BC Wildlife Federation: Noise Management for Outdoor Shooting Ranges

Research and Findings

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Prepared for:

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1.0 Executive Summary

Currently there are no standards established in Canada for shooting ranges to refer to when considering noise management. This is an issue that needs to be addressed, as noise complaints are becoming a more common occurrence that can result in a range being closed down.

A common misconception is that the "common law" applies, i.e., new comers have to adapt to those who were there first. This not the case. "A landowner does not retain vested rights when a neighbourhood changes – he must comport himself with the character of the neighbourhood as it evolves" (ref. Milne v Salt Spring Island Rod and Gun (SSIRG). The common law defence was done away by statutory amendment to the Land Title Act in 1971.

The BC Wildlife Federation has undertaken this study to share processes, best practices, and mitigation measures that may provide options and solutions that can be used on a country-wide basis.

This report reviews a variety of suggestions on how to deal with noise complaints and issues management for shooting ranges. The information herein was compiled from various academic reports, with many of the suggested standards being taken from other countries, such as Sweden and the United States, that have already established effective noise management criteria.

It is recommended that sound levels at the property line of your gun range do not exceed 65 dB(A) in an urban or suburban residential area.

Suggested sound levels may vary slightly depending on what category of district your range shares a border with, e.g. -

- 1. during the daytime :
 - a. 60 dBA when received at a point of reception in a Quiet District;
 - b. 65 dBA when received at a point of reception in an Intermediate District;
 - c. 70 dBA when received at a point of reception in an Activity District
- 2. during the nighttime:
 - a. 55 dBA when received at a point of reception in a Quiet District;
 - b. 60 dBA when received at a point of reception in an Intermediate District;
 - c. 70 dBA when received at a point of reception in an Activity District

d. When approaching this issue, shooting ranges need to consider a number of different things. What are the sound levels being produced from your range, and are they within the recommended standards.

At no time should your range result in noise level in excess of 140 dBA at the property line – the level at which permanent hearing damage occurs.

If levels are not within the recommended standards, there are options for reducing sound levels to acceptable levels, be it through natural or engineered techniques. The techniques suggested in this report are listed below, and will vary widely depending on your situation.

- 1. Proactive and continuous public relations efforts
- 2. Restriction of certain firearm usage
- 3. Reduction of range operating hours
- 4. Range layout alterations
- 5. Engineered sound barriers
- 6. Sound attenuating materials (QBO blankets)
- 7. Natural barriers
- 8. Baffle systems
- 9. Tube ranges
- 10. Suppressors

The bottom line is that there are solutions to managing this issue. There are costs associated with every method, and what makes sense for your range will vary depending on your situation. Taking action before the unwanted happens could end up ensuring the future of your shooting range.

2.0 Introduction

This report aims to set the preliminary standards and best practices for managing noise at Canadian outdoor shooting ranges, in addition to providing resources on information regarding the various technologies available that assist in achieving the recommended standards. With the help of the information within this report, shooting ranges across Canada will be able to reduce noise levels at property lines bordering inhabited areas to 65 dB or lower, and 140 dB or lower at property lines bordering uninhabited areas.

The issue of public encroachment on outdoor shooting ranges is a very present issue in the lives of those associated with gun clubs today. Increasing amounts of people are moving from cities to the countryside where the majority of outdoor shooting ranges are in operation. Despite the fact that the majority of these ranges have been in operation for many years before any of public took up residence in the area, it is still within an individual's legal boundaries to register noise complaints against the sounds coming from shooting ranges. There have been an increasing amount of cases resulting in the involved gun clubs ceasing operations.

Although this report focuses on noise mitigation techniques at outdoor shooting ranges, proper noise management at both outdoor and indoor ranges is an incredibly important thing for both the safety of those engaging in shooting activities, as well as those being affected by the noise output created from shooting sports.

In addition to protecting the hearing of members and staff, as well as the peace and privacy of neighbors, taking action to ensure gun clubs are not forced to shut down in turn promotes safer and more environmentally conscious sporting. For those engaging in hunting activities, improving accuracy is typically only achievable through practicing at shooting at ranges. Proficiency with a firearm is fundamental to ethical hunting, as poor accuracy may result in the unnecessary wounding and loss of an animal.

Ranges are also important for public safety, as law enforcement also heavily rely on shooting ranges to practice shooting and improve accuracy and familiarity with their firearms.

This study was undertaken in hopes to prevent any further closures of ranges due to noise complaints, so that future generations of shooting enthusiasts can enjoy and safely engage in their activities, and so that law enforcement will continue to have access to facilities that will allow them to improve and maintain skills essential to their duties.

This report was prepared by Michael T. Smillie, a 4th year bachelor of commerce student at the University of Victoria recruited by BC Wildlife Federation to conduct research and report on the issue at hand.

3.0 Noise Standards

Currently Canada does not have any standards established for noise management at outdoor shooting ranges. What this report hopes to accomplish is to create a set of preliminary standards and best practices that can be implemented country wide: based on academic research and benchmarked against various countries around the world that already has standards in place.

Noise can be an issue at any outdoor shooting range for both those using the range facilities and the residents living in the surrounding area. Ensuring that noise levels on ranges and the surrounding area are within their legal or socially acceptable limits could save a gun club from being forced to cease operations.

Noise levels are typically measured in decibels (dB), which is the basic unit of level in acoustics. A change in power by a factor of 10 corresponds to a 10 dB change in level, which to the human ear is either twice as loud, or half as loud, the formula being dB=10 log10[w2/w1]. An assessment of categorized noise exposure levels in decibels is below.

