Appendix ‘M’ – Environmental Noise Assessment

GUELPH | OWEN SOUND | LISTOWEL | KITCHENER | LONDON | HAMILTON | GTA
650 WOODLAWN RD. W., BLOCK C, UNIT 2, GUELPH ON N1K 1B8 P: 519-824-8150 F: 519-824-8089 WWW.GMBLUEPLAN.CA

REPORT

GRAND RIVER CROSSINGS EA

BRANTFORD, ONTARIO

ENVIRONMENTAL NOISE ASSESSMENT
RWDI # 2000042
April 16, 2021

SUBMITTED TO

Matt Scott
Project Engineer
matt.scott@gmblueplan.ca

GM BluePlan
650 Woodlawn Road West, Block C-2
Guelph, ON N1K 1B8
T: 519 824 8150

SUBMITTED BY

Alain Carrière, B.A., Dipl. Ecotox.
Senior Project Manager / Associate
Alain.Carriere@rwdi.com

Slavi Grozev, P.Eng.
Senior Noise Engineer
Slavi.Grozev@rwdi.com

RWDI
Consulting Engineers & Scientists
600 Southgate Drive
Guelph, ON N1G 4P6
T: 519.823.1311
F: 519.823.1316

EXECUTIVE SUMMARY

GM BluePlan retained RWDI to conduct the noise and vibration study for the environmental assessment of the rehabilitation of three Grand River crossings in Brantford, Ontario. The three crossings included in this assessment are: Lorne Bridge, Brant's Crossing Bridge, and TH&B Crossing Bridge.

The objective of the study is to predict potential sound and vibration levels as it relates to the project, review municipal noise control by-laws, and provide conceptual mitigation measures to minimize the potential for any impacts. Noise sensitive areas have been investigated while identifying the closest receptor to each of the three crossings.

The project is expected to cause no change in operational sound and vibration levels. However, the primary noise and vibration impact will be from construction activities. Construction sound is temporary in nature but will be noticeable at times at existing noise sensitive areas in proximity to the activity. The estimated maximum sound level of the construction noise is between 74 dBA and 79 dBA at locations nearest to the construction activity. This estimated sound level has the potential to be an annoyance to noise sensitive areas within the study limits of this project. For noise sensitive areas with a larger separation distance, the anticipated sound level due to construction will be lower.

Methods to minimize construction noise impacts should be included in the Special Provisions, as outlined in Section 4.4 of this report. The City of Brantford has a noise by-law which prohibits nighttime construction activities unless an exemption is granted. The current project plans will avoid nighttime construction activities which is recommended to minimize the potential for noise complaints.

Construction vibration impacts have been assessed and were predicted to be below the threshold of interfering with surrounding structures integrity or causing any potential annoyance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

LIST OF APPENDICES

1 INTRODUCTION

GM BluePlan retained RWDI to conduct the noise and vibration study for the environmental assessment of the rehabilitation of three Grand River crossings in Brantford, Ontario. The three crossings included in this assessment are: Lorne Bridge, Brant's Crossing Bridge, and TH&B Crossing Bridge. The purpose of the rehabilitation is to preserve infrastructure integrity, extend the service life of the structures, and remove the limited winter load limit for Lorne Bridge. There will be no major re-alignments or significant changes in the crossings geometry, per information provided by GM BluePlan. This assessment has been conducted in accordance with the Terms of Reference outlined in the Request for Proposal (RFP) 2019-82 dated July 2019, with the scope based on Sections xvii of the Terms of Reference.

The objective of the study is to predict sound and vibration levels as it relates to the project, review municipal noise control by-laws, and provide conceptual mitigation measures to minimize the potential impacts.

A plain language description of the terminology and relationships between everyday sounds to aid the non-technical reader is provided in Appendix A.

1.1 Project Description

The project includes structure rehabilitation of three Grand River crossings in Brantford, Ontario. The three crossings included in this assessment are: Lorne Bridge, Brant's Crossing Bridge, and TH&B Crossing Bridge. No major re-alignment will be done for Lorne Bridge and thus there are not any changes anticipated in the vehicle traffic volumes. Brant's and TH&B crossings are pedestrian bridges. Thus, the operational noise and vibration impacts are expected to be unchanged after the completion of the proposed project and the current assessment will only focus on the potential impacts associated with the construction activities.

The construction activities for each crossing involve preparation and then rehabilitation of each of the substructure and the superstructure. The construction equipment associated with Lorne Bridge will include: haul trucks, excavators, backhoes, compactors, pavers, pavement milling machines, concrete pumps and trucks, generators, chipping guns, and air compressors. For Brant's and TH&B crossings, the used construction equipment will include: haul trucks, cranes, backhoes, concrete pumps and trucks, concrete vibrators, generators, chipping guns, and air compressors. More details on the construction equipment types, quantities, phasing, and associated sound power levels are provided in Appendix C.

1.2 Study Area

The study area associated with the project has been selected in accordance with practices and guidelines of the Ontario Ministry of Transportation (MTO) and Ministry of the Environment, Conservation and Parks (MECP, previously known as Ministry of the Environment (MOE)). Noise sensitive areas have been identified within the study area. The noise sensitive areas expected to have worst-case construction sound levels have been presented in detail.

2 APPLICABLE GUIDELINES

A number of guidelines and documents related to assessing road traffic noise impacts have been reviewed that are applicable to this project and are presented herein.

2.1 Ontario Provincial Guidelines and Policies

The MTO has two current guidelines and documents related to assessing road traffic noise impacts. These documents and policies are:

- Ontario MTO, Environmental Guide for Noise (MTO 2006, Version 1.1 July 2008)
- Ontario MTO, Environmental Reference for Highway Design (MTO 2009)

These guidelines apply to construction of new provincial highways, and reconstruction of existing provincial highways. The Environmental Guide for Noise includes guidance on roadway construction activities.

2.2 Noise Sensitive Areas

2.2.1 Definition of Noise Sensitive Areas

Under the Environmental Guide for Noise, Noise Sensitive Areas (NSAs) include the following land uses, provided they have an outdoor living area associated with them (MTO, 2008):

- Private homes (single family units and townhouses)
- Multiple unit buildings such as apartments, provided they have a communal outdoor living area associated with them
- Hospitals and nursing homes for the aged, provided they have an outdoor living area for use by patients
- Schools, educational facilities and daycare centres where there are outdoor living areas for students
- Campgrounds that provide overnight accommodation
- Hotels and motels with outdoor communal outdoor living areas (e.g., swimming pools) for visitors

The following land uses are generally not considered by the either the MTO or MOE to qualify as NSAs:

- Apartment balconies
- Cemeteries
- Parks and picnic areas not part of a defined outdoor living area
- All commercial
- All industrial

2.2.2 Location and Number of NSAs within the Area of Investigation

The general locations of NSAs within the Area of Investigation for the project are shown in Figure 1. The NSA's highlighted within Figures 1 consist mainly of private homes and apartment buildings. The maximum area of investigation as defined in the MTO's Environmental Guide for Noise, is 600 m perpendicular from the closest edge of pavement. Only worst-case receptors are included in the different cardinal directions. All other residences are anticipated to have sound levels lower than the modelled receptors.

2.2.3 Representative NSAs for Analysis

Two worst-case representative noise receptors (NRs) were modelled on each bank of each of the three crossings. All noise receptors are shown in Figure 1. NR1, NR3 and NR4 are residential apartment buildings while NR2 and NR5 are two-storey residential homes. NR4 is chosen as the closest receptor on the east side of both Brant's and TH&B crossings. The sound levels from general construction activities at NR5 are expected to be the loudest due to the minimal separation distance, approximately 70 m, between TH&B rehabilitation activities and the home. Sound levels at other receptors within the area of investigation are expected to be lower with greater distance from the construction activity.

2.3 Construction Noise Guidelines

2.3.1 Local Noise Control By-laws

The proposed project lies within the local jurisdictions of the City of Brantford. City of Brantford has a noise control By-law "Chapter 554" (City of Brantford, Chapter 554), provided in Appendix B, which regulates noise that is likely to disturb residents within the City.

The noise by-law states that noise associated with any equipment in connection with construction activities is prohibited from 09:00 pm any day to 07:00 am the next day. Based on the information provided by GM BluePlan, the construction activities will not occur during the nighttime hours when noise is prohibited as per the City noise control by-law. However, the by-law indicates an exemption procedure where an application has to be filed to the city and potential exemptions may be granted for a maximum period of six months.

2.3.2 MOE Model Municipal Noise Control Bylaw

The MOE stipulates limits on sound levels from individual items of equipment, rather than for overall construction noise. In the presence of persistent noise complaints, sound emission standards for the various types of construction equipment used on the project should be checked to ensure that they meet the specified limits contained in MOE Publication NPC-115 - "Construction Equipment", as follows (MOE, 1977b):

Table 1: NPC-115 Maximum Noise Emission Levels for Typical Construction Equipment

Type of Unit	Maximum Sound Level[1] (dBA)	Distance (m)	Power Rating (kW)
Excavation Equipment[2]	83	15	Less than 75 kW
	85	15	75 kW or Greater
Pneumatic Equipment[3]	85	7	-
Portable Compressors	76	7	-

Notes: [1] Maximum permissible sound levels presented here are for equipment manufactured after Jan. 1, 1981.
[2] Excavation equipment includes bulldozers, backhoes, front end loaders, graders, excavators, steam rollers and other equipment capable of being used for similar applications.
[3] Pneumatic equipment includes pavement breakers.

2.4 Construction Vibration Guidelines

Vibration is assessed against two sets of criteria, one for damage and one for annoyance. These criteria are expressed on a different basis, with damage criteria being based on instantaneous peak vibration levels, while annoyance criteria are linked to root mean square (RMS) vibration levels (i.e., representative of the "average" over time). Annoyance criteria are typically the limiting condition compared to building damage since people usually detect perceptible vibrations at levels below where damage occurs. Both need to be considered however, since a very brief intense vibration event may exceed building damage criteria and not be readily perceptible.

The building damage criterion was defined as vibration Peak Particle Velocity (PPV) of 5 mm/s which corresponds to the vibration level for which sensitive buildings (i.e. heritage buildings) are susceptible to vibration damage (City of Toronto, Chapter 363). Although the project assessed within this scope is outside the City of Toronto, the building damage criterion developed by the City of Toronto is widely used as guidance in jurisdictions where no such guidance exists and is aligned with current best practices for vibration assessment.

The annoyance criteria were defined based on the FTA threshold for residential spaces during nighttime being RMS vibration level of 72 VdB (FTA, 2018). This agrees with the human perceptibility thresholds defined in the ISO 2631-2 (ISO, 1989).

3 OPERATIONAL NOISE AND VIBRATION IMPACTS

Operation and maintenance noise, relating to noise from operations of the project following project completion, are generally of primary importance for surface transportation projects. For this project, the construction activities will not alter the lane widths, shoulder width, or roadway material for Lorne Bridge with the other two crossings being pedestrian walkways. Thus, the project is expected to cause no change in operational sound and vibration levels at the NSAs. The evaluation of noise impacts from road traffic is therefore not required.

4 CONSTRUCTION NOISE AND VIBRATION IMPACTS

For this project, the primary noise and vibration impacts will be from construction activities. Construction activities are temporary in nature, and largely unavoidable. With adequate controls, impacts can be minimized. However, for some periods of time and types of work, construction noise will be noticeable. This section of the report provides sound levels from expected construction activities over distance and vibration zones of influence and discusses guidelines and conceptual mitigation measures to minimize potential for construction noise impacts.

