54.3			
8 - 5526 54 Street	65.8		65.8	71.4
9 - 25 Bella Coola Drive	60.3		60.5	62.7
10 - 4414 43B Ave	57.7	59.1	57.8	60.9
11 - 3911 39 Street	53.6	58.6	56.5	61.4
13 - 23 Willow Park Estates	70.2		73.9	74.6
14 - 37 Apache Crescent	57.4			
15 - 5509 - 51 Street		57.6	54.8	
16 - 3801 - 34A Street			51.8	
17 - 8 Snowdrop Court				53.6
18 - 118 Windrose Drive				52.9

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Questions?