

Los Altos Rod and Gun Club: Shooting Noise Mitigation Measures Assessment

A technical assessment of noise mitigation alternatives for the Gun Club ranges.

by

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Executive Summary

This is a companion report to “Los Altos Rod and Gun Club: Shooting Noise Assessment” which the author prepared to assess compliance with the noise standards and policies of Santa Cruz County. That report demonstrates full compliance with all standards and policies for noise exposure, even if the Los Altos Rod and Gun Club (LARGC, or the Gun Club) were to be reviewed as a new project. Nonetheless, the Gun Club has stated a willingness to work with the community to reduce noise exposure by all reasonable means.

This report provides a technical assessment of various noise mitigation alternatives with only cursory consideration of costs, efficacy or affect on range safety and operation. Only general comments are made with respect to these non-acoustical factors, based upon my experience. The Gun Club, working with their legal counsel, will evaluate the assessments from this report, determine the effectiveness and feasibility of each, and provide their comments regarding possible implementation, or rejection, of the noise mitigation alternatives addressed herein.

This report was prepared by John C. Freytag, P.E., INCE Bd. Cert., whose experience is described in the companion report and its Appendix F.

Gun Club Background

LARGC, a non-profit corporation, was established in 1955 at a secluded location in the Santa Cruz mountains. Since that time, there has been some low-density residential development in the area, most extensively in and around the Indian Rock Ranch development beginning a mile northwest of the Gun Club. The Gun Club is open to members and the public Thursdays through Sundays from 9:00 am to 5:00 pm (9:00 am to 4:00 pm during winter), and open to members only during these same hours Mondays through Wednesdays. No shooting is allowed outside these hours. The Gun Club has five active ranges (shown in Figure 1), each managed by a trained range officer, which includes: a 25-yard pistol range, a 40-yard, a 50-yard and a 100-yard rifle and/or pistol ranges and a trap range used for shotgun target shooting of clay pigeons. Weekends have the most shooting activity.

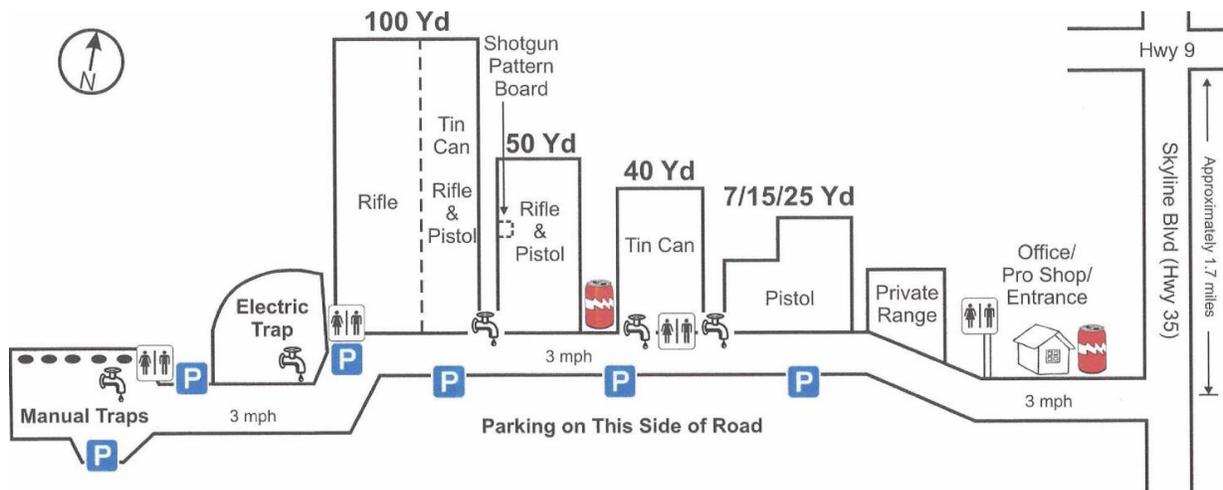


Figure 1 – Layout of the Los Altos Rod & Gun Club Ranges

On a busy weekend day more than 20,000 total rounds may be fired from these ranges, though the annual daily average is about one third of that number. Appendix G of the companion report lists the average daily number of rounds fired from each specific type of firearm.