4.1 Anticipated Construction Activities

The following construction activities are anticipated as part of this project:

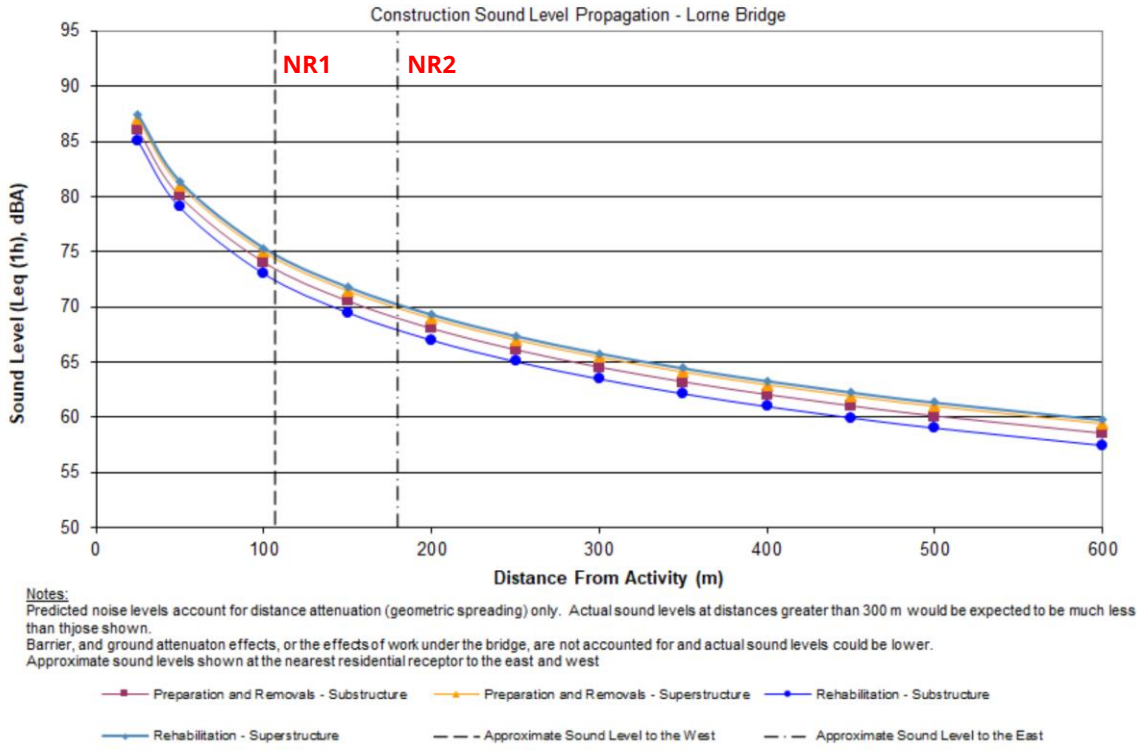
- paving existing shoulders,
- milling existing asphalt pavement and placing new asphalt on pavement,
- structure rehabilitation of crossing structures,
- replacing expansion joints,
- concrete patches to the abutments and piers, and
- reinforcement of various steel members throughout the structure.

Equipment used for the different phases of the construction activities for each of the three crossings are provided in Appendix C.

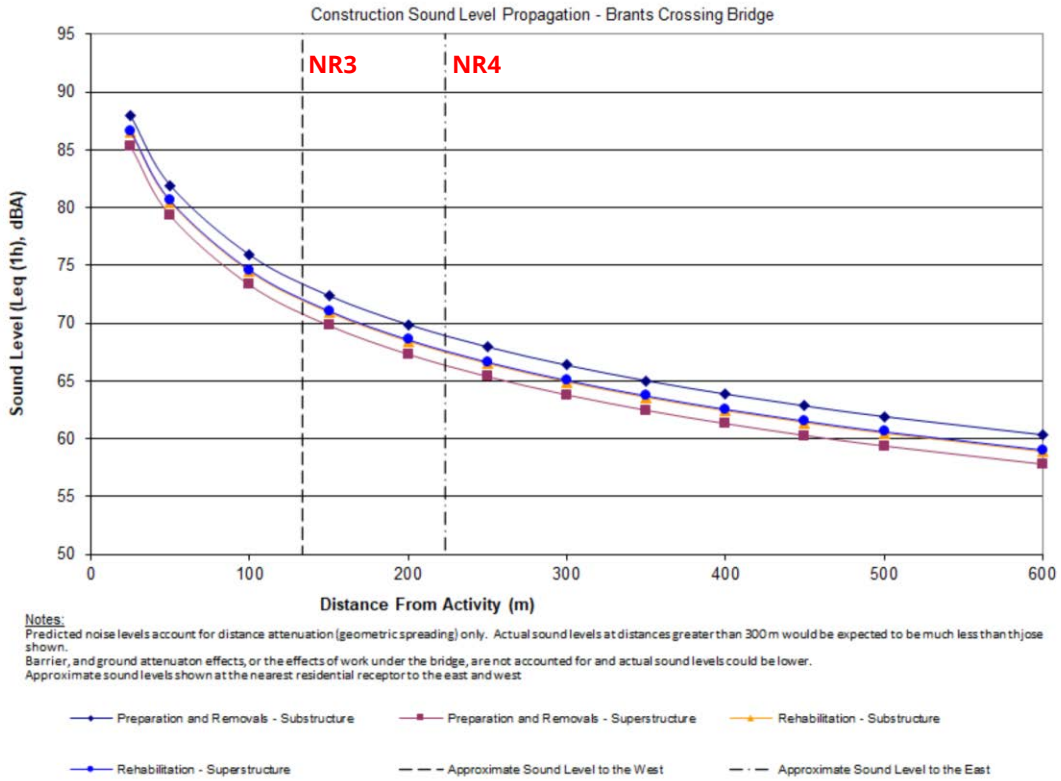
4.2 Anticipated Construction Sound Levels

Construction activities will vary temporally and spatially as the project progresses. Sound levels from construction at a given receptor location will also vary over time as different activities take place, and as those activities change location along the span of the crossings.

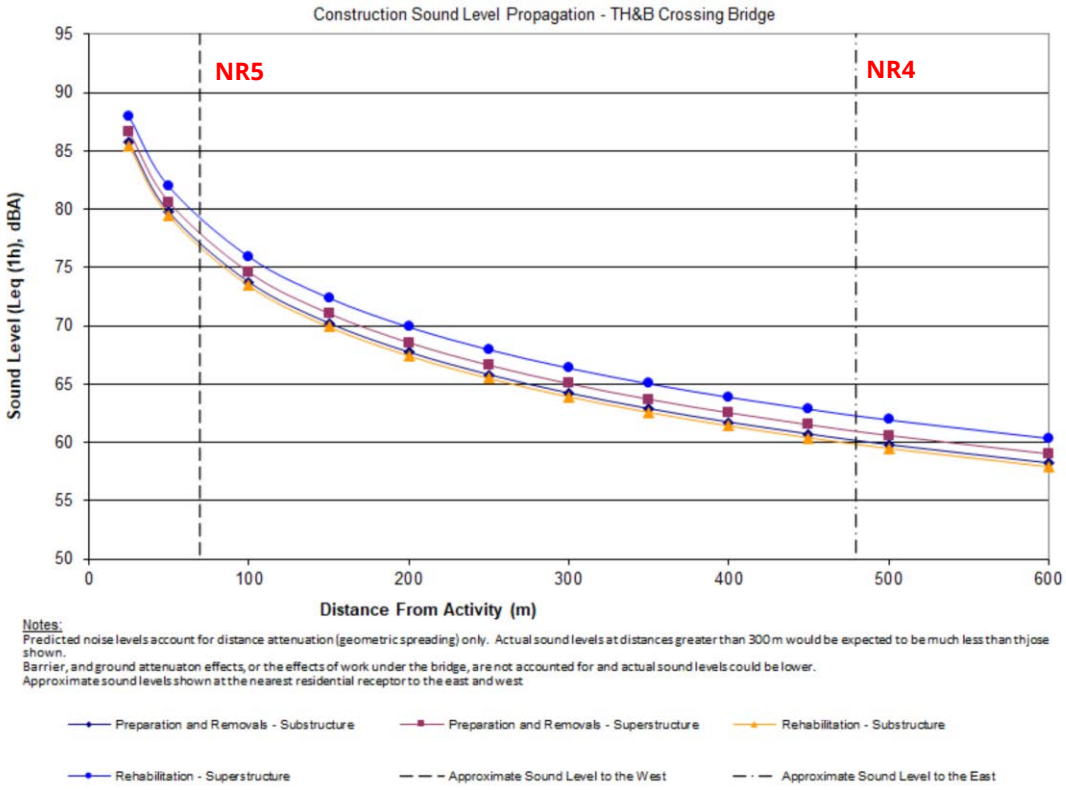
An analysis of potential worst-case construction sound levels has been conducted based on the provided data (equipment types and activities). The exact locations of the construction equipment are currently uncertain. Thus, it has been conservatively assumed that all the construction equipment can operate simultaneously in close proximity at either end of the bridge in a worst-case hour. The only exception was for Lorne Bridge where some heavy machinery was explicitly indicated to be only working on the west end. As a result of the conservative approach, the actual sound levels are expected to be lower. Each crossing has been assessed for the four construction phases: preparation and then rehabilitation of both the substructure and superstructure. Graphs 1, 2 and 3 show the anticipated sound level for the construction activities over distance for Lorne Bridge, Brant's and TH&B crossings, respectively. The graph presents construction sound level decrease as distance to the NSAs increases. The vertical lines on each graph depict the anticipated sound levels for worst-case receptor on the east and west sides of each crossing. The number, type of construction equipment, and associated sound power level for each piece of construction equipment used in the calculations of the graph below can be found in Appendix C. Appendix C summarizes the equipment used for each phase of construction activities.



Graph 1: Anticipated Construction Noise Levels for Lorne Bridge



Graph 2: Anticipated Construction Noise Levels for Brant's Crossing



Graph 3: Anticipated Construction Noise Levels for TH&B Crossing

The activities will progress along the span of the crossings and will occur in proximity to different NSAs at different times during the construction period, producing a temporary effect at each NSA. To examine the potential for construction activities to influence certain NSAs, a generic analysis was performed to predict construction sound levels as a function of distance from the various construction activities. The results shown in Graphs can be used to predict what the maximum construction-related sound level that may occur at any NSA, based on its distance from the undergoing activity of construction.

The NSA closest to Lorne Bridge (NR1) is approximately a distance of 107 m from the general construction and pavement activities and marked by a dashed line in Graph 1. The maximum construction-related sound level associated with Lorne Bridge is below 75 dBA at 107 m away. The NSA closest to Brant's Crossing (NR3) is approximately at a distance of 134 m and marked by a dashed line in Graph 2. The maximum construction-related sound level associated with Brant's Crossing is just below 74 dBA at 134 m away. The NSA closest to TH&B's Crossing (NR5) is located at a distance of about 70 m and marked by a dashed line in Graph 3. The construction-related sound level associated with TH&B's Crossing is approximately 79 dBA at 70 m away. The highest sound levels were predicted at NR5 were mainly attributed to close proximity rather than the nature of the construction activities for the TH&B crossing,

The estimated sound levels have the potential to be an annoyance to NSA's within the study limits of this project. A comparative chart of sound pressure levels and human perception to aid the reader is found in Table 3 of Appendix A. These are the worst-case potential sound levels from the various construction activities among the various NSAs. For all other NSAs with a larger separation distance, the anticipated sound level due to construction will be lower.

There are presently no receptor-based limits for roadway construction noise impacts. MOE NPC-115 should be followed and actions are required if noise sensitive receptors create complaints. Conceptual noise mitigation measures have therefore been provided in Section 4.4 to minimize the potential for noise impacts.

4.3 Anticipated Construction Vibration Levels

Construction vibration levels have been assessed for the three crossings based on the associated construction equipment indicated in Appendix C. Only heavy construction equipment is accounted for in the vibration assessment. Smaller equipment, such as pneumatic hand-tools and generators, are not expected to generate notable vibrations that require assessment. For Lorne Bridge, heavy equipment included haul trucks, excavators, backhoes, compactors, pavers and chipping guns. For Brant's and TH&B crossings, heavy equipment included haul trucks and chipping guns.