3.1 Distance and Sound Propagation

Sound spreads spherically from the source, and dissipates at a rate of 6 dB each time the distance from the source is doubled. For each 6 decibel reduction, there is also a 50% reduction in sound pressure and a 75% in sound intensity of the initial value. That being said, when developing a range or modifying an existing one it is important to keep in mind that distance can be one of your greatest assets when it comes to noise management. Something as simple as buying land adjacent to you can significantly help in reducing noise complaints.

Additional reductions in sound levels can occur depending on surrounding environmental factors. For example, a soft surface such as a grass-covered field creates a reflection that interferes with the sound going in a straight line from the source, resulting in as much as a 25 dB reduction.

The weather also has a significant effect on the way sound travels. Due to the fact that under most weather conditions wind and temperature vary with height above the ground, the vertical gradients cause the speed of sound to also vary with height. It is also important to note that sound levels can be increased or decreased depending on atmospheric conditions, and therefore could differ on a daily basis even if the source remains the same.

3.2 - Noise exposure levels (dB) and standards

Below is a brief example of how different sound levels are heard by the human ear. A list of sound descriptors that can help associate decibel levels with more common noise occurrences can also be found in the appendix.

10-50 dB moderate to faint 60-90 dB loud to very loud 100-110 dB threshold of discomfort 110-120 dB threshold of pain 130-140 dB loudest recommended exposure with hearing protection 150+ dB painful acoustic trauma

Refer to appendix 9.1 for further details on sound descriptors.

Canada does not currently have any standards in place for noise management at outdoor shooting ranges; however we can look at existing American and European standards to gain an idea of what is being used globally. In America, the U.S Environmental Protection Agency has established guidelines stating that a source that does not exceed a yearly day-night level of 55 dB(A) is acceptable. While it varies slightly per country, European noise standards are typically between 55 and 65 dB(A) at the property line.

It is recommended that sound levels at the property line of your gun range do not exceed 65 dB(A) in urban and suburban residential areas.

Consulting with your provinces Ministry of the Environment will provide you with province-wide legislation, and each municipality will have their own noise by-laws and/or discharge of firearms by-laws. For example, the city of Victoria has the following permitted noise levels. (An "activity district" - typically areas permitting the highest noise levels within city limits):

- 1. during the daytime:
 - a. 60 dBA when received at a point of reception in a Quiet District;
 - b. 65 dBA when received at a point of reception in an Intermediate District;
 - c. 67.5 dBA when received at a point of reception in a Harbour Intermediate District;
 - d. 70 dBA when received at a point of reception in an Activity District

- 2. during the nighttime:
 - a. 55 dBA when received at a point of reception in a Quiet District;
 - b. 60 dBA when received at a point of reception in an Intermediate District;
 - c. 60 dBA when received at a point of reception in a Harbour Intermediate District;
 - d. 70 dBA when received at a point of reception in an Activity District

Refer to appendix 9.2 for additional examples of sound limits.

3.3 Legalities and Regulations

A common misconception is that the "common law" applies, i.e., new comers have to adapt to those who were there first. This not the case. "A landowner does not retain vested rights when a neighbourhood changes – he must comport himself with the character of the neighbourhood as it evolves" (ref. Milne v Salt Spring Island Rod and Gun (SSIRG). The common law defence was done away by statutory amendment to the Land Title Act in 1971.

The "Order after Application" in Milne v SSIRG, requires that "The defendant will implement sufficient controls to limit outdoor range shooting noise to **no more than 50 decibels at the plaintiff-defendant property line**, and will prohibit any shooting reasonably expected to exceed that limit". This is more stringent than the RCMP recommended guidelines. Note, SSIRG are appealing this and a number of other items in the Order.

A defence not raised in the Milne v SSIRG was the defence of legislative authority (Lacombe Decision). If a nuisance has been legislatively authorized, in very strict circumstances, no liability for nuisance by that activity is imposed. It might have been argued that the grant of the permits to operate a gun club by the Federal Government provided the Legislative authority to support this defence. It is by no means certain that this defence could be successful. Note, some US States provide immunity (subject to conditions) from noise pollution, e.g. Vermont.

Please refer to section 10.5 for further information regarding the Lacombe decision.

As previously stated, it is within a citizen's legal right to move into the proximity of an existing shooting range and file complaints regarding noise or other environmental issues. This has, and will continue to jeopardize the future of outdoor shooting ranges unless preventive action is taken. It is important for ranges to comply not only for the legal requirements, but also to remain in good standing with their neighbors. Ranges

must accommodate themselves to their changing neighborhoods, as their pre-existence is simply not enough.

Below is a table showing the maximum permitted exposure level for an 8 hour period of continuous noise, and the maximum peak pressure level permitted for British Columbia's noise regulations. Levels established by the remaining provinces can be found in appendix 9.1 of this report.

Jurisdiction	Continuous Noise*		Impulse / Impact Noise*
(federal, provincial, territorial)	Maximum Permitted Exposure Level for 8 Hours: dB(A)	Exchange Rate dB(A) +	Maximum Peak Pressure Level dB(peak)
British Columbia	85	3	140

Refer to appendix 9.3 for remaining provincial levels.

While the above table can help with establishing basic targets to aim for in noise levels, the peak sound level created through a firearm discharge is an impulse noise event. Due to the nature of an impulse noise event, a defensive response to "sudden or threatening stimuli" is triggered, adding to discomfort and annoyance.

3.4 - Post Assessment

After assessing what noise levels your range is required to remain within, sound testing will need to be conducted to measure the levels currently being produced. Typically an acoustical engineer would be brought in to conduct the testing in order to achieve the best results. If hiring an engineer is not feasible for your gun range, there are various sound level meters available for purchase that can achieve the same if not similar results through companies like ITM Instruments. If purchasing your own sound level meter, you must ensure that the decibel range it covers is applicable to noise coming from a shooting range. The models of these devices which are capable of reading firearm discharge levels can often reach up to \$2000 in price.