The Indian Rock Ranch development of approximately 50 residences is centered about 1500 meters (approximately a mile) northwest of the LARGC and about 2000 meters (about one and a third mile) west-northwest of a police shooting range (the SCCPOA range). Figure 2 shows the location of the two ranges, sensitive neighbors to the north and our acoustical measurement location. The LARGC is by far the most active range and the primary concern of local residents.

A total of 21 complainant letters or emails were submitted to the Santa Cruz County Planning Department and/or the County Board of Supervisors. Of these, 14 are in the immediate area with locations shown in Figure 2, three are out of the area, and four did not identify their location in their correspondence. None of the correspondence mentioned the SCCPOA range. Most of the complainants mentioned general annoyance from firearm noise, some mentioned reduced property value concerns, several felt that the Gun Club is an incompatible use, some believe that there has been much more shooting in recent years, several stated that the Gun Club was polluting, and some were generally disparaging about firearms in general. Generally, complaints reflect quality of life issues. Additionally, some reported activity that does not occur at the Gun Club: use of fully automatic firearms and .50 BMG rifles, and nighttime shooting. Appendix B of the companion report lists the complainant locations.

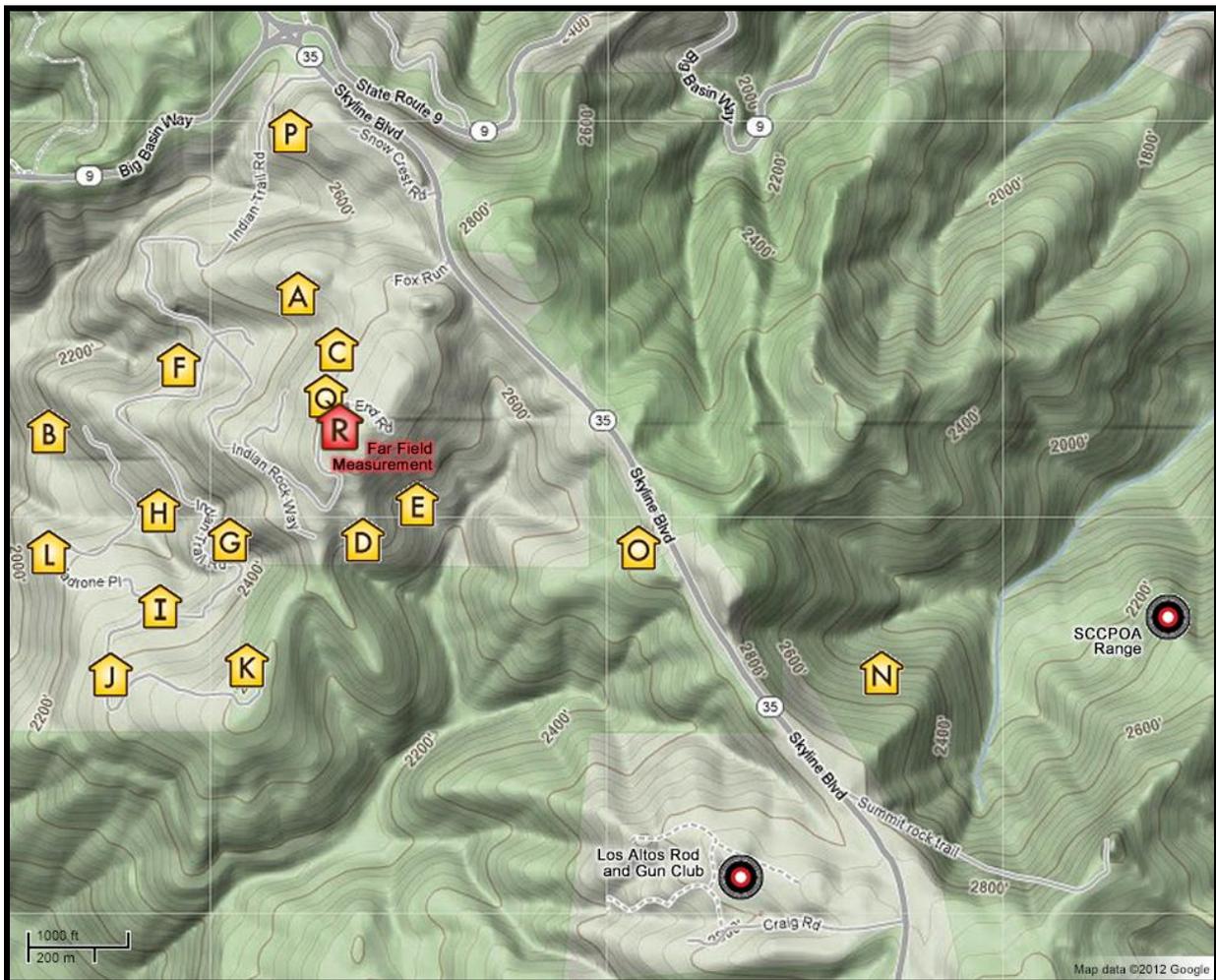


Figure 2 – Shooting Ranges, Measurement Location, Prediction Locations and Complainant Locations

Gun Club and Community Meeting and Correspondence

During 2012, as Gun Club noise complaints were submitted to the County Board of Supervisors, LARGC representatives, including the Gun Club president and vice president, met with various residents from the surrounding community. The primary group speaking on behalf of the community is the Community Association for Life in the Mountains (CALM). The Gun Club has retained legal counsel and technical experts to address noise and other environmental issues in conjunction with concerns expressed by the County Board of Supervisors. The Gun Club has retained the author to serve as their acoustical consultant.

In July 2012 the author and Gun Club vice president, Don Olson, met with CALM representatives to hear their complaints and suggested noise mitigation measures to reduce firearm noise emanating from the Gun Club. Subsequently a group from CALM attended a site inspection at the Gun Club during an active weekend, during which time this author conducted the noise study for the companion report and for the noise mitigation assessments herein. CALM subsequently submitted a letter, dated August 26, 2012 to (then) County Supervisor Mark Stone detailing their noise issues, research and suggestions for noise mitigation measures. The letter is included as Appendix A of this report.