The vibrations assessment summary for the three crossings is shown in Table 2. The relatively heavier equipment associated with Lorne Bridge led to larger vibration Zone of Influence (ZOI) as compared with the other two crossings. However, the closest sensitive receptor for each crossing is outside the corresponding vibration ZOI for the two assessed criteria, i.e. building damage and annoyance. Thus, no adverse vibration impacts are anticipated for the planned construction activities.

Table 2: Construction Vibration Zones of Influence

Crossing	Building Damage ZOI (m)	Annoyance ZOI (m)	Closest Sensitive Receptor Setback (m)
Lorne Bridge	8.1	41.2	107
Brant Crossing	4.0	22.3	134
TH&B Crossing	4.0	22.3	70

4.4 Conceptual Noise Mitigation

Based on the predicted construction sound levels, mitigation measures are provided below to minimize the potential for construction noise impacts. It is required that these be written into the contract documentation for the contractor.

- There should be explicit indication that Contractors are expected to comply with all applicable requirements of the contract and local noise by-laws. Enforcement of noise control by-laws is the responsibility of the Municipality for all work done by Contractors.
- All equipment should be properly maintained to limit noise emissions. As such, all construction equipment should be operated with effective muffling devices that are in good working order.
- Monitor and maintain haul routes to minimize movement over rough ground and potholes which in turn can generate noise.
- All equipment shall be kept in good working order as deterioration may increase equipment sound levels. A documented, regular inspection and maintenance program must be implemented.

- Vehicle on-site speed limits must be met and will be enforced.
- Idling vehicles will be kept to a minimum.
- In the presence of persistent noise complaints, all construction equipment should be verified to comply with MOE NPC-115 guidelines.
- In the presence of persistent complaints and subject to the results of a field investigation, alternative noise control measured may be required, where reasonably available. In selecting appropriate noise control and mitigation measures, consideration should be given to the technical, administrative and economic feasibility of the various alternatives.
- Additional means to reduce annoyance and the risk of persistent complaints may be beneficial for the closest residences. This can include installation of temporary localized noise barriers, such as those shown in Appendix D, or similar custom-built ones.

5 CONCLUSIONS

The potential noise and vibration impacts of the rehabilitation of three Grand River crossings in Brantford, Ontario have been assessed. The project is expected to cause no change in operational sound and vibration levels. However, the primary noise and vibration impact will be from construction activities. Construction sound is temporary in nature but will be noticeable at times at existing noise sensitive areas in proximity to the activity. The estimated maximum sound level of the construction noise is approximately 79 dBA. A comparative chart of sound levels is found in Appendix A, Table 3. The table gives relative general sounds to approximate the sound levels of the construction noise. This estimated sound level has the potential to be an annoyance to noise sensitive areas within the study limits of this project.

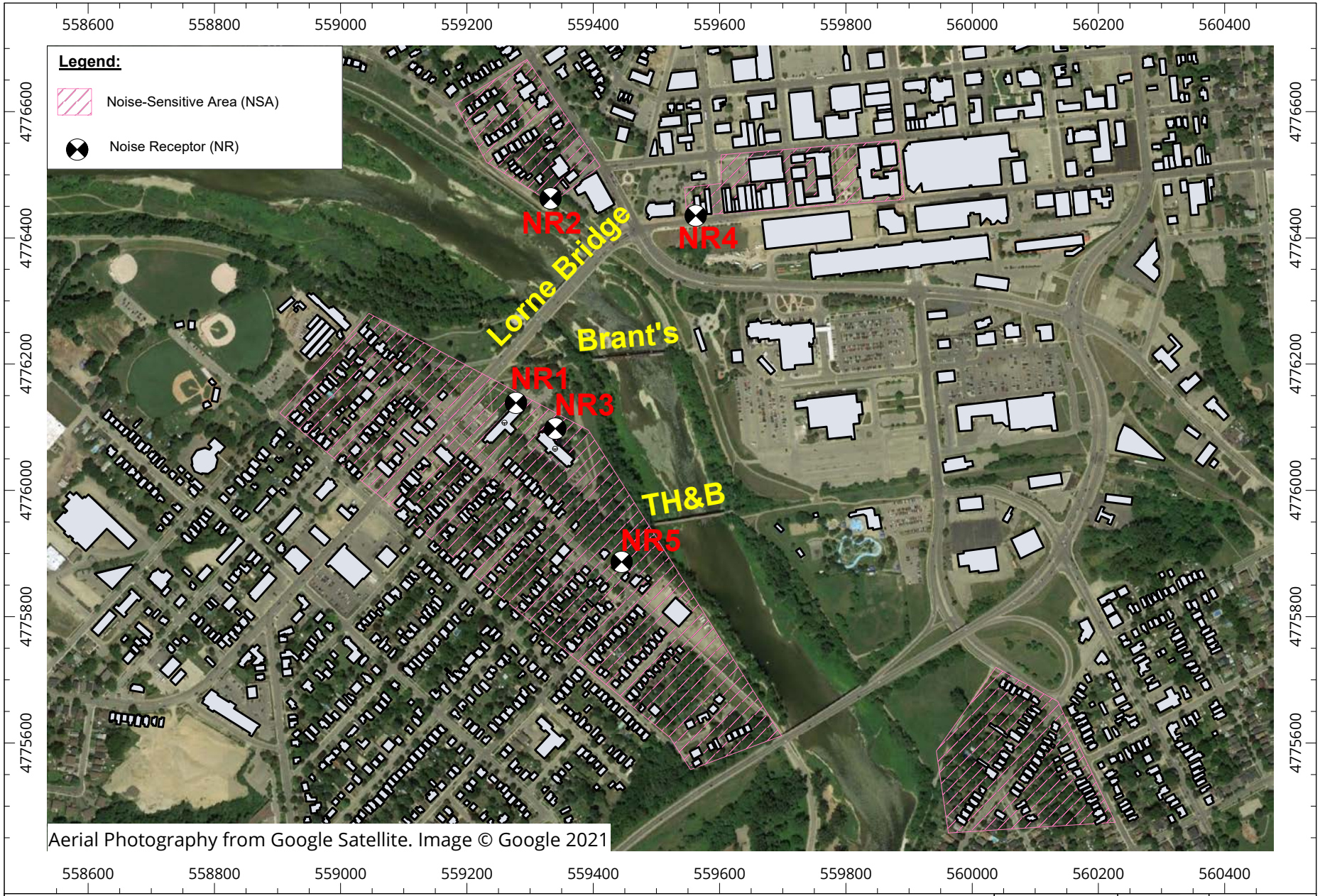
Methods to minimize construction noise impacts should be included in the Special Provisions, as outlined in Section 4.4 of this report. The City of Brantford has a noise by-law which prohibits nighttime construction activities unless an exemption is granted. The current project plans will avoid nighttime construction activities which is recommended to minimize the potential for noise complaints.

Construction vibration impacts have been assessed and were predicted to be below the threshold of interfering with surrounding structures integrity or causing any potential annoyance.

6 REFERENCES

1. Brantford, Noise Control By-law "Chapter 554".
2. City of Toronto, Municipal Code "Chapter 363".
3. Federal Transit Administration (FTA), 2018, U.S. Department of Transportation, Transit Noise and Vibration Impact Assessment.
4. International Organization for Standardization (ISO), 1989, ISO 2631-2 Evaluation of Human Exposure to Whole-Body Vibration, Part 2: Continuous and Shock-Induced Vibration in buildings.
5. Ontario Ministry of Transportation (MTO), 2006, Environmental Guide for Noise updated July 2008.
6. Ontario Ministry of Transportation (MTO), 2009, Environmental Reference for Highway Design.
7. Ontario Ministry of the Environment (MOE), 1977b, Model Municipal Noise Control Bylaw, which includes Publication NPC-115 – Construction Equipment.

FIGURES



Noise Sensitive Areas

Grand River Crossings

Brantford, Ontario

True North

Project #2000042

Drawn by: AFS	Figure: **01**
Scale:	1:8500
Date:	April 05, 2021

APPENDIX A

TRANSPORTATION SOUND BASICS

Sound Levels

Sound is, in its simplest form, a dynamic, fluctuating pressure, in a fluid medium. That medium can be air, other gases, or liquids such as water. These fluctuations are transmitted by pressure waves through the medium from the source to the receiver. For the majority of transportation engineering purposes, the primary interest is with sound waves in air, with human beings as the receptor. Noise is defined as unwanted sound. The standard practice within the acoustical industry is to use these two terms interchangeably.

Decibels

A decibel (dB) is a logarithmic ratio of a value to a reference level. The general mathematical format is:

$$\text{Level in dB} = 10 \log (\text{Value} / \text{Reference})$$

Any value can be expressed in decibels. Decibels are very useful in performing comparisons where there are huge ranges in levels. For example, an acoustical engineer can expect to deal with acoustical energy values ranging from 0.00001 W to 100 W (sound power), and pressures ranging from 0.002 Pa to 200 Pa (sound pressure).[1] For completeness, decibels should always be stated with their reference level (e.g., 20 dB re: 20 µPa). However, in practice the reference level is often left out.

Sound Pressure Level

Sound pressure level is what humans experience as sound. Sound waves create small fluctuations around the normal atmospheric pressure. These pressure fluctuations come into contact with eardrums and create the sensation of sound. Sound pressure is measured in decibels, according to the following equation:

$$\text{Sound Pressure Level, dB} = 10 \log (p^2 / p_o^2)$$

Where: p = root mean square (r.m.s.) sound pressure, in Pa
p_o = reference sound pressure, 20 µPa

The reference pressure represents the faintest sound that a "typical" human being can hear. The typical abbreviation for sound pressure level is SPL, although L_p is also often used in equations. "Sound level" or "noise level" are also sometimes used.

---

[1] Equivalent to Sound Power Levels ranging from 70 to 140 dB and Sound Pressure Levels ranging from 20 dB to 140 dB

Octave Bands

Sounds are composed of varying frequencies or pitches. Human sensitivity to noise varies by frequency, with a greater sensitivity to higher frequency sounds. The propagation of sound also varies by frequency. The unit of frequency is Hertz (Hz), which refers the number of cycles per second (number of wave peaks per second of the propagating sound wave). The typical human hearing response runs from 20 Hz to 20,000 Hz. Frequencies below 20 Hz are generally inaudible, although response is variable, and some individuals may be able to hear or perceive them.

Sound is typically analysed in octave bands or 1/3-octave bands. An octave band is defined as a band or range of sound frequencies where the frequency range doubles for succeeding octave (alternately, the highest frequency in the range is twice the value of the lowest frequency). Octave band and 1/3-octave band frequencies of interest frequencies of interest are shown in the table on the following page. Road and rail transportation noise sources tend to be broadband in nature, having roughly equal sound energy in many octave bands. Heavy rail traffic and heavy truck traffic may produce significant noise in lower frequencies < 200 Hz.