("ITM Instruments Inc.", 2016)

For dealing with noise complaints, sound levels should be measured from various locations on the range, although the sound level exposure limits apply to sound that carries to the edge of the property. This might also be a great opportunity to test for levels close to the source of the noise in hopes to make range use safer for both members and staff.

Avoiding hearing damage is an easily achievable feat that should not be overlooked, and ensuring that noise levels at the source are within safe limits (with or without hearing protection) should be a necessity at every range for the sake of those working and enjoying its use.

Monitoring the sound levels coming from your shooting range should be done on a consistent basis. Annual testing is recommended to ensure there are no drastic fluctuations in levels. It is also recommended to perform testing during peak hours, after any structural changes occur to the range, and during any special events or competitions. It is also a good idea to perform testing while relatively loud firearms are being used, such as a .338 Winchester. Keeping continuous logs of test results will assist in keeping track of any significant changes, in addition to showing a pro-active approach to sound management.

Once sound levels have been measured, the range will either be deemed within the standard sound level limits set in this report or not. If levels are too high, actions must be taken in order to produce a reduction in noise levels significant enough to fall within the standardized requirements for your province. A number of approaches to sound mitigation techniques applicable to this situation have been assessed in the following sections of this report.

4.0 - Noise Mitigation Solutions

The information on the various alternatives presented below was retrieved from a variety of academic based resources all included in the references of this document. The information was retrieved between January 5th 2016 and March 16th 2016. Noise mitigation alternatives may be either: 1) administrative, controlling noise emission sources, or 2) technical, providing engineered noise controls. In addition, there is a distinction between options that are more likely to be effective in the short term and in the long term.

4.1 - Proactive and Continuous Public Relations Efforts

Completely eradicating noise on a shooting range is simply not possible with our current resources. Therefore, proactively maintaining good relationships with your neighbors, those sharing the sounds coming from the gun range with club members, is an extremely important interaction that can assist in preventing noise complaints. Below are a number of options that may help to assist with your ranges public relations efforts.

- 1. Invite members of the community to voice their concerns directly to the club
 - a. Let's community members feel like they have some sort of control, and that the club is willing to listen
- 2. Display and communicate community efforts
 - a. Youth training courses
 - b. Shooting competitions translate into money for the community
- 3. Notify the public of events (especially particularly loud events) prior to the event date
- 4. Keep member logs of when and what they shoot
 - a. Other shooting activity in the area could be being blamed on the range
- 5. Encourage law enforcement to actively use the range
 - a. Promotes public safety and well-being

4.2 - Restriction of Certain "Loud Guns" or Attachments / Reduction on Firearm Discharge Time

4.2.1 - Restriction of Certain Firearms

One of the easiest solutions to reaching a common ground with neighbors complaining of noise issues is to simply restrict the use of certain firearms or reduce the hours available for club members to shoot.

Refer to appendix 9.4 and 9.5 for a comparison of different firearm noise levels.

The engineering behind firearm design allows for diversity in the noise expulsion levels of differing makes of guns. It is inevitable that certain guns will be much louder than others, and therefore cause more of a public disturbance in the surrounding areas. The restriction of these types of firearms may help in reducing irritating noise for gun club neighbors.

Taking this route may help to reduce noise exposure to neighbors, however there are a number of problems that arise. The noise emissions from individual firearms varies from several factors such as barrel length, firearm weight, cartridge load, barrel compensators or muzzle brakes, and bullet weight (affecting muzzle velocity). It is not possible for a range officer to estimate, by cursory inspection, noise emissions of any particular firearm and cartridge combination. For safety reasons, firearms must be, and remain, put away during check-in, and may not be taken out until they arrive at the particular range.

AR style semi-automatic rifles, now very popular with shooters, often are fitted with a muzzle brake. This brake reduces the recoil of the firearm to make the shooter more comfortable, accurate and stable for subsequent shots. Muzzle brakes, however, also change the directivity of the muzzle blast noise emission, turning it back on the shooter and propagating less noise downrange. Therefore, measuring noise at the shooting station from a muzzle brake firearm would register a louder noise level while actually providing a lower noise level downrange in the community area.

The same phenomenon occurs with certain pistols equipped with compensators, essentially the same devices as muzzle brakes but for pistols instead of rifles. Noise monitoring may not be effective because it is difficult to isolate noise emissions from a single firearm amidst a line of shooters firing nearly simultaneously. Special considerations could be made for firearms such as a .338 Winchester, as the impulse noise level it produces is significantly higher than many other firearms available for use in Canada.

4.2.2 - Reduction in Shooting Range Hours

Another solution is to reduce the hours in which members can discharge their firearms on the range. Simply allowing access to the range 1 or 2 hours later in the morning and/or 1 or 2 hours earlier in the afternoon may assist in reducing noise complaints by providing more quiet time in the morning and in the afternoon when many might like to be outdoors barbequing or enjoying the quiet.

Another option in this category is to restrict specific ranges (those that are more difficult to provide sound attenuation solutions for such as trap ranges) to shortened and/or specific hours. While this option does not directly change overall noise levels, it may help in finding a common ground with those who share the noise. It would be very beneficial to include both neighbors being affected by the shooting range noise and gun club members in a discussion on when the most optimal times for both parties are for shooting activities.

4.3 - Range Layout Alterations

4.3.1 – Directional

The layout of a shooting range can have a dramatic effect on the sound levels that carry into surrounding areas. When discharging a firearm the noise generated from the muzzle blast propagates spherically in all directions, and is approximately 10-15 decibels louder when heard in front of the gun (the direction of firing). Whether your gun club is in the design phase or already fully operational, ensuring that the direction of firearm discharge on all ranges on the property is pointing away from the surrounding public to the best of your abilities can be a simple fix, or at the very least a feasible step in the right direction.