On December 8, 2012 this author, Don Olson and County Planner, Ken Hart, again met with CALM representatives to report the findings of the noise assessment and discuss the recommendations in the August 26 CALM letter. In this meeting the Gun Club also committed to providing these two reports to Mr. Hart by December 17, 2012 for his review and preparation for the January 2013 County Board of Supervisors meeting to discuss noise issues at LARGC.

CALM's Proposed Noise Mitigation Alternatives

On July 21 the author and Don Olson, LARGC Vice President, met with five CALM representatives to discuss their specific noise concerns and objectives. Noise mitigation alternatives were then evaluated from their August 6 letter to Supervisor Stone. The alternatives suggested were taken from three documents cited by CALM and were found to be a comprehensive list for shooting ranges:

- National Rifle Association, 'The Range Source Book – A Guide to Planning and Construction', January 2004.
- Royal Canadian Mounted Police, *Shooting Ranges and Sound*, undated ("RCMP Report").
- National Shooting Sports Foundation, "Environmental Aspects of Construction and Management of Outdoor Shooting Ranges", 1997.

Noise mitigation alternatives may be either: 1) administrative, controlling noise emission sources, or 2) technical, providing engineered noise controls. The CALM letter addressed both mitigation types.

Firing Sheds

The first suggestion was construction of shooting stations (also called firing sheds). Noise in general may be mitigated either at the source or by interposing a structure between the sound source and sound receiver. California law strictly prohibits manufacture, possession, transportation or sale of all firearm sound suppression devices (silencers).¹ Therefore, the only alternative for engineering noise mitigation for the current Gun Club firearm noise is through interposing a structure or structures, or by relocating or reorienting the ranges.

¹ California Penal Code, Section 12500-12501.

A firing shed design has been developed and tested at numerous shooting ranges around the world.² These may provide effective noise mitigation for rifle and pistol ranges under many circumstances. However, trap shooting, employing shotguns firing at sporting clays, cannot be enclosed.