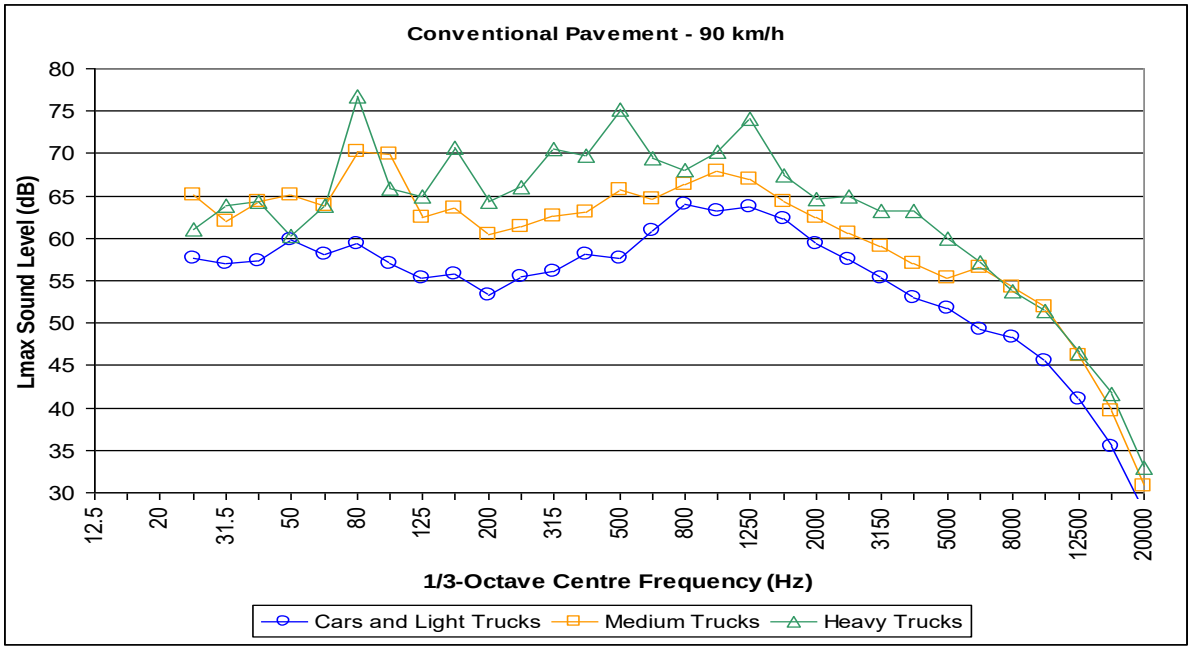
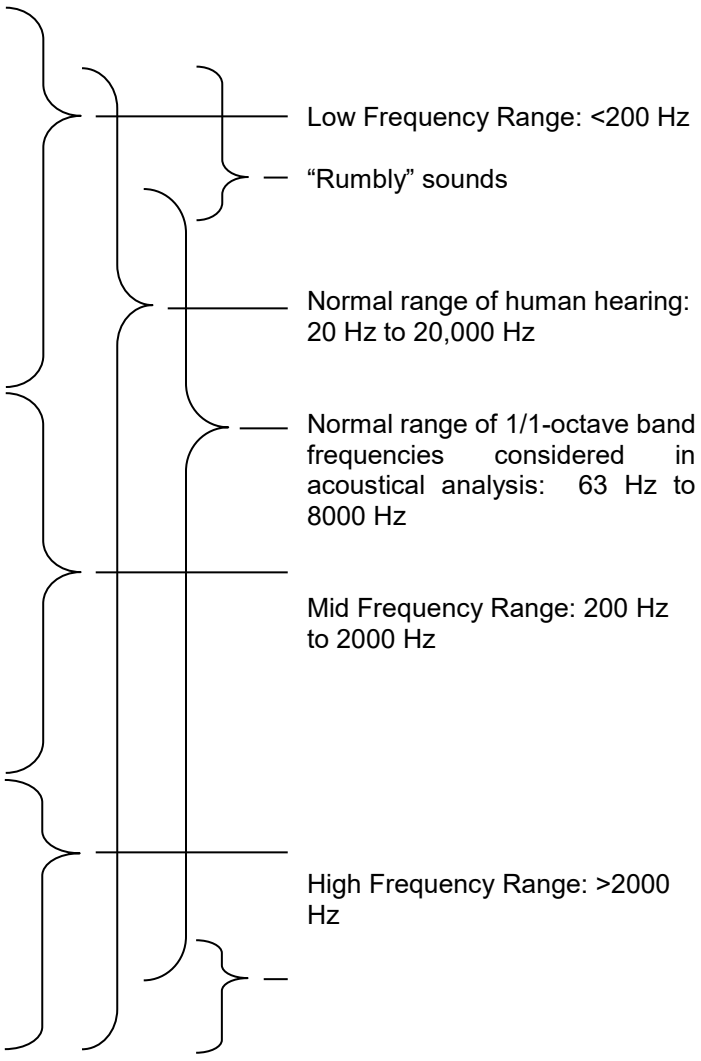


Figure 1: Typical Frequency Spectra of Traffic Noise - Vehicle Pass-bys at 90 km/h

Table 1: Octave Band Frequencies of Interest

Centre-Frequency (Hz)		Band No.	Frequency Range (Hz)
1/3-Octave	1/1-Octave		
12.5	16	N/A	11 to 22
16			
20			
25	31.5	0	22 to 45
31.5			
40			
50	63	1	45 to 89
63			
80			
100	125	2	89 to 177
125			
160			
200	250	3	177 to 345
250			
315			
400	500	4	345 to 707
500			
630			
800	1,000	5	707 to 1,414
1,000			
1,250			
1,600	2,000	6	1,414 to 2,828
2,000			
2,500			
3,150	4,000	7	2,828 to 5,657
4,000			
5,000			
6,300	8,000	8	5,657 to 11,314
8,000			
10,000			
12,500	16,000	N/A	11,314 to 22,627
16,000			
20,000			



Note: Per ISO 266-1975

A-Weighting

When the overall sound pressure level is expressed as a single value (i.e., not expressed in frequency band levels) the variation in human frequency response must be accounted for. People do not hear low frequency noise as well as noise in mid or high frequencies. To account for this, frequency-weighting networks have been developed to better account for human hearing response. The most frequently used networks are the A-Weighting and C-Weighting.

The A-Weighting network was developed to correspond to how humans hear low to medium levels of noise. The A-Weighting is the most frequently used scheme, and the majority of noise guidelines are expressed in A-Weighted decibel values, denoted as "dBA" levels. C-Weighted "dBC" values are sometimes used in assessing low-frequency noise impacts, which are generally not of concern in transportation noise impact assessment. The A-Weighting and C-Weighting values are shown in the following table and figure.

Table 2: A- and C-Weighting Values

1/1-Octave Frequency (Hz)	A-Weighting Value (dB)	C-Weighting Value (dB)
31.5	-39.4	-3.0
63	-26.2	-0.8
125	-16.1	-0.2
250	-8.6	0
500	-3.2	0
1,000	0	0
2,000	1.2	-0.2
4,000	1.0	-0.8
8,000	-1.1	-3.0

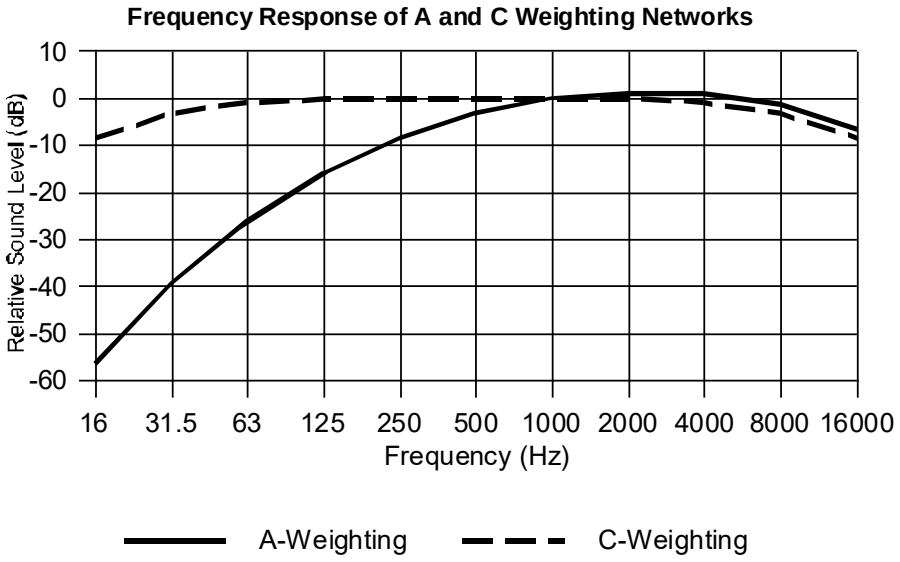


Figure 2: A-Weighting and C-Weighting Networks

Ranges of Sound Levels

People experience a wide range of sound levels in their daily activities. The table below presents a graphical comparison of "typical" noise levels which might be encountered, and the general human perception of the level.

Table 3: Ranges of Sound Levels

Sound Levels		Sources of Noise
Human Perception	**SPL, in dBA**	
Deafening	125	Sonic booms
	120	Threshold of Feeling / Pain
	115	Maximum level, hard rock band concert
	110	Accelerating Motorcycle at a few feet away
Very Loud	105	Loud auto horn at 3 m (10 ft) away
	100	Dance club / maximum human vocal output at 1 m (3 ft) distance
	95	Jack hammer at 15 m (50 ft) distance
	90	Indoors in a noisy factory
Loud	85	Heavy truck pass-by at 15 m (50 ft) distance
	80	School cafeteria / noisy bar; Vacuum Cleaner at 1.5 m (5 ft)
	75	Near edge of major Highway
	70	Inside automobile at 60 km/h
	65	Normal human speech (unraised voice) at 1 m (3 ft) distance
Moderate	60	Typical background noise levels in a large department store
	55	General objective for outdoor sound levels; typical urban sound level
	50	Typical suburban / semi-rural sound level (24h)
	45	Typical noise levels in an office due to HVAC; typical rural levels (24h)
Faint	40	Typical background noise levels in a library
	35	
	30	Broadcast Studio
	25	Average whisper
Very Faint	20	Deep woods on a very calm day
	15	
	10	
	5	Human breathing
	0	Quietest sound that can be heard

Sound levels from 40 to 65 dBA are in the faint to moderate range. The vast majority of the outdoor noise environment, even within the busiest city cores, will lie within this area. Sound levels from 65 to 90 are perceived as loud. This area includes very noisy commercial and industrial spaces. Sound levels greater than 90 dB are very loud to deafening, and may result in hearing damage.

Transportation noise events, which vary with time, can also be considered in terms of their maximum noise level (L_{max}) during a vehicle pass-by, as shown in the following table:

Table 4: Typical Pass-By Noise Levels at 15 m from Noise Source

Event	Range of Noise Levels (dBA) at 15 m
Semi-Trailer Trucks	75 - 85
Aircraft	69 – 85 [1]
Conventional Light Rapid Transit (Streetcars)	72 – 80 [2]
Large Trucks	71 - 78
Street Motorcycle	76
Diesel or Natural Gas Bus	70 - 78
Trolley Bus	69 - 73
Small Motorcycle	67
General Busy Auto Traffic	66 - 70
Individual Automobiles	63 - 69

Notes: Source: BKL Consultants Ltd.

[1] Aircraft flyover not at 15 m distance

[2] Based on data provided for the Calgary, Edmonton and Portland LRT systems.

Noise Descriptors – Leq Values

At this time, the best available research indicates that long-term human responses to noise are best evaluated using energy equivalent sound exposure levels (L_{eq} values), in A-Weighted decibels (L_{eq} values in dBA)[2, 3] including adjustments to account for particularly annoying characteristics of the sounds being analyzed.

Sound levels in the ambient environment vary each instant. In a downtown urban environment, the background noise is formed by an "urban hum", composed of noise from distant road traffic and from commercial sources. As traffic passes near a noise receptor, the instantaneous sound level may increase as a vehicle approaches, and then decrease as it passes and travels farther away. The energy equivalent sound exposure level L_{eq} is the average sound level over the same period of time with same acoustical energy as the actual environment (i.e., it is the average of the sound energy measured over a time period T). As a time-average, all L_{eq} values must have a time period associated with them. This is typically placed in brackets beside the L_{eq} tag. For example, a thirty-minute L_{eq} measurement would be reported as an L_{eq} (30 min) value.