("Capitol City Rifle & Pistol Club | Shooting Range", 2016)

This could be the most simple, straightforward, and affordable fix if your range doesn't already have this in place. Quite often it can be accomplished by the staff of the range itself, or with minimal expenses of hiring an excavator to build simple dirt berms for bullet containment.

4.3.2 - Submerged Range

Creating a natural barrier by means of submerging a range can assist in keeping noise levels down. Simply by hiring an excavator and lowering the depth at which the club members are shooting from creates natural earth barriers that reflect and absorb noise. This option is on the less expensive side of the spectrum when it comes to noise attenuation techniques, while still remaining moderately effective.

4.4 - Barriers and Sound Attenuating Materials

4.4.1 - Barriers

Installing engineered barriers in order to create natural dirt barriers can assist in the efforts of mitigating noise by redirecting and absorbing sounds made from shooting sports. Barriers can come in a variety of forms, from high walls to surround an entire

gun club, to walls surrounding specific ranges or firing sheds for members to shoot from. Barriers are typically effective in reducing high frequencies by 10-15 decibels and low frequencies by 2-5 decibels.



("Sound Barriers Diagram and Technical Information", 2016)

While placing barriers close to the source of receiver is very effective, the most significant reductions in noise levels occur when barriers are placed close to the shooter. Walls surrounding entire gun clubs or individual ranges are relatively far from many shooting positions, and therefore are less effective in reducing both the noise from the muzzle blast and the supersonic projectile shockwave created from a gunshot.

Building a firing shed out of noise attenuating materials and placing smaller barriers between shooter locations is the best approach to both reducing noise carrying to gun club neighbors, and improving range safety and communication for members.



("Shooting Ranges | Shoot Houses | Range Systems", 2016)

4.4.2 - QBO Blankets

Lining existing firing shacks or building simple new ones to line with a sound attenuating material such as QBO sound blankets is also a more affordable option. The blankets are used to combat outdoor stationary noise, and protect neighbors from excessive decibel levels. These blankets have been tested to collapse up to 90% of the noise that is sourced from within them. The blankets can be ordered in various sizes, starting at \$320 for 1 4x6 blanket, and ranging up to \$1080 for 1 4x20 blanket. The QBO blankets can also be cut to size to fit your scenario.



("QBO Sound Blankets | Acoustic Materials - Soundproofing by Netwell Noise Control", 2016)

4.4.3 - Trees and Vegetation

Trees and vegetation can act as natural sound barriers in the right circumstances. Trees scatter and absorb sound with the effectiveness directly correlating with density. Foliage absorbs the high frequencies with low frequencies being reduced through ground absorption. The branches and trunk of the trees scatter sound. Studies have shown noise reductions between 3 and 30 decibels per 100 meters of dense forest. If you are considering locations for the creation of a new range, this is something that should be taken into consideration. Existing ranges are either subject to what they currently have in regards to surrounding vegetation, or they will need to transplant new trees.



("NPC Online Library: Highway Traffic Noise", 2016)

4.5 - Baffle Systems and Tube Ranges

4.5.1 - Baffle Systems

Baffle systems essentially reflect and absorb sound. When discharging a firearm, the sound hits the baffles and is reflected upwards, or hits sound-absorbing surfaces several times before it reflects back towards the shooter. Reflections from baffle systems can produce louder sounds behind the shooter than the direct sound due to the directivity of the muzzle blast. Most often, the majority of this sound results from the interaction with the first baffle. Therefore, mitigating noise on the first baffle will reduce the loudest event, which has been correlated to complaints.



("No Blue Sky?" 2015)

Equipping your shooting range with a variety of engineered baffles and/or barriers may be on the more expensive side of things when it comes to noise mitigation techniques, often costing upwards of \$100,000 per individual range for a full "no-blue-sky" setup. However, the positive effects brought on in the form of both sound management and shooting safety are well worth the investment if it is within your budget.

Material usage when designing and building baffles or barriers is a very important consideration, as it will have an effect on the significance of your sound reduction, as well as other safety hazards. Materials such as rubber or fiberglass are not "acoustical" materials, and contribute to fire hazards or mold and mildew growth.

Companies such as Troy Acoustics have looked into combatting this with their "Portland Cement Wood Fiber Board", which has a 0 flame spread and 0 smoke developed fire rating, as well as significant effects on noise reduction.

The example venetian blind absorber depicted below is a series of reflector plates, 4 feet wide at a 45-degree angle. The panels can be constructed of 3/4-inch pressure-treated plywood covered with 2-inch fiberglass boards (6 pounds per cubic foot). Sound is reflected upward or hits sound-absorbing surfaces several times before it reflects back toward the shooter. This particular baffle system is designed for a 10 dB reduction or 50-percent loss in volume.



(Hansen, 2016)

See Appendix 9.6 and 9.7 for examples of a covered shooting structure design and typical baffled range layout.

4.5.2 - Tube Ranges

Tubes, or muzzle blast mufflers, are a relatively new approach to sound mitigation techniques. They have been tested in the United States and Switzerland, and have been shown to reduce muzzle blast volume by 10 - 20 decibels. This technique does not succeed in abating the projectile shock sound; however reducing the muzzle blast also decreases the noise level exposure for adjacent shooters, limiting the potential for hearing damage. If shooting from a firing shack or similar structure, this option is relatively simple and cheap to do on your own.



("Calton Moor Range - Target Shooting & amp; Informal Long Range Shooting Practice", 2016)



("backyard indoor gun range - Saubier.com", 2016)

4.6 - Suppressors (Long-Term, Highly Effective)

Suppressors are quite possibly the most effective, practical, and feasible method of sound mitigation at outdoor shooting ranges, the only catch being that they are currently illegal in Canada. Many other countries around the world take a different approach to silencers, often promoting or even requiring their use.