Figure 3 depicts the most well-established and effective design for a shooting shed. This shed includes a continuous rear wall.

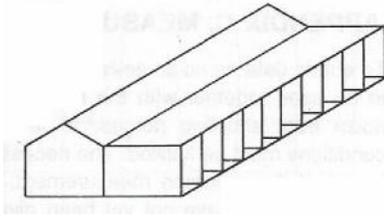


Figure 3 – Firing Shed

The preferred shed design uses a typical roof over the shooting area with a 5-meter extension towards the targets, although a version with a 3-meter extension is also often constructed providing reduced sound attenuation. This shed provides an effective barrier to areas from the side of the shed and includes sound-absorbing material on the shed interior to reduce noise to the shooters as well as to outlying areas. The firing shed is least effective to areas directly downrange and, by enclosing the back of the firing shed, most effective to areas rearward. Intermediate attenuation is afforded to sideline locations.

Tables A and B show the relative contribution of the pistol, rifle and trap range operations without mitigation and with mitigation respectively. While rifle and pistol noise may be reduced appreciably for some residential locations, the greatest noise output remains from the trap range where firing shed mitigation is not possible. Therefore, the net noise exposure reduction from the firing sheds is generally negligible.

Table A – Relative CNEL Noise Exposure Contribution of Pistols, Rifles and Shotguns - No Sheds (dB)

Location	Unmitigated CNEL			
	Pistol	Rifles	Trap	Total
Test Res.	35	33	43	44
Loc. P	15	13	25	25
Loc. B	23	20	32	32
Loc. K	36	35	45	46
Loc. D	36	34	45	46
Loc. O	31	30	39	40
Loc. N	32	31	39	39

² Nordtest Method, NT ACOU 099, Edition 2, Finland.

Table B – Relative CNEL Noise Exposure Contribution of Pistols, Rifles and Shotguns with Sheds (dB)

Location	Mitigated CNEL			
	Pistol	Rifle	Trap	Total
Test Res.	31	29	43	43
Loc. P	12	11	25	25
Loc. B	18	15	32	32
Loc. K	30	30	45	45
Loc. D	32	30	45	45
Loc. O	29	28	39	39
Loc. N	28	28	38	38

CALM rejected the alternative of constructing firing sheds because they would provide only minimal noise reduction.

Prohibiting Certain Loud Guns

Another suggestion was made to prohibit certain loud guns, accompanied by a recommendation to regularly monitor sound levels at the range. This may potentially reduce noise exposure to the affected community; however, this may also be problematic for several reasons.

- The Club already prohibits .50 BMG and similar large caliber firearms at all ranges.
- 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.

Firearm Discharge Reduction/Creating More Quiet Time

The suggestion of additional quiet time was expressed in the August 26 CALM letter, and subsequently discussed in greater detail at our meeting of December 8. The concept is to reduce the number of shooters during certain timeframes, or eliminate certain days for all shooting activities. This would, of course, reduce community noise exposure, unless the shooters simply rescheduled their shooting times/days, thereby shooting the same amount and producing the same net CNEL noise exposure over the day, or subsequent days. For the same firearms and ammunition, reducing the amount of shooting by half reduces the CNEL noise exposure by 3 dB, a just-noticeable change. More specific quiet time suggestions by CALM from the December 8 meeting are as follows:

- Reducing Club shooting hours on Sunday to 11:00 am to 3:00 pm affording local residents more quiet time in the mornings and an opportunity for a quieter late afternoon barbecues.
- Limiting the types of firearms for specific periods of time. More specifically, limiting range use to rimfire only and closing use of the trap ranges.
- Changing the fee structure for range users to pay more for louder firearms. Perhaps a discount for rimfire firearms, intermediate fees for centerfire rifles and pistols, and increased fees for trap range use. This is essentially a 'cap and trade' proposal for noise emissions.

Regrouping noise events does not change CNEL noise exposure; that is, reduced quiet time offset by higher noise at other times produces no net CNEL noise reduction. These types of tradeoffs have not been shown to reduce overall community noise annoyance.