The L_{eq} concept is illustrated in Figure 3, showing noise levels beside a small roadway, over a 100 second time period, with two vehicle pass-bys:

---

2 Berglund and Lindvall, Community Noise, 1995.

3 ISO 1996:2003(E), *Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures*.

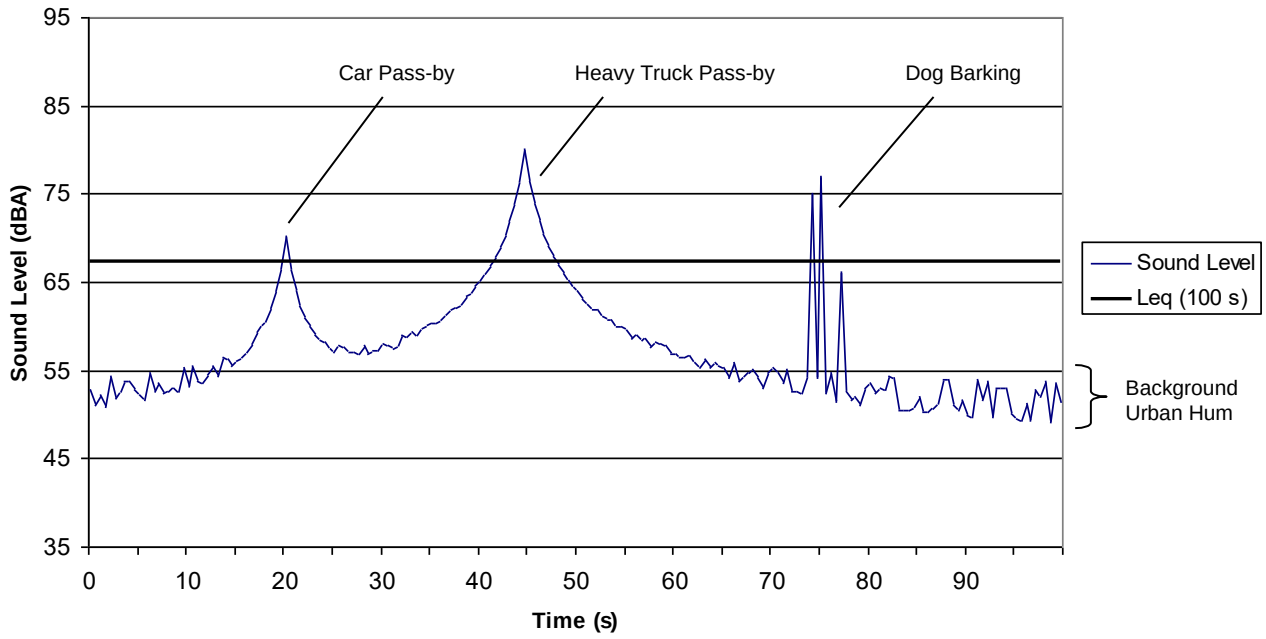


Figure 3: Example of the L_{eq} Concept

In this example, the background "urban hum" is between 47 and 53 dBA. A car passes by at 20 seconds. As it approaches, the noise level increases to a maximum, and then decreases as it speeds away. At 45 seconds, a heavy truck passes by. Near 75 seconds, a dog barks three times. The maximum sound level (L_{max}) over the period is 80 dBA and the minimum is 47 dBA. For almost 50% of the time, the sound level is lower than 55 dBA.

The L_{eq} (100s) for the above example is 67 dBA, which is much higher than the statistical mean sound level of 55 dBA. This illustrates that the L_{eq} value is very sensitive to loud noise events, which contain much more sound energy (as sound is ranked on a logarithmic scale) than the normal background. It is also sensitive to the number of events during the time period, and the duration of those events. If only the truck had passed by during the measurement (no car and no dog barks), the L_{eq} (100s) would be 66 dBA. If only the car and dog barks had occurred, the L_{eq} (100s) would have been 61 dBA. This shows that the truck pass-by is the dominant event in our example, due to its level and duration.

The ability of the L_{eq} metric to account for the three factors of level, duration and frequency of events makes it a robust predictor of human response to noise. It is for this reason that the vast majority of noise standards are based on L_{eq} values.

Typical Durations for Leq Analyses

For transportation noise impact analyses, the following durations are typically used:

L_{eq} (24h) – The sound exposure level over then entire 24-hour day

L_{eq} Day – Either: L_{eq} (15h), from 7am to 10 pm; or
L_{eq} (16h), from 7am to 11 am

L_{eq} Night – Either: L_{eq} (9h), from 10 pm to 7 am; or
L_{eq} (8h), from 11 pm to 7 am

L_{dn} – A special L_{eq} (24h) value with a 10 dB night-time penalty applied to overnight sound levels (10pm to 7am)

L_{eq} (1-h) – The sound exposure over a 1-hour time period

L_{eq} (24h) values are appropriate for examining impacts of transportation noise sources with small changes in sound exposure levels over the 24-hour day. For example, freeway noise levels are generally consistent over the 24-hour day. Therefore, for freeways, there is little difference between L_{eq} (24h) values and the corresponding L_{eq} Day and L_{eq} Night values.

L_{eq} Day values, covering off the AM-peak and PM-peak travel periods, are generally appropriate for examining the impacts of non-freeway highways and municipal arterial roadways. The vast majority of noise associated with these sources is concentrated in the daytime hours, where typically, 85% to 90% of the daily road traffic will occur.[4] Thus, if reasonable sound levels occur during the daytime (and appropriate guideline limits are met), they will also occur (and be met) at night.

To account for increased annoyance with noise overnight in a single value, the U.S. Environmental Protection Agency (U.S. EPA) developed the L_{dn} metric. It is a special form of the L_{eq} (24h) with a +10 dB night-time penalty. L_{dn} values and a related metric, the day-evening-night level (L_{den}) are also used in some European guidelines. L_{dn} values are not used in Canadian Provincial jurisdictions in evaluating transportation noise. Instead, guideline limits for separate L_{eq} Day and L_{eq} Night periods are generally used.

L_{eq} (1-h) values are the average sound levels over a one-hour time period. These tend to fluctuate more over the day, as traffic levels can fluctuate significantly hour to hour. L_{eq} (1-h) values are useful in assessing the impact of transportation sources which also vary hourly, and which may vary in a different manner than the background traffic. These values are often used to assess haul route noise impacts, for example.

[4] Based on research conducted by Ontario Ministry of Transportation, and provided in the *MTO Environmental Office Manual Technical Areas – Noise*. Daytime refers to a 16 hour day from 7am to 11 pm.

Some transportation noise sources may have significant traffic levels occurring over-night. For example, freight rail traffic in heavily used corridors can be shifted to over-night periods, with daytime track use being reserved for freight switcher traffic and passenger traffic. In situations such as this, an assessment of both daytime and night-time noise impacts may be appropriate.

Decibel Addition

Decibels are logarithmic numbers, and therefore have special properties of addition. Decibel values must be added logarithmically. If two sources, each emitting the same amount of sound energy, are placed side-by-side, then the total increase in sound level will only be 3 dB. If the difference in sound energy emitted is greater than 10 dB, then effectively the sound level will be the same as for the loudest unit (i.e., the increase in noise will be less than a decibel). This is shown in Table 5.

Table 5: Decibel Addition Chart

dB Difference Of	dB Value to Add to Highest Number
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4

This affects transportation noise from projects, as noise emission is logarithmically related to traffic volume. Doubling the traffic volume (essentially the same as adding a source with the same sound emission) will only result in a 3 dB increase over the original levels. The decibel increase in noise due to the increase in traffic volume, assuming all other factors remain the same, can be estimated by:

$$\text{dB increase} = 10 \log (\text{new volume} / \text{original volume}).$$

Human Response to Changes in Sound Levels

The human ear does not interpret changes in sound level in a linear manner. The general subjective human perception of changes in sound level is shown in the following table.

Table 6: Subjective Human Perception of Changes in Sound Level [5,6]

Change in Broadband Sound Level (dB)	Human Perception of Change
< 3	Imperceptible change
3	Just-perceptible change
4 to 5	Cleary noticeable change
6 to 9	Substantial change
> 10 and more	Very substantial change (half or twice as loud)
> 20 and more	Very substantial change (much quieter or louder)

Notes: Adapted from Bies and Hansen, p53, and MOE Noise Guidelines for Landfill Sites, 1998. Applies to changes in broadband noise sources only (i.e., increases or decreases in the same noise or same type of noise only). Changes in frequency content or the addition of tonal or temporal changes would affect the perception of the change.

The above table is directly applicable to changes in sound level where the noise sources are of the same general character. For example, existing road traffic noise levels can be directly compared to future road traffic noise levels, using the above relationships. In comparing road traffic noise to road plus rail traffic noise, the different frequency and temporal nature of the noise means that the rail noise may be more noticeable. Adjustments for the nature of the new sound can be applied to better account for temporal and frequency differences.

For transportation noise sources, research conducted by the U.S. Environmental Protection Agency indicates that a 5 dB change in sound levels is required to trigger a change in large-scale community response to noise. This correlates to a clearly noticeable increase in noise levels.

---

5 Bies, D.A., and C.H. Hansen 1988. *Engineering Noise Control – Theory and Practice, 2nd Ed.* E & FN Spon, London, p 53.

6 Ontario Ministry of the Environment 1998. Noise Guidelines for Landfill Sites. Queen's Printer for Ontario.

Decay of Noise with Distance

Noise levels decrease with increasing distance from a source of noise. The rate of decay is partially dependent on the nature of the ground between the source: whether it is hard (acoustically reflective) or soft (acoustically absorptive). Transportation noise sources in general act as *line sources* of sound. For line sources, the rate of decay is approximately:

- Hard ground: 3 dB for each doubling of distance from the source
- Soft ground: 5 dB for each doubling of distance from the source

This is shown graphically in Figure 6, based on a reference distance of 15 m from the source:

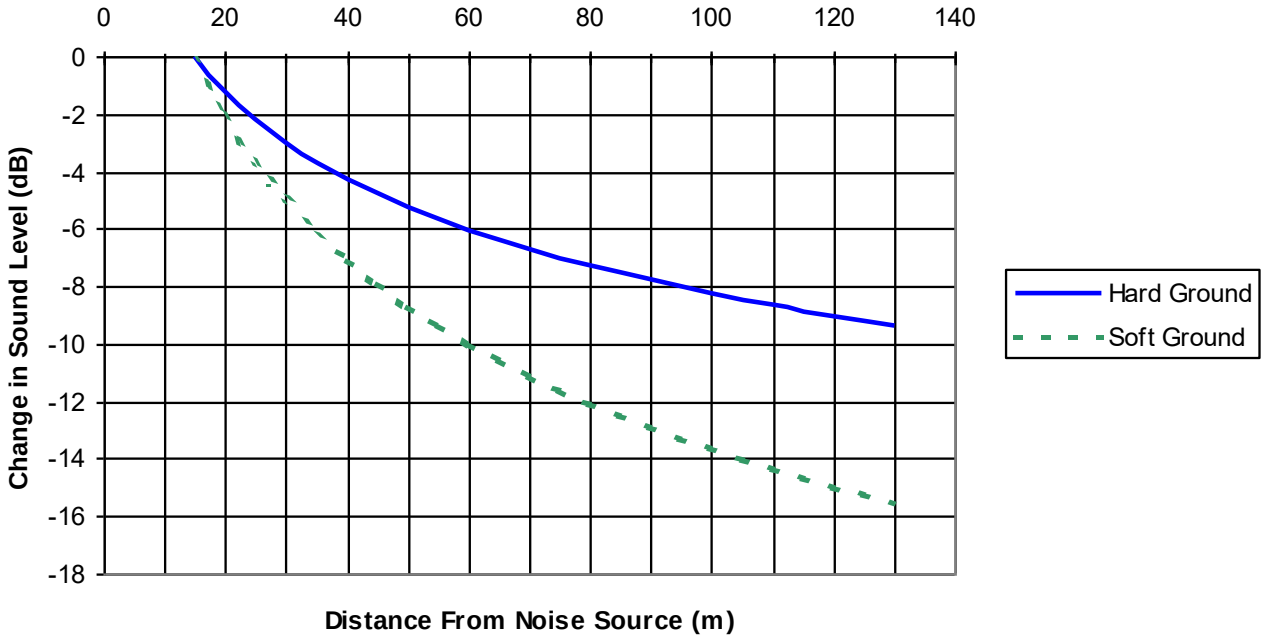


Figure 4: Decay of Noise Versus Distance for Line Sources

APPENDIX B

PROTECTION

Chapter 554
NOISE CONTROL

CHAPTER INDEX

Article 1
INTERPRETATION

554.1.1 Clerk and Deputy Clerks – defined
"Clerk" and "Deputy Clerk" shall mean the Clerk and Deputy Clerk(s) of The Corporation of the City of Brantford. By-law 32-2017, 28 February, 2017