Currently in America they are legal to purchase in 41 states after meeting certain requirements such as age restrictions, paperwork, and background checks. The process often can take up to 12 months.



("Carbon Fiber Suppressors - Shooters Depot", 2016)

Suppressors (or silencers) act as containment systems with a series of baffles that help contain and re-direct the expanding gasses that exit the end of a firearms barrel when it is discharged. These devices have incredible benefits for shooting sports, removing the need for additional ear protection such as muffs or plugs. This is turn makes shooting safer, improving the ability for compliance with instruction and range safety commands. Suppressors also increase shooting accuracy through reduced recoil of up to 50%, and reduction of "noise anticipation" which causes shooters to tense up or flinch before a gun is fired.

The only negative aspect of suppressors is the fact that many people think suppressors increase the potential for crime-related gun use. This is a pre-conceived notion brought on by the way suppressors are depicted in movies and television shows. In actuality there are very few crimes committed with the use of a suppressor. In a study done in California between 1995 and 2005, it was shown that 0.00006% of felonies and 0.1% of armed robberies committed in the state involved the use of a suppressor. Suppressors also make a firearm longer, heavier, and more difficult to conceal, making it less desirable for criminal activity.

The vast majority of military and law enforcement professionals I have spoken with agree that the fear and concern for suppressor use is unfounded, and support efforts to remove restrictions on the use of suppressors for hunting and use at shooting ranges. Many European countries such as France, Finland, Norway, and Sweden promote or even require their use while engaging in shooting activities for their numerous benefits.

It is highly recommended that some sort of collaboration with the federal government in regards to the legalization of suppressors be undertaken whenever possible. Adopting their use as a standard in Canada is the best all-around technique to sound abatement.

According to the National Institute for Occupational Safety and Health (NIOSH), any exposure to noise over 140db causes immediate and irreparable hearing loss. Unsuppressed handguns and rifles generally create a muzzle report well above this threshold. Gunfire noise is a "preventable" occupational risk and an unnecessary liability. A suppressor can protect against hearing loss.

5.0 - Recommended Best Practices and Standards

It is recommended that every outdoor shooting range have sound testing done to assess the levels coming from their range, and to ensure that they are within the standards recommended within this report (65 dB at the property line, averaged from the standards on noise in a quiet district vs an activity district in Victoria), however if

levels can be reduced even further it would only have positive effects on public relations.

Once sound levels have been tested, the recommendations for reducing those levels entirely depend on your budget. Range layout alterations are the easiest to undergo, and one of the less expensive methods. It is recommended that all outdoor shooting ranges ensure that the direction of firearm blasts are pointed away from the general public. If this is not the case, simply hiring an excavator to make the physical changes is a relatively inexpensive method, and can be done in a very short amount of time.

The most effective sound mitigation method is to have the entire range outfitted with baffles, barriers, and firing sheds. This method is also the most costly, often ranging into the hundreds of thousands of dollars depending on range size. This option is highly recommended if it is within your budget. If money is an issue, constructing firing sheds and lining them with sound attenuating materials such as the QBO blankets shown in the previous section is more inexpensive, yet still effective approach.

Finally, it is highly recommended that outdoor shooting ranges make public relations and community engagement a priority. Offering benefits to neighbors such as free or reduced membership prices, or instructional sessions on shooting practices can significantly help to reduce neighbor irritation, and may prevent the occurrence of noise complaints. Encouraging law enforcement to make use of your shooting range is also an effective method to increase perception of your range in the public eye, as it is assisting in the protection of the public.

6.0 - Issues Management

Please heed the following considerations and questions should your range receive a sound complaint.

- 1. Who is the complainant? Can it be worked out? Can you give the complaining person a club benefit? Do they want to belong to the club? Can you give them free membership?
- 2. Is the club violating a noise ordinance? Is the shooting in early morning or at night? What are your Sunday and holiday schedules?
- 3. The following information applies to when a noise ordinance is involved.
 - a. What does the preamble say? For example, does the ordinance control certain types of noises from a particular emitter zone only during certain hours?

- b. Are there exemptions that fall under the category of "recreation, shooting and training"? Please note the importance of your range name. Mention ranges or shooting in your range/club's purpose statement or bylaws or include words such as "...for all other purposes consistent with law...."
- c. Are quantitative, described levels specified? Without a specific level, an ordinance is too vague or subjective.
- d. If quantitative levels are not established, does the ordinance define such words as hazardous, objectionable or nuisance? Be careful when subjective words are used. Some people apply their own value judgements to ranges. When this happens, difficulties arise in defending sound issues.
- e. Does the ordinance specify the scale, mode, location for measurement, hours of the day, time weighted average (TWA), noise zones or other information pertinent to decibel testing?
- 4. What to do when no noise ordinance exists
 - a. Since there is no violation of law, range officials who might otherwise conduct testing are at a disadvantage. Without standards prescribed by ordinance, range officials may not know:
 - i. what mode or scale to use on the test meter.
 - ii. what type of meter to use.
 - iii. who to share the results with once they have conducted the test.
 - iv. whether the results will be interpreted as a/an:
 - 1. hazardous level.
 - 2. nuisance level.
 - 3. objectionable level.
 - 4. area where a Time Weighted Average applies.

Having a plan on how to deal with noise complaints before they occur is an ideal tool for any range to implement, and should be taken very seriously. Conducting a SWOT analysis can help in managing what your range's current situation is in regards to positives and negatives.