The primary concern expressed by the Gun Club is the loss of revenue and reduced shooting opportunities for Club members and patrons. This is a particular concern at a time when the Gun Club has spent considerable unplanned revenue on environmental and noise mitigation, consultants and studies, such as this, to address community complaints.

CALM has also expressed an appreciation for the financial constraints on the Gun Club and realizes that LARGC would not be the beneficiary of their suggested measures for additional quiet time. However, CALM maintains that some fee restructuring may not necessarily reduce LARGC revenue.

Mockups and Testing

The August 26 letter further suggested that noise may not be effectively modeled and that it would therefore be necessary to construct mockups of the shooting stations (firing sheds) discussed above. However, acoustical modeling is part of an established and proven reliable acoustical engineering discipline; mockups are not generally required to determine their acoustical attenuation effectiveness. The firing shed results presented are directly from measured results.² Further, the modest noise reduction from the firing sheds suggested a greater focus on other noise mitigation alternatives.

Long-Term Monitoring

CALM has also recommended long-term monitoring to track noise levels emanating from the Gun Club. The author does not recommend long-term noise monitoring, because it provides no noise reduction benefits. For a firing range operation where the noise environment is comprised of many very short duration (impulsive) firearm shot events separated by comparatively long periods between, it is not possible to automatically distinguish firearm noise from all other noise sources with unattended measurements. That is, it is necessary to have an observer present to record and monitor each firearm shot event to separate that noise from other neighborhood noises such as aircraft, children playing, yard work, construction, wind noise through nearby foliage, local vehicles, etc. Attended monitoring would prove very costly and results may be contentious.

Reversing the Direction of the Shooting Ranges

Reversing the direction of the shooting ranges would significantly reduce noise exposure to those residences to the north, directing that noise exposure to residents and Castle Rock State Park to the south. This is singularly the most effective option for reducing noise to the Indian Rock Ranch development community.

It would be necessary to relocate the trap range to the north because shooting south from its existing location would fire shot and clays into the Park. This relocation would face the trap range and rifle ranges towards each other, an unacceptably dangerous configuration. To mitigate this safety issue, it would be necessary to construct a large wall between the ranges; there is likely insufficient room for an earthen berm between the ranges. Such a wall would result in some reflected noise to residents, though most of the Indian Rock community would realize a noise reduction.

Initially the Club has rejected this alternative because: 1) it would not be feasible environmentally due to the location of seasonal drainage and would likely never be permitted by the County, and 2) the costs for the project are well beyond the financial wherewithal of LARGC. However, in the December 8 meeting, CALM requested that the Gun Club revisit this possibility despite the costs. Acknowledging the grand scope of such a project, it was agreed that the Gun Club may further investigate reversing only the trap range because it is the greatest source of noise, however, the reconfiguration would result in cross-fire with the rifle and pistol ranges and most likely would not be possible to engineer in a safe operating design.

The primary environmental concern from turning around the trap range is the depositing of shot and clays into seasonal drainage areas adjacent to Castle Rock State Park. This would require considerable environmental investigation, a mitigation plan and likely some combination of State and County permitting. As referenced above, a safety issue also arises from opposing the orientation of the trap and rifle/pistol ranges; this is contradictory to range design practice and requires mitigation such as a wall between the ranges. Additionally, it is likely that opposition may arise from Park users and residents to the south of the Gun Club since noise would be transferred to these areas.

Noise Mitigation at the Receptor

Noise mitigation alternatives not suggested by CALM, are those which may be affected at the receptor.

Homeowners may mitigate the effect of audible firearm noise by altering the background noise at their outdoor locations. As mentioned earlier, the audible effects of firearm noise at residential distances are due to the low ambient, or background, noise level in the area. Thus a 55-dB sound heard in a 40-dB background location may not be audible in a 60-dB background location because the 'signal-to-noise ratio' has been reduced. The property of one sound overcoming, or drowning out, another is termed sound masking. Many homeowners have successfully mitigated various undesirable noise intrusions by installing fountains, small waterfalls or other water features in outdoor use areas to mask unwanted noise intrusion.