554.1.2 Construction – defined
"construction" includes erection, alteration, repair, dismantling, demolition, structural maintenance, painting, moving, land clearing, earth moving, grading, excavating, the laying of pipe and conduit whether above or below ground level, street and highway building, concreting, equipment installation and alteration and the structural installation of construction components and materials in any form or for any purpose, and includes any work in connection therewith. By-law 32-2017, 28 February, 2017

554.1.3 Construction equipment – defined
"construction equipment" means any equipment or device designed and intended for use in construction or material handling, including but not limited to, air compressors, pile drivers, pneumatic or hydraulic tools, bulldozers, tractors, excavators, trenchers, cranes, derricks, loaders, scrapers, pavers, generators, off-highway haulers or trucks, ditchers, compactors and rollers, pumps, concrete mixers, graders or other material handling equipment. By-law 32-2017, 28 February, 2017

554.1.4 Conveyance – defined
"conveyance" includes a vehicle and any other device employed to transport a person or persons or goods, from place to place but does not include any such device or vehicle if operated only within the premises of a person. By-law 32-2017, 28 February, 2017

554.1.5 Council – defined
"Council" means the Council of The Corporation of the City of Brantford. By-law 32-2017, 28 February, 2017

554.1.6 Highway – defined
"highway" includes a common and public highway, street, avenue, parkway, driveway, square, place, bridge, viaduct or trestle designed and intended for, or used by, the general public for the passage of vehicles. By-law 32-2017, 28 February, 2017

554.1.7 Minister – defined
"Minister" means Minister of the Environment. By-law 32-2017, 28 February, 2017

554.1.8 Ministry – defined
"Ministry" means Ministry of the Environment. By-law 32-2017, 28 February, 2017

554.1.9 Motor vehicle – defined
"motor vehicle" includes an automobile, motorcycle, and any other vehicle propelled or driven otherwise than by muscular power; but does not include the cars of electric or steam railways, or other motor vehicles running only upon rails, or a motorized snow vehicle, traction engine, farm tractor, self-propelled implement of husbandry or road-building machine within the meaning of the Highway Traffic Act. By-law 32-2017, 28 February, 2017

554.1.10 Motorized conveyance – defined
"motorized conveyance" means a conveyance propelled or driven otherwise than by muscular, gravitational or wind power. By-law 32-2017, 28 February, 2017

554.1.11 Municipality – defined
"municipality" means the land within the geographic limit of the City of Brantford. By-law 59-80, 24 May, 1980; By-law 32-2017, 28 February, 2017

554.1.12 Noise – defined
"noise" means sound and vibration arising therefrom, emitted in such a manner or with such volume as to likely disturb local inhabitants. By-law 38-2009, 6 April, 2009; By-law 32-2017, 28 February, 2017

554.1.13 Noises Likely to Disturb – defined
"noises likely to disturb" include a noise which disturbs a police officer (or by-law officer) investigating complaints which are received in regard to enforcement of this Chapter, the noise or sound caused or made by an amplifier or loud speaker carried in or attached to a motor vehicle being operated or standing on a public highway and the noise or sounds caused or made by an amplifier or loud speaker carried in or attached to a motor vehicle being operated or standing on a public highway. By-law 21-2018, 27 February, 2018

554.1.14 Noise Control Administrator – defined
"Noise Control Administrator" means the person or persons designated by Council as responsible for the administration of this Chapter and shall be the Chief of Police of the City of Brantford, and the Chief Building Official for the City of Brantford. By-law 32-2017, 28 February, 2017

554.1.15 Point of reception – defined
"point of reception" means any point on the premises of a person where sound or vibration originating from other than those premises is received. By-law 32-2017, 28 February, 2017

554.1.16 Shall – mandatory
The word "shall" is mandatory and not directory. By-law 32-2017, 28 February, 2017

554.1.17 Singular - plural - present - future tense
Words in the singular include the plural; words in the plural include the singular number; and words in the present tense include the future. By-law 59-80, 24 May, 1980; By-law 32-2017, 28 February, 2017.

Article 2
APPLICABILITY

554.2.1 Designated area
The provisions of this Chapter shall apply to all land within the geographical limits of the City of Brantford. By-law 59-80, 24 May, 1980; By-law 115-93, 20 September, 1993

554.2.2 Designated area – exception
Nothing in this chapter shall prohibit any operational noise from lands zoned for Commercial or Industrial uses which are permitted to escape through open doors, windows or apertures and are audible from a distance of 70 metres to a Residentially zoned property except between the hours of 10:00pm to 7:00am Monday to Saturday and 10:00pm to 9:00am Sundays. By-law 21-2018, 27 February, 2018

554.2.3 Interpretation
For the purposes of Section 554.2.2, "manufacturing industry," "re- search industry," "wholesale industry," "warehouse industry," and "industry engaged in the storage of goods, materials or things" shall have the same meanings as those terms have in Zoning By-law 160-90 of the City, as amended from time to time.

554.2.4 Environmental Protection Act – prohibition
Nothing in this Chapter shall be interpreted to authorize the making of any noise where the same would be a contravention of the Environmental Protection Act.

554.2.5 Environmental Protection Act – authorization
Nothing in this Chapter shall prohibit the making of any noise where such noise is made under the authority of a Certificate of Approval or Provisional Certificate of Approval issued pursuant to the provisions of the Environmental Protection Act. By-law 115-93, 20 September, 1993.

Article 3
GENERAL PROHIBITIONS

554.3.1 Emission - prohibited - Schedule 'A'
No person shall emit or cause or permit the emission of noise resulting from any act listed in Schedule 'A' of this Chapter, from any point located on land

within the geographical limits of the City of Brantford, within a prohibited time shown in said Schedule 'A' if said emission is clearly audible at any point of reception located on land within the geo- graphical limits of the City of Brantford.

554.3.2 Emission - noise – acts
No person shall emit or cause or permit the emission of noise resulting from an act listed in this Article, and which noise is clearly audible at a point of reception within the geographical limits of the City of Brantford. By-law 9-80, 24 May, 1980; By-law 115-93, 20 September, 1993; By-law 38-2009, 6 April, 2009

554.3.3 Racing - motorized conveyance – exception
Racing of any motorized conveyance other than in a racing event regulated by law is prohibited.

554.3.4 Tires – squeal
The operation of a motor vehicle in such way that the tires squeal is prohibited.

554.3.5 Operation - engine - ineffective muffler
The operation of any combustion engine or pneumatic device without an effective exhaust or intake muffling device in good working order and in constant operation is prohibited. By-law 59-80, 24 May, 1980.

554.3.6 Trailer - insecure load - inadequate maintenance
The operation of a vehicle with a trailer resulting in banging, clanking, squealing or other like noises due to improperly secured load or equipment, or inadequate maintenance is prohibited. By-law 38-200, 6 April, 2009.

554.3.7 Operation - horn - not required – unauthorized
The operation of a motor vehicle horn or other warning device except where required or authorized by law or in accordance with good safety practices is prohibited.

554.3.8 Construction equipment - with ineffective muffler
The operation of any item of construction equipment without effective muffling devices in good working order and in constant operation is prohibited. By-law 59-80, 24 May, 1980

554.3.9 Loud speakers and amplifiers – noise
The noise or sounds caused or made by an amplifier or loud speaker carried in or attached to a motor vehicle being operated or standing on a public highway is prohibited. By-law 21-2018, 27 February, 2018

Article 4
EXEMPTION – EMERGENCY MEASURES
PUBLIC SAFETY

554.4.1 Emission - legal – acts
Notwithstanding any other provisions of this Chapter, it shall be lawful to emit or cause or permit the emission of noise in connection with emergency measures undertaken. By-law 38-2009, 6 April, 2009

554.4.2 Immediate health - safety – welfare
Incidental noise for the immediate health, safety or welfare of the in- habitants or any of them is permissible.

554.4.3 Preservation - restoration - property - exception Incidental noise for the preservation or restoration of property; unless such sound or vibration is clearly of a longer duration or nature more disturbing, than is reasonably necessary for the accomplishment of such emergency purpose is permissible. By-law 59-80, 24 May, 1980.

Article 5
GRANT - OF EXEMPTION

554.5.1 Application – conditions – requirements
Notwithstanding anything contained in this Chapter, any person may make application to the City Clerk or Deputy Clerk, in a form and with such content as required by the City Clerk or Deputy Clerk, to be granted an exemption from any of the provisions of this Chapter with respect to any source of noise for which such person might be prosecuted, and the City Clerk or Deputy Clerk may refuse to grant any exemption or may grant the exemption applied for or any exemption of lesser effect, and any exemption so granted shall specify the time period, not in excess of six (6) months, during which said exemption shall be effective, and may contain such terms and conditions as the City Clerk or Deputy Clerk sees fit. By-law 32-2017, 28 February, 2017

554.5.2 Breach - exemption – void
Breach by the applicant of any of the terms or conditions of the exemption shall render the exemption null and void. By-law 59-80, 24 May, 1980

554.5.3 Repealed: By-law 38-2009, 6 April, 2009

554.5.4 Repealed: By-law 38-2009, 6 April, 2009

554.5.5 Application – fee
An application fee of one hundred dollars ($100.00) shall be submitted along with any application for an exemption from the provisions of this Chapter.

Applications not accompanied by the required application fee shall be rejected without further notice to the applicant. By-law 32-2017, 28 February, 2017.

554.5.6 Application – notification requirement

Prior to making an application for an exemption pursuant to subsection 554.5.1 above, the applicant shall provide written notice, by way of personal service or regular or registered mail, to all residential properties located within one hundred and twenty (120) metres of the proposed event location, at least sixty (60) days prior to the proposed event wherein the noise will be emitted. The required notification shall be in a form and with such content as required by the City Clerk or Deputy Clerk. A copy of the notice, along with confirmation of the required distribution, must be attached to the application form for the exemption and submitted to the City Clerk or Deputy Clerk. By-law 32-2017, 28 February, 2017

554.5.7 Permit – Issued – Displayed

If an application for exemption is approved pursuant to subsection 554.5.1 above, the City Clerk or Deputy Clerk shall issue a permit to the applicant providing for the noise exemption and noting the period of time to which the exemption shall apply, as well as the conditions attached to said exemption. The applicant shall display said permit in a conspicuous location at the premises where the noise will be emitted, so that said permit is visible to the general public. The permit shall remain displayed in the manner required pursuant to this subsection 554.5.7 until such time as said permit expires. By-law 32-2017, 28 February, 2017

Article 6
ACTIVITIES - EXEMPTED

554.6.1 Emission - permitted – acts

Notwithstanding any other provisions of this Chapter, this Chapter does not apply to a person who emits or causes or permits the emission of noise in connection with any of the activities set out in Sections 554.6.2 through 554.6.7 inclusive. By-law 38-2009, 6 April, 2009

554.6.2 Parade – authorized

Incidental noise from any parade duly authorized by the City of Brantford Police Force is permissible.

554.6.3 Bells - chimes - Church activities

Incidental noise from the use of bells or chimes normally associated with Church activities is permissible.

554.6.4 Carnival - circus - midway - valid licence

Incidental noise from any carnival, midway or circus holding a valid licence issued by The Corporation of the City of Brantford is permissible. By-law 59-80, 24 May, 1980

554.6.5 Event - performance - permit – issued
Incidental noise up to 11:00 p.m. from any sporting, recreational, musical, entertainment or other event or performance in municipal parks, Harmony Square, or municipal buildings for which a permit has been issued by the Parks and Recreation Department of the City of Brantford is permissible. By-law 38-2009, 6 April, 2009

554.6.6 Activities - maintenance - essential services
Incidental noise from all activities of The Corporation of the City of Brantford, or its servants or agents, associated with the provision of maintenance and essential services is permissible.