("Stock Images similar to ID 185217368 - swot business infographic", 2016)

When speaking with those who are complaining about the noise levels coming from your shooting range, ensure that you are speaking professionally and courteously at all times. Standardizing responses and letting them know how seriously you take noise management can benefit the relationship between you and your neighbors immensely. Filling them in on your pro-active approach to noise management and consistent noise level monitoring displays good intentions and a commitment to maintaining a good relationship.

7.0 - Conclusion

A variety of noise mitigation alternatives have been assessed in regards to addressing the issue of noise management at outdoor shooting ranges in Canada. Both administrative and engineered alternatives have been evaluated and described in the above sections of this report. Certain alternatives may be better suited depending on range location, terrain, extent of noise management issues etc.

Shooting ranges should conduct sound level measurements at property lines to ensure they are within the recommended standards of approximately 65 dB(A) in a continuous noise form. As for sound reduction techniques, the greatest potential for a simple and effective solution is to pursue the removal of restrictions on suppressor use in Canada, however this will also take the longest to achieve. It is highly recommended that efforts are made to work with the federal government towards to legalization of suppressors. The most effective option currently available for both noise mitigation and safety would be to have your entire range outfitted with baffles, barriers, and firing shelters. This approach is on the costlier side of the proposed options, however if it is within your budget the benefits would be extremely significant. Companies such as Troy Acoustics and Range Systems can provide these services. If an approach requiring less financial investment is necessary then simple range layout alterations, simple barriers positioned properly for noise reflection, or use of sound mitigating QBO blankets could be a better option. However, it is of my opinion that a combination of these techniques suited to specific ranges would be most effective.

The bottom line is that sound needs to be carefully managed. Sound tests must be taken at various locations on and around the range. Once sound levels are measured, a plan can be developed using natural or manmade objects to assist in attenuating sound. Remember when dealing with complainants about noise: In the absence of a noise ordinance, range officials will be on the range to prove that their noise emissions are reasonable.

8.0 - Glossary

Acoustics: (1) The study of sound, including its generation, transmission, and effect. (2) The properties of such areas as rooms and theaters, which have to do with how clearly sounds are transmitted and heard in it.

Activity District: An area such as a public park that is available for use to the general public for various types of activities.

A-Weighted Sound Level (La): Sound pressure level, filtered or weighted to reduce the influences of the low and high frequency noise. It was designed to approximate the response of the human ear. Noise is measured on a dBA scale. Small arms fire is generally measured on the A weighted scale and impulse response mode.

Baffle: A shielding structure or series of partitions which reduces noise by lengthening the path of sound transmission between source and receiver.

Continuous Noise: Noise which remains constant and stable over a given time period

Daytime: The hours between 7 a.m. and 7 p.m.

Decibel (dB): In layman's terms, the unit used to measure the relative loudness or level of a sound. The range of human hearing is from 0 to 140 decibels.

Evening: The hours between 7 p.m. and 10 p.m.

Impulsive Sound: Noise with an abrupt onset, high intensity, and short duration typically less than one second and often rapid changing spectral composition.

Nighttime: The hours between 10 p.m. and 7 a.m.

Noise: Any unwanted sound, and by extension, any unwanted disturbance within the frequency band. Sound that is loud, disagreeable, untimely or unwanted

Noise Level Reduction: The amount of noise level reduction achieved through the incorporation of noise attenuation in the design and construction of the structure.

Peak Sound Pressure: The maximum instantaneous sound pressure (a) for a transient or impulsive sound of short duration, or (b) in a specific time interval for a sound of long duration.

Quiet District: An area such as a community of residences in which the well-being and privacy of the people living there needs to be respected and taken into consideration when it comes to noise levels.

Sound: A vibratory disturbance in the pressure and density of a fluid or in a solid, with frequency in the approximate range between 20 and 20,000 htz, capable of being detected by the organs of hearing.

Sound Level: The weighted sound pressure level obtained by use of a sound level meter having standard frequency-filter for attenuating part of the sound spectrum.

Sound Level Meter: An instrument, comprising of a microphone, an amplifier, an output meter, and frequency-weighting networks. Sound level meters are used for the measurement of noise and sound levels in a specific manner.

Sound Pressure: (1) The minute fluctuations in the atmospheric pressure which accompany the passage of a sound wave. The pressure fluctuations on the tympanic membrane are transmitted to the inner ear and give rise to the sensation of audible sound. (2) For steady sound, the value of the sound pressure averaged over a period of time.

Sound Pressure Level (SPL): In dB, 20 times the logarithm to the base 10 of the ratio of the pressure of this sound to the reference pressure. The reference pressure shall be explicitly stated. The following reference pressures commonly used are:

- (1) 20 micropascals (2x.0001 microbar) [20 micro newton/meter squared]
- (2) 1 microbar
- (3) 1 pascal

Suppressor: Also known as a silencer; a firearm extension that assists in recoil reduction, accuracy, and noise mitigation.

Yearly Day-Night Average Sound Levels (DNL): The 24-hour average sound level, in decibels, for the period from midnight to midnight. Day night averages are obtained after the addition of ten decibels to sound levels for the periods between midnight and 7 am and between 10 pm and midnight, local time, as averaged over a span of one year. It is the standard metric of the Federal Aviation Administration for determining the cumulative exposure of individuals to noise.

9.0 – Appendices

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9.1 - Example of sound level descriptors

This table displays descriptions of various sound sources and their pressure levels in decibels.