Noise to interior spaces may be reduced by sound insulating sensitive spaces, such as bedrooms. This requires identification of the weakest sound insulating elements, typically windows and vents, and affecting retrofit treatment or replacement of those elements. Generally, the services of an acoustical consultant are advisable for design of effective sound insulation.

Conclusion

Various noise mitigation alternatives have been acoustically evaluated for reducing noise to the Indian Rock Ranch development north of the Gun Club. Both administrative and engineering alternatives have been assessed. The greatest potential for significant noise reduction is reversing the direction of the loudest range, the trap range. The potential for implementing any of the noise mitigation alternatives outlined herein will be further addressed in correspondence to CALM and the County by the Gun Club and their legal counsel. Also, the Gun Club is reviewing other noise mitigation alternatives that may be included in that correspondence.

Appendix A

August 6, 2012 Letter from CALM to Supervisor Mark Stone

August 06, 2012

Supervisor Mark Stone
Santa Cruz County Board of Supervisors
701 Ocean Street, Room 500
Santa Cruz, CA 95060

Regarding: Appeal of the Los Altos Rod and Gun Club clubhouse building permit

Dear Supervisor Stone:

Good progress has been made between the Los Altos Rod and Gun Club ("LARGC") and the neighborhood group known as "CALM" (Community Association for Life in the Mountains) since the May 8 Supervisor's meeting. CALM has met face-to-face with representatives from the LARGC multiple times. We are pleased with their attitudes and willingness to constructively work toward mitigating the impact of sound created by their operations. After a few meetings, a tour of the facility, and the urging of Jack Freytag (the LARGC's sound consultant), CALM has assembled its thoughts on how the LARGC might curb the gun noise affecting our community.

While CALM has members who are designers, engineers, and university professors, none of us are sound experts. However, we have drawn many of our suggestions from publications by respected sources within the shooting community. These include:

- "NRA Range Source Book" by the National Rifle Association (NRA)
- "Shooting Ranges and Sound" by the Royal Canadian Mounted Police (RCMP)
- "Environmental Aspects of Construction and Management of Outdoor Shooting Ranges" by the National Shooting Sports Foundation (NSSF)

We realize that this is a complex problem and there are no "cookie-cutter" solutions that will work in every case. Also, being that each range has its own unique characteristics, there is no accurate way of predicting what will work. A technique which reduces sound on one range might very well cause it to be worse on another. Therefore, our first recommendation is that any infrastructure solutions under consideration be simulated and tested prior to implementation. This should help assure that the LARGC does not spend construction money needlessly while simultaneously assuring that neighbors experience an improvement.

Objective:

The main objective is to reduce the disruptive affect that gun noise has on the surrounding community. This can be done in multiple ways, including improvements in infrastructure (sound baffling, shooter enclosures, etc.), aiming/firing in a direction away from the community, and increasing the amount of quiet time, just to name a few. There are many, many ways to solve this problem and we are open to any that meet our objective. Since we were prompted to do so, we provide a few suggestions that seem rational to us.

Lowering the Sound Level (rifle and pistol range):

Building shooting stations would seem to be a logical choice to contain sound. This is mentioned in RCMP, section 4.2.1; NSSF, section 2.2.2.3; and NRA, chapter 6, article 3.04.1. This technique was used

at the Scott's Valley Sportsman's Club (SVSC) as well. However, we are concerned that the success of the method is complicated by the direction which the range is oriented (essentially toward critical sound receivers--our community).

Shooting stations are generally enclosed structures with the sound source at one end and sound escaping out of the other open end (SVSC). This configuration describes a device used to direct sound for the purpose of amplification: a megaphone. Being that many "megaphones" would be essentially pointed in our direction, we are concerned that this technique has the possibility of actually making matters worse. There are some ways to deal with the situation, such as further enclosing the open end by shooting through a window or portal and lining the inside walls with sound absorbing material to prevent sound reflection (RCMP, section 4.2.1). We don't profess to understand the acoustic aspects of designing such a structure, but we suspect that this solution alone does not represent a viable alternative.