554.6.7 Firework - detonation - authorized - Fire Department
Incidental noise from the detonation of fireworks duly authorized by the City of Brantford Fire Department is permissible.

Article 7
REGULATIONS

554.7.1 Practices - procedures - by resolution
The Council of The Corporation of the City of Brantford may make regulations by resolutions:

(a) prescribing and governing practices and procedures on appeals to Council under this Chapter and respecting any matter arising from or incidental to such appeals and providing for time limits for such appeals;

(b) prescribing and governing practices and procedures on applications for exemption from any of the provisions of this Chapter as provided in Sections 554.5.1 and 554.5.2. By-law 59-80, 24 May, 1980.

Article 8
ENFORCEMENT

554.8.1 Fine - for contravention
Every person who contravenes any of the provisions of this Chapter is guilty of an offence and shall, upon conviction thereof, forfeit and pay a penalty of not more than $5,000, exclusive of costs and every such fine is recoverable under the Provincial Offences Act. By-law 55-92, 23 March, 1992.

554.8.2 Officers
The provisions of this Chapter shall be enforced by Municipal Law Enforcement Officers designated by Council, and by members of the Brantford Police Force.

Article 9
REPEAL - ENACTMENT

554.9.1 By-laws - previous

City of Brantford By-laws 2283, 54-75, and 14-80 are herewith repealed. Section (9) of City of Brantford By-law 877 is herewith repealed. By-law 59-80, 24 May, 1980.

554.9.2 Minister of Environment - approval - By-law 59-80

By-law 59-80 was approved by Harry Parrott, Minister of the Environment, pursuant to the provisions of the Environmental Protection Act, at Toronto on the 24th day of May, 1980.

Minister of Environment - approval - By-law 115-93

By-law 115-93, amending By-law 59-80, was approved by the Minister of Environment and Energy, pursuant to the provisions of the Environmental Protection Act, on the 10th day of November, 1993. By-law 38-2009, 6 April, 2009

SCHEDULE

Schedule 'A' - Prohibitions by time and place

Act	Prohibited Period of Time
1. The detonation of fireworks or explosive devices not used in construction.	At all times
2. Noise from the discharge of firearms is prohibited except from a shooting club or shooting range that has received the appropriate approval under the *Firearms Act* and any other applicable legislation, hunting or an agricultural purpose permitted by law, and not otherwise prohibited by any other by-law of The Corporation of the City of Brantford. By-law 21-2018, 27 February, 2018	At all times
3. The operation of a combustion engine which: (a) is; or (b) is used in; or (c) is intended for use in, a toy, or a model or replica of any device which model or replica has no function other than amusement and which is not a conveyance.	At all times
4. The noise or sound made or created by any radio, phonograph, public address system, sound equipment, loud speaker, musical instrument or other sound-producing equipment, when the equipment is played or operated in such a manner that the sound or noise made or created thereby disturbs the peace, comfort or repose of any person in a dwelling house, or a police officer acting in accordance with their duties under the *Police Services Act*, or successor. By-law 21-2018, 27 February, 2018	2100 one day to 0700 next day
5. The operation of any motorized conveyance other than on a highway or other place intended for its operation.	At all times

6. Persistent barking, calling or whining or other similar persistent noise making by any domestic pet or any other animal kept or used for any purpose other than agriculture.	At all times
7. The operation of a commercial car wash with air drying equipment	2100 one day to 0700 next day
8. Yelling, shouting, hooting, whistling or singing	2100 one day to 0700 next day
9. All selling or advertising by shouting or outcry or amplified sound.	2100 one day to 0700 next day
10. Loading, unloading, delivering, packing, unpacking, or otherwise handling any containers, products, materials, or refuse, whatsoever, unless necessary for the maintenance of essential services or the moving of private household effects.	2100 one day to 0700 next day, 0900 Saturdays and Sundays
11. The operation of any equipment in connection with construction.	2100 one day to 0700 next day
12. The operation or use of any tool for domestic purposes other than snow removal.	2100 next day to 0700 next day
13. The operation of a motor vehicle, off-road vehicle, snowmobile, or other similar motorized conveyance for recreational purposes on any property other than a highway or private driveway.	At all times

By-law 38-2009, 6 April, 2009; Schedule ‘A’; By-law 38-2013, 22 April, 2013; By-law 32-2017, 28 February, 2017; By-law 21-2018, 27 February, 2018.

APPENDIX C

Highway Construction Noise Assessment - Preparation - Substructure (Lorne Bridge)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Preparation - Substructure

	Amt	Act. PWL[1]	Max. SPL[2]	Equipment
	3	118	85	Hand Tools
	3	114	85	Chipping Gun
	3	112	80	Air Compressor
	4	117	82	Generator
	2	107	76	Haul truck (Typical 3-axle)
TOTAL	**15**	**122**		

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Preparation - Substructure

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	86
50	80
100	74
150	71
200	68
250	66
300	65
350	63
400	62
450	61
500	60
600	59

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Preparation - Superstructure (Lorne Bridge)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Preparation - Superstructure

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
1	109	81	Excavators
2	107	76	Haul truck (Typical 3-axle)
3	114	85	Chipping Gun
3	112	80	Air Compressor
2	110	79	Backhoes / Wheeled Loaders
4	117	82	Generator
1	120	90	Pavement Milling Machines (scarafier)
TOTAL **16**	**123**		

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Preparation - Superstructure

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	87
50	81
100	75
150	71
200	69
250	67
300	65
350	64
400	63
450	62
500	61
600	59

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Rehabilitation - Substructure (Lorne Bridge)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Rehabilitation - Substructure

	Amt	Act. PWL[1]	Max. SPL[2]	Equipment
	20	117	76	Haul truck (Typical 3-axle)
	5	114	79	Concrete trucks
	4	112	81	Concrete pumps
	4	117	82	Generator
TOTAL	**33**	**121**		

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Rehabilitation - Substructure

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	85
50	79
100	73
150	70
200	67
250	65
300	63
350	62
400	61
450	60
500	59
600	57

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Rehabilitation - Superstructure (Lorne Bridge)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Rehabilitation - Superstructure

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
1	109	81	Excavators
20	117	76	Haul truck (Typical 3-axle)
1	108	83	Compactor
10	117	79	Concrete trucks
2	117	85	Paver
4	114	83	Compactor
4	117	82	Generator
TOTAL **42**	**123**		

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Rehabilitation - Superstructure

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	87
50	81
100	75
150	72
200	69
250	67
300	66
350	64
400	63
450	62
500	61
600	60

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Preparation - Substructure (Brants and TH&B Bridges)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Brants

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
5	120	85	Hand Tools
5	117	85	Chipping Gun
5	115	80	Air Compressor
5	117	82	Generator
2	107	76	Haul truck (Typical 3-axle)
TOTAL	**22**	**124**	

2. TH&B

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
3	118	85	Hand Tools
3	114	85	Chipping Gun
3	112	80	Air Compressor
3	115	82	Generator
2	107	76	Haul truck (Typical 3-axle)
TOTAL	**14**	**122**	

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Preparation - Substructure (Brants)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	88
50	82
100	76
150	72
200	70
250	68
300	66
350	65
400	64
450	63
500	62
600	60

Predicted Construction Noise Levels - Preparation - Substructure (TH&B)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	86
50	80
100	74
150	70
200	68
250	66
300	64
350	63
400	62
450	61
500	60
600	58

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Preparation - Superstructure (Brants and TH&B Bridges)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Brants

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
2	108	81	Cranes
2	113	85	Chainsaw
4	120	85	Hand Tools
2	114	82	Generator
TOTAL	**10**	**121**	

2. TH&B

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
4	114	80	Air Compressor
4	121	90	Quick saw
4	117	82	Generator
TOTAL	**12**	**123**	

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Preparation - Superstructure (Brants)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	85
50	79
100	73
150	70
200	67
250	65
300	64
350	62
400	61
450	60
500	59
600	58

Predicted Construction Noise Levels - Preparation - Superstructure (TH&B)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	87
50	81
100	75
150	71
200	69
250	67
300	65
350	64
400	63
450	62
500	61
600	59

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Rehabilitation - Substructure (Brants and TH&B Bridges)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Brants

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
5	114	79	Concrete trucks
2	109	81	Concrete pumps
4	120	85	Hand Tools
4	111	80	Concrete Vibrator
4	117	82	Generator
TOTAL **19**	**122**		

2. TH&B

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
5	114	79	Concrete trucks
2	109	81	Concrete pumps
3	118	85	Hand Tools
3	109	80	Concrete Vibrator
3	115	82	Generator
TOTAL **16**	**121**		

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Rehabilitation - Substructure (Brants)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	86
50	80
100	74
150	71
200	68
250	66
300	65
350	64
400	62
450	61
500	60
600	59

Predicted Construction Noise Levels - Rehabilitation - Substructure (TH&B)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	85
50	79
100	73
150	70
200	67
250	65
300	64
350	63
400	61
450	60
500	59
600	58

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

Highway Construction Noise Assessment - Rehabilitation - Superstructure (Brants and TH&B Bridges)

Job No: 2000042
Job Name: Brantford Grand River EA

1. Brants

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
2	108	81	Cranes
6	121	85	Hand Tools
3	115	82	Generator
2	110	79	Backhoes / Wheeled Loaders
TOTAL **13**	**123**		

2. TH&B

Amt	Act. PWL[1]	Max. SPL[2]	Equipment
4	114	80	Air Compressor
4	120	85	Hand Tools
4	117	82	Generator
4	120	85	Hand Tools
TOTAL **16**	**124**		

Notes:
-- All values in dBA
1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Predicted Construction Noise Levels - Rehabilitation - Superstructure (Brants)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	87
50	81
100	75
150	71
200	69
250	67
300	65
350	64
400	63
450	62
500	61
600	59

Predicted Construction Noise Levels - Rehabilitation - Superstructure (TH&B)

Distance to Centre-line *R* (m)	L_{eq} (1h) [1.]
25	88
50	82
100	76
150	72
200	70
250	68
300	66
350	65
400	64
450	63
500	62
600	60

Notes:
- All values are in dBA unless otherwise noted
1. Equivalent Activty PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist^2))

APPENDIX D

ENVIRONMENTAL
NOISE CONTROL

ACOUSTICAL K-RAIL / JERSEY BARRIER MOUNTED SOUND WALL

ENC's K-Rail/Jersey barrier mounted sound walls allow for **quick** and **easy** positioning and movement througout the site to provide a flexible noise control solution for mobile equipment or operations. The K-Rail/Jersey mounted barrier panels can be **customized** to meet your needs, with heights from 8-16 feet. This product line is an effective solution if the site does not allow earth boring.



BARRIER BLANKET SPECIFICATIONS

- Sound Transmission Class rated STC-25, 32 & 43 in accordance with ASTM E-413
- Engineered to meet IBC Wind Load requirements
- Flame Retardant to California Fire Marshall F-419.01 Specifications
  Length of Char: 3.5, After Flame: 2 Seconds
- Working Temperature: -40 °F to +200 °F
- Oil resistant, UV resistant, Fiber-Free, Anti-Fungal, Self-Drying Poly-Vinyl Chloride Outer Shell with specially developed inner core septum barrier

FREESTANDING ACOUSTICAL PANELS ARE NOT INTENDED FOR USE IN HIGH WIND CONDITIONS WITHOUT A SUPPORTING STRUCTURAL ANAYLSIS

Learn more about commercial noise control at
www.environmental-noise-control.com or call us at **1-800-679-8633**

TEMPORARY ACOUSTICAL NOISE BARRIER SYSTEMS

Designed to provide optimum sound control in blocking and absorbing unwanted noise.