Sound Pressure Level (dB)	Description of Sound Source	Subjective Evaluation
140	Jet engine	Deafening
130	Jet during takeoff (300 ft. away)	Painful
120	Rock concert	Onset of pain
107	Air hammer	Temporary hearing loss
100	Crowd noise at a football game	Very loud
92	Heavy city traffic	Very loud
80	Alarm clock	Very loud
70	B-757 aircraft cabin during flight	Loud
65	Busy restaurant	Loud
60	Conversational speech	Moderate
50	Window air conditioner	Moderate
34	Soft whisper	Faint
20	Rustling leaves	Very faint
10	Human breathing	Very faint

9.2 - City of Calgary Noise Bylaws

Below is a section of the noise level bylaws for the city of Calgary, as compared to the example of the City of Victoria included in the body of the report.

These activities are allowed during the "daytime," meaning:

- (a) beginning at 7 a.m. and ending at 10 p.m. of the same day, Monday to Saturday; or
- (b) beginning at 9 a.m. and ending at 10 p.m. of the same day, Sunday and holidays.

Under the bylaws, you cannot cause (or permit to be caused) a continuous sound that exceeds:

- (a) 65 decibels (dBA) measured over a one (1) hour period during the day-time; or
- (b) 50 decibels (dBA) measured over a one (1) hour period during the night-time;

Under the bylaws, you cannot cause (or permit to be caused) a non-continuous sound that exceeds:

- (a) 85 decibels (dBA) measured over a period of 15 minutes during the day-time; or
- (b) 75 decibels (dBA) measured over a period of 15 minutes during the night-time;

Fines for violations of these regulations range between \$50 and \$200.

9.3 - Continuous noise / Impulse noise limits per province

This table displays the noise level limits for continuous and impulse noise levels on a provincial and country wide basis.

	Continuous Noise*	Impulse / Impact Noise*	
Jurisdiction (federal, provincial, territorial)	Maximum Permitted Exposure Level for 8 Hours: dB(A)	Maximum Peak Pressure Level dB(peak)	Maximum Number of Impacts
Canada (Federal)	87	-	-
British Columbia	85	140	-
Alberta	85	-	-
Saskatchewan	85	-	-
Manitoba	85	-	-
Ontario	85	-	-
Quebec	90	140	100
New Brunswick	85	140	-
Nova Scotia	85	-	-
Prince Edward Island	85	-	-
Newfoundland and Labrador	85	-	-
Northwest Territories	85	140	100
Nunavut	85	140	-
Yukon Territories	85	140	90
Average	85.5	140	96.7

9.4 - Gun Shot Noise Levels

This chart displays the decibel levels of various types of firearms and other noise emitting sources.



("The Smoking Barrel - Shooting Straight", 2016)

9.5 - Duration of Peak Pressure Levels for Various Firearms

This table displays the duration of peak pressure levels for various firearms.

Rifle # Description	dB PPL (SLM)	Duration (millisec)
1. 7 mm Mouser	154.9	3.3
2270 cal with BOSS; 130 grain Power Point	164.6	3.5
2270 cal with BOSS; 150 grain	163.9	3.8
2270 cal with attachment—No BOSS; 130 grain	158.1	3.5
2270 cal with attachment—No BOSS; 150 grain	157.3	
3. (?) No BOSS, no attachment; 130 grain	157.9	3.4
3. (?) No BOSS, no attachment; 150 grain	157.1	3.2
4. Browning .22/250 with BOSS; 40 grain	163.4	1 2.9
4. Browning .22/250 with BOSS; 55 grain	162.9	9 3.1
4. Browning .22/250 with cover-No BOSS; 40 grai	n 155.3	- 3
4. Browning .22/250 with cover-No BOSS; 55 grai	n 154.′	1 -
5300 Win Mag bolt with cover-No BOSS; xxx an	nmo 157.5	3.5
5300 Win Mag bolt with cover-No BOSS; high ve	elocity 161.5	5 3.0
5300 Win Mag bolt with BOSS; xxx ammo	164.8	8 4.1
5300 Win Mag bolt with BOSS; high velocity amm	165.5	5+ 3.5
6. 7 mm "Plain Jane"; 140 grain	158.	3 3.7
6. 7 mm "Plain Jane"; 160 grain	157.	5 3.4
7.7 mm with BOSS; 140 grain (same as #6 ammo)	163.	6 3.7
7. 7 mm with BOSS; 160 grain (same as #6 ammo)	163.	5 3.6
7. 7 mm with cover—No BOSS; 140 grain (same as	s #6) 159.	5 2.8
7. 7 mm with cover—No BOSS; 160 grain (same as	\$ #6) 157	.8 3.5
8300 Win Mag plain barrel; 180 grain	158.3	3 3.5

Version 1.0 dated 18 April 2016

8300 Win Mag plain barrel; 180 grain high velocity	158.8	4.0
9338 Win with cover—No BOSS; 210 grain	157.1	3.5
9338 Win with cover—No BOSS; 250 grain	156.8	3.8
9338 Win with cover—No BOSS; 250 grain high energy	161.5	3.7
9338 Win with BOSS; 210 grain	164.5	3.4
9338 Win with BOSS; 250 grain	163.8	3.8
9338 Win with BOSS; 250 grain high energy	164.5	3.8



9.6 - Covered Shooting Structure Example

NRA Range Source Book. (2012) (1st ed.). Fairfax.

9.7 - Typical Baffled Range Layout



NRA Range Source Book. (2012) (1st ed.). Fairfax.