We think that a big part of the problem has to do with the direction of fire of the range. As previously mentioned, the direction of fire is generally toward the residential community. This is not recommended practice (RCMP, section 5.3.1; NSSF, section 2.2.2.2). There is a low hill (perhaps 30' high) between the range and community, however sound is able to bend over the top of this hill. The RCMP paper shows sound dispersal patterns 360 degrees around the muzzle at the time of fire (section 1.3, figures 1 & 2). They show a dramatic difference in sound levels depending upon orientation, with the area directly behind the shooter being much less loud. We would suggest assessing a reversing of the shooting direction so that it is away from the community.

Now that shooters would be firing away from the community, additional measures, such as a continuous sound wall behind shooters (RCMP section 4.2.1) and a properly designed roof might go a long way to further reduce sound that makes its way to the community (which would have to bend 180 degrees).

One further suggestion would be to monitor sound levels at the range and implement a maximum loudness rule. During our tour of the facility it was apparent that a few of the guns were VERY loud compared to others. Since reducing noise is the main objective, prohibiting certain very loud guns may have a large positive impact on the environment. As a practical matter, it would probably become clear which models or guns or ammunition were responsible for very loud sounds and the LARGC could warn customers in advance that certain models often violate their loudness rule.

Lowering the Sound Level (shotgun ranges):

Currently, trap shooting is not only aimed toward the neighboring community but is also in direct line of sight (and sound) to nearby homes with no possibility of a barrier. Additionally, shooting is out over a valley. Both of these factors run contrary to recommended practices.

Just as reorienting the shooting range could represent a big improvement to the sound situation caused by target shooting; it may also be possible to do the same for the trap range. To do this, the shooting positions would be moved from their present location to a ridge across a small valley to the north (still within the LARGC's property). So the shooting direction would now be roughly to the south, 180 degrees from the community. There is already a dirt access road to this area. Also, a sound wall with roof directly behind shooters would provide further sound reduction for the community while not affecting the shooters.

We think that these changes might result in significant improvement. However, if testing shows that not to be the case, we look to the LARGC to suggest additional changes for the trap/shotgun areas.

Creating More Quiet Time:

The basic idea is to reduce operating hours or perhaps even closing on certain days. This is covered in the NSSF paper, section 2.2.2.1. Among these ideas, the most attractive to CALM would be to delay opening the range on weekend mornings (for example, start at 11am as opposed to the current opening of 9am), and/or close two weekend days per month (publicized so that we could plan around these closures).

Mockups and Testing:

To verify whether any of these ideas will actually reduce sound levels in the nearby community and by how much, we recommend:

- Constructing mockups of shooting shelters.
- Conducting tests where shots are fired from within and outside such shelters.
- Simulating a range reorientation through test firings both toward and away from the community.
- Recording / tabulating results both subjectively and objectively in order to determine which measures are the most effective.

This activity would be a joint effort between the club and the community with CALM members providing subjective data and a sound engineering consultants measuring and recording objective data.

Long-Term Monitoring

With the ongoing popularity of shooting and the lack of new local gun ranges, we expect a natural pressure on the LARGC toward ever-increasing attendance. Since it was this gradual increase in noise that led to the appeal of their proposed clubhouse, we believe that noise monitoring is a vital part of ongoing operations. The details of monitoring are beyond our expertise, but a formula for assessing the noise should be developed and agreed upon.

With monitoring comes the responsibility of taking action should threshold limits be exceeded. We propose that the gun range trends the noise data, so that it will see an increase coming before violations of the limits, providing time for corrective actions on their part prior to exceeding thresholds. Should limits be exceeded, mandatory reductions in hours of operation would be imposed.

Timing

LARGC has taken many steps toward being a good neighbor. These include hiring consultants and meeting with members of CALM. They appear willing to move forward with some infrastructure changes which are being evaluated at this time. Since there remain many unknowns with respect to how difficult, time consuming, and costly the changes to the range might be, we propose that the clubhouse building permit remain unapproved until these unknowns can be reduced. Returning to our first recommendation in this letter, we welcome the chance to participate in mock-up testing of the various sound reduction ideas, which we believe could happen quickly.

We appreciate the continued support of the Board of Supervisors in this matter and would be happy to answer any questions you may have.

Sincerely,

CALM Task Force

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