ENVIRONMENTAL

ENTERTAINMENT

CONSTRUCTION

INDUSTRIAL

OIL & GAS

TEMPORARY NOISE BARRIER PANEL SYSTEM

At the heart of our temporary sound wall is our Environmental Noise Control (ENC) acoustical noise barrier panel system, which is manufactured using state-of-the-art acoustical composite materials. Our sound panels are fabricated with a polyvinyl-chloride coated outer shell, multiple layers of noise absorbing and blocking material and feature a specially developed septum barrier inner core. The ENC temporary sound wall system is available from 6 to 40 ft. high.

Temporary Sound Panel Systems

Sound Transmission Loss (dB)

% Octave Band Center Frequency	STC 25 Transmission Loss	STC 32 Transmission Loss
63 Hz	8 dB	16 dB
80 Hz	10 dB	20 dB
100 Hz	11 dB	18 dB
125 Hz	10 dB	16 dB
160 Hz	7 dB	16 dB
200 Hz	7 dB	17 dB
250 Hz	11 dB	19 dB
315 Hz	17 dB	23 dB
400 Hz	23 dB	26 dB
500 Hz	28 dB	32 dB
630 Hz	33 dB	34 dB
800 Hz	36 dB	35 dB
1000 Hz	39 dB	35 dB
1250 Hz	41 dB	36 dB
1600 Hz	41 dB	36 dB
2000 Hz	40 dB	36 dB
2500 Hz	41 dB	37 dB
3150 Hz	44 dB	39 dB
4000 Hz	46 dB	40 dB
5000 Hz	50 dB	43 dB

The modular design of ENC's temporary sound panel systems **meets or exceeds** code requirements.

An independent acoustical laboratory has conducted tests in accordance with ASTM E-90 and ASTM E-413 requirements, to measure sound transmission loss and validating the Sound Transmission Class rating of STC-25, STC-32 and STC-43. The ENC composite barrier/absorber blankets, which are laboratory tested and certified, meet or exceed the specifications in the Sound Transmission Loss Data Table.

1 (800) 679 8633 | International +1 310 679 8633 | www.environmental-noise-control.com

CORPORATE OFFICE
Hawthorne, CA

REGIONAL OFFICES & FIELD OPERATIONS
Aledo, TX; Carson, CA; Firestone, CO
Napa, CA; Shreveport, LA; Washington, PA
Calgary, Alberta

For more information on our quality products or possible applications, please see our website or call to speak with one of our ENC representatives. Rapid engineering and deployment response is available worldwide.

Behrens & Associates, Inc.
Environmental Noise Control

ENVIRONMENTAL
NOISE CONTROL

Soft dB

Heavy Duty Soundproofing

Soundproofing Blankets

Isotex-dB

Distributed by:

Noise Reduction®

SOFTDB.COM

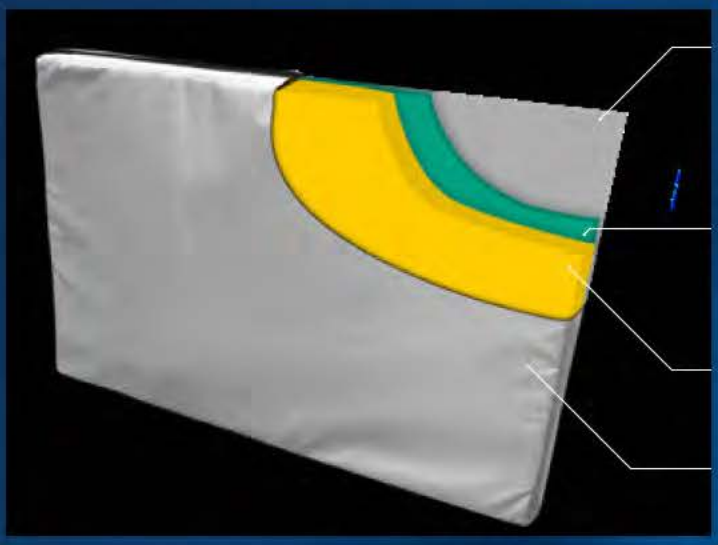
Who Are We?

Soft dB has been providing acoustical and vibration consulting services since 1996. Its PhDs, engineers and technicians have undertaken numerous environmental, industrial, architectural, mining, commercial, institutional and residential projects.

For all types of noise and vibration control problems, **Soft dB** has expertise at the cutting edge of acoustical knowledge.

Soft dB has offices located in Boston, Montreal, Quebec City, Malartic and Luxembourg. Our acoustics & vibration experts provide consulting services all across United States, Canada, Europe, and Africa.

Isotex-dB | INDUSTRIAL GRADE COMPOSITION



1. An outer protective fabric layer with robust bands and fasteners prevents noise leakage and makes the cover both waterproof and UV resistant.

2. A sound-blocking layer composed of a mass-loaded polymer material prevents noise propagation.

3. A high-performance mineral fibre layer efficiently absorbs sound.

4. A Silicone-impregnated inner fabric layer provides industrial strength over a wide range of temperatures and contaminants.

OPTIMAL PERFORMANCE

Isotex-dB soundproofing blankets are effective in reducing noise from industrial equipment, especially at low frequencies. Having an STC 33 sound insulation index, these covers are the ideal solution for your noise problems.

Before / After

Turnkey Solution

Quotation and Evaluation On-Site

Our team will travel to the project site to evaluate the facility and accurately assess your needs.

Design and Manufacturing

The design is customized for the exact dimensions of your equipment. The manufacture of the panels is then made in the factory.

Installation

We provide detailed installation plans so that your team or ours can install the blankets.

VARIOUS APPLICATIONS

Isotex-dB soundproofing blankets are suitable for industrial use both outdoors and indoors. They make a significant difference to the sound level radiated by the equipment they cover by acting directly at the source of the problem.

STATIONARY EQUIPMENT

- Lightweight Structures;
- Machinery;
- Compressors;
- Pipelines;
- Etc.

MOBILE EQUIPMENT

- Trucks;
- Heavy Machinery;
- Ships;
- Etc.

Electrical Equipment

Soft dB has installed the **Isotex-dB** soundproofing blanket system on several electrical transformers to significantly reduce the noise emitted by these devices.

Electrical equipment such as power transformers generally produce noise at low frequencies, which are the most difficult to attenuate.

Isotex-dB soundproofing blankets have been specially designed to effectively reduce this type of noise radiation.

Soft dB

A Unique Solution!

Based on an exclusive patented design*, **Isotex-dB** soundproofing blankets are the only ones to provide the ease of installation provided by magnetic anchors. The panelized blankets are mounted to a stainless-steel frame fitted with magnetic anchors, allowing the frame to be installed and removed rapidly, without drilling or damaging the equipment being treated. The system is ideal for all types of metal surfaces.

Thanks to its flexible and customized designs, **Isotex-dB** soundproofing blankets perfectly fit the shapes of geometrically problematic equipment to ensure maximum efficiency.

** A system and a method of attaching and supporting sound reduction or thermal insulation blankets to metallic machinery or structural frames. ID: 773/12562.35*

AN OUTSTANDING PARTNER

Developed in collaboration with our insulation partner, **Isotex-Pro International (IPI), ISOTEX-dB** soundproofing blankets ensure impeccable quality.

IPI

SPECIFICATIONS

Transmission Loss						
125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	STC
14	22	29	39	41	38	33

Assessed according to ASTM E2249-02 (2016)

Absorption Coefficients						
125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	NRC
0.52	0.76	0.83	0.73	0.54	0.41	0.72

Assessed according to ASTM C 0423 (2002)

Environmental	
Temperature	-40 °C to 149 °C (-40 °F to 300 °F)*
Water	Water Repellent

*High-temperature resistant and spark resistant versions are available

Physical	
Thickness	100 mm (4")*
Area Density	16.1 kg/m^2 (2.4 lbs/sqft)

*50 mm (2") thickness are available.

Options and Accessories	
Fastening	Velcro, Hem or Eyelet
Mounting	Custom Aluminium Frame and Hardware available
Sealing	Velcro Sound Barrier Strips

Contact Us

USA
Columbus, OH
Houston, TX
(614) 290-9791

Canada
Cambridge, ON
(519) 651-3330

Technical Support
info@dbnoisereduction.com

Sales & Estimating
sales@dbnoisereduction.com

www.dbnoisereduction.com

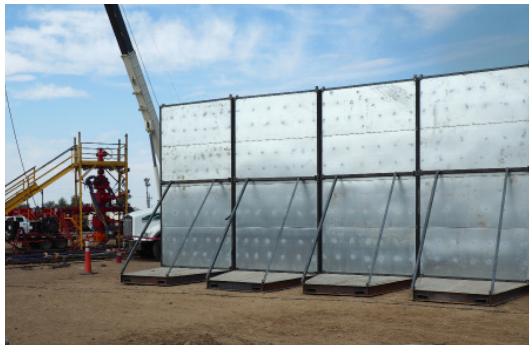
Soft dB

ENVIRONMENTAL
NOISE CONTROL

FREESTANDING SK-8 NOISE CONTROL PANEL

PORTABLE LOW FREQUENCY NOISE BARRIER/ABSORBER PANELS

The freestanding, portable SK-8 acoustical panels are **engineered** for **quick** positioning close to noise sources and are designed for maximum **low frequency** sound blocking and absorbing. Structurally engineered to be **freestanding** and meet regulatory code requirements. Heights available from 16 to 24 feet with accommodations for doors, gates, truck loading and emergency exits.




SK-8 BARRIER PANEL SPECIFICATIONS

- Sound Transmission Class rated STC-43 in accordance with ASTM E-413
- Sound Absorption Rating of N.R.C. 1.00
- Engineered to meet UBC/IBC Wind Load requirements
- Panels available with emergency exit signs and doors
- Sizes: 8 feet wide by 16 to 24 feet high

Learn more about commercial noise control at
www.environmental-noise-control.com or call us at **1-800-679-8633**

TEMPORARY ACOUSTICAL NOISE BARRIER SYSTEMS

Designed to provide optimum sound control in blocking and absorbing unwanted noise.

ENVIRONMENTAL

ENTERTAINMENT

CONSTRUCTION

INDUSTRIAL

OIL & GAS

FREESTANDING SK - 8 NOISE BARRIER PANELS

At the heart of our freestanding sound wall is our Environmental Noise Control (ENC) acoustical noise barrier panel system, which is manufactured with state-of-the-art acoustical composite materials. Our proprietary SK-8 sound panels are fabricated with a galvanized steel exterior, absorptive acoustical insulation with a septum barrier and perforated metal panels. The ENC SK-8 temporary sound wall system is available in 8 feet wide modules with heights of 16, 20 or 24 feet.

Freestanding SK-8 Sound Panel System

Sound Transmission Loss (dB)	
% Octave Band Center Frequency	Transmission Loss
31.5 Hz	21
63 Hz	14
125 Hz	26
250 Hz	32
500 Hz	28
1000 Hz	51
2000 Hz	60
4000 Hz	67
STC	43

The modular design of ENC's temporary SK-8 sound panel system is engineered to **meet or exceed** UBC and IBC code requirements.

An independent acoustical laboratory has conducted tests in accordance with ASTM E-90 and ASTM E-413 requirements to measure sound transmission loss and to validate a Sound Transmission Class rating of STC-43 for the SK-8 panel. The ENC SK-8 panels meet or exceed the specifications in the Sound Transmission Loss Data Table.

1 (800) 679 8633 | International +1 310 679 8633 | www.environmental-noise-control.com

CORPORATE OFFICE
Hawthorne, CA

REGIONAL OFFICES & FIELD OPERATIONS
Aledo, TX; Carson, CA; Longmont, CO
Napa, CA; Shreveport, LA; McDonald, PA
Calgary, Alberta

For more information on our quality products or possible applications, please see our website or call to speak with one of our ENC representatives. Rapid engineering and deployment response is available worldwide.

Behrens & Associates, Inc.
Environmental Noise Control

ENVIRONMENTAL
NOISE CONTROL