10.0 - Cases reviewed:

10.1 - Spruce Grove Gun Club

Spruce Grove Gun Club vs Parkland (County) Subdivision and Development Appeal Board, 2016 ABCA 29 Appeal No. 1503-0285AC

http://www.sggc.ca/

10.2 - Salt Spring Island Gun Club

Salt Spring Island Rod and Gun Club Various individual cases <u>http://www.saltspringislandrodandgunclub.ca/</u>

10.3 - Ontario Community Safety and Correctional Services Appeal

Ontario Community Safety and Correctional Services Appeal PA14-554 <u>http://canlii.ca/t/gmtnc</u>

10.4 - Vancouver Trap and Gun Club

The Vancouver Trap and Gun Club http://www.vancouvertrapandgunclub.com/index2.html

The Columbian - Bill Targets Shooting Range Noise Complaints <u>http://www.columbian.com/news/2012/feb/23/bill-targets-noise-complaints-shooting-ranges/</u>

10.5 - Canadian Owners and Pilots Association

Quebec (Attorney General) vs. Canadian Owners and Pilots Association "Lacombe Decision"

https://www.canlii.org/en/ca/scc/doc/2010/2010scc39/2010scc39.html?searchUrl Hash=AAAAAAAAAAAAEAFDIwMTAgU0NDIDM4IChDYW5MSUkpAAAAAQAOLzI wMTBjc2Mtc2NjMzgB&resultIndex=1

11.0 - Bibliography

Hansen, S. *Policy Track: Environmental Issues*. Retrieved from <u>https://www.nssf.org/ranges/rangeresources/library/NSRS/04PolicyTrack/SoundAttenua</u>tion.pdf

This report discusses the fundamentals of sound, sound laws and regulations, and basic sound mitigation techniques. The information retrieved from this report contributed towards further research into baffle systems and tube ranges, as well as information regarding the fundamentals of sound, gunshot noise events, and sound regulations.

Joines, J. (1996). *Designing and Operating a Range to Minimize Sound*. Retrieved from <u>http://www.nssf.org/ranges/rangeresources/library/detail.cfm?filename=facility_mngmnt/design/designing_and.htm&CAT=Facility%20Management</u>

This report defines and differentiates between sound and noise, as well as discusses the various effects natural and man-made barriers can have when used on a gun range. The information retrieved from this report contributed towards a better understanding of sound itself, and issues management strategies.

Cotter, D. (1993). Shooting Range Public Relations, Management and Planning Manual. Retrieved from

http://www.nssf.org/ranges/rangeresources/library/detail.cfm?filename=community_relat ions/shooting_range_public_relations.htm&CAT=Community%20Relations

This report explores techniques that can assist in a shooting range's public relations efforts. The content assisted in providing a basis of understanding to work with in regards to dealing with noise complaints.

Levein, B., & Ahrlin, U. (1988). Annoyance Caused by Shooting Range Noise. *Journal Of Sound And Vibration*, *127*(3). Retrieved from http://www.sciencedirect.com.ezproxy.library.uvic.ca/science/article/pii/0022460X88903872

This report discusses the different aspects of annoyance caused by shooting range noise. Testing was performed on 3 military ranges and 1 civilian range.

Murphy, W., & Tubbs, R. (2007). Assessment of Noise Exposure for Indoor and Outdoor Firing Ranges. *Journal Of Occupational And Environmental Hygiene*, *4*(9), 688-697. <u>http://dx.doi.org/10.1080/15459620701537390</u>. Retrieved from <u>http://www-tandfonline-</u> com.ezproxy.library.uvic.ca/doi/pdf/10.1080/15459620701537390

This report contains an assessment of noise exposure levels for indoor and outdoor shooting ranges. In addition, it includes information on noise measurements, equipment, calibration.

Benefits of Using Suppressors for Hunting and Shooting Sports (2016). nssf.org. Retrieved 5 February 2016, from <u>http://www.nssf.org/factsheets/PDF/Suppressors.pdf</u>.

This report contains information from the National Shooting Sports Foundation on the benefits of using suppressors for hunting and shooting sports.

Now Hear This. (2016). *nssf.orf.* Retrieved 7 February 2016, from <u>http://www.nssf.org/factsheets/PDF/Suppressors.pdf</u>

This article covers a number of choices range operators have when it comes to protecting shooting range staff and members hearing.

City of Victoria,. (2015). *City of Victoria Noise Bylaw*. Victoria: Corporation of the city of Victoria. Retrieved January 12th, 2016 from http://www.victoria.ca/assets/City~Hall/Bylaws/bylaw-03-012.pdf

This government publication states the noise bylaws for the city of Victoria, British Columbia, Canada. It includes information on noise level limits, types of noise, and descriptions of the various districts for which noise level limits differ.

National Institute for Occupational Safety and Health,. (2011). *Noise and Lead Exposures at an Outdoor Firing Range*. California. Retrieved from http://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0069-3140.pdf

This report contains information and recommendations on noise testing performed at a California shooting range.

Carmichel, E. (2016). *The Decibel (dB) & Sound Measurement*. Retrieved from <u>http://www.elcaudio.com/decibel.htm</u>

This report provides information that assists in understanding sound measurement, and contains tables for various firearm peak pressure levels.

NRA Range Source Book. (2012) (1st ed.). Fairfax.

The National Rifle Association Range Source Book contains extensive information on all aspects of shooting ranges, including noise management and range development and operations.

The City of Calgary,. (2016). Bylaws Related to Noise. Calgary.

This government publication states the noise bylaws for the city of Calgary, Alberta, Canada. It includes information on noise level limits, types of noise, and descriptions of the various districts for which noise level limits differ.

RCMP,. (1999). *Shooting Ranges and Sound*. Ottawa. Retrieved from <u>http://file:///C:/Users/Owner/Downloads/Range-Guidlines-sound.pdf</u>

This publication covers information on the physics of sound, and how it applies to firearms. In addition, it discusses a variety of information on sound level assessment and measurement, shooting range design, and sound abatement techniques.

Now is the Time to Reconsider Legislation Governing Firearm Sound Suppressors. (2012). Retrieved from <u>http://file:///C:/Users/Owner/Downloads/LegalizeSuppressors.pdf</u>

This report provides various information on firearm sound suppressors including basic background information, how they protect the environment, and proposed firearm suppressor legislation.