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Boise Police Department
Outdoor Firing Range Noise Study

prepared for:

McAlvain Construction

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Summary

This outdoor firing range has long been used to train Boise Police Department officers. Other occasional law enforcement users include the Meridian PD, the FBI, and the US Marshals. Based on the planned modifications of the range, sound levels were evaluated at the nearest existing homes.

Some adverse noise impacts exist for one nearby residence, but this is a longstanding situation. The planned range modifications will not add perceptibly to the existing noise that already occurs. The range upgrades will cause no net increase in perceptible noise at the two nearest homes.

Use of the Range

This range has been operating in this location since 1960. The hillside home (#2105) was built later in 1976. The original structure of the lower valley home (#2000) was built in 1949, but the main house appears to be much newer than that. The range is not planned to operate during the nighttime hours. There will be some limited night time certification training that happens between the hours of 6-9 pm. We were unable to get specifics on the dates and frequency of this night training, but it is generally limited in scope and done during the fall when days are shorter and homes have closed windows. Even though the activity is in the evening (not during the nighttime hours after 10 pm) the potential noise impact is reduced by closed windows.

The range is used a total of 21 weeks per year by Boise PD, whose officers must qualify with their firearms quarterly. Firing is done with both .223 caliber AR-style rifles and with .45 ACP semi-automatic pistols, the standard duty weapon used by the department. The rifles are somewhat louder than the pistols, but not by a wide margin. The officers also qualify periodically with the 12 gauge shotgun and a few other devices and systems.

According to information provided by the range officers, Meridian PD also uses this range about six weeks a year. (Meridian PD is in the process of planning and building a range of their own, which will essentially eliminate their use of this facility).

The FBI and US Marshals also use this range for about three days each per year. (It is possible but unverified that they too would use the indoor Meridian PD range once it is built, further decreasing training activity on this outdoor range).

Firing is typically done in brief bursts lasting two minutes or less, with 10-15 minutes in between courses of fire. Standard courses of fire take place at 50 yards, then the shooters move forward to 25 yards, then finally at 7 yards near the impact berm downrange. During the pauses, targets are changed, magazines are reloaded, and the range officer briefs the shooters on the next course of fire. During the site visit and sound measurements, the number of shooters varied between one and eight. It is more typical to have 10-20 shooters at a time during training.

Nearest Receiver Locations

The range lies at the end of Mountain Cove Road in the foothills well past Fort Boise. There are two homes that are near the range to the north / northeast, and basically have direct line of sight.

The nearest residence is at #2000 Mountain Cove Road, and lies well below the elevation of the range itself. (In this report, we refer to it as the "valley" home for clarity). This home lies roughly 35 feet below the elevation of the range, at a distance of about 870 feet from the nearest firing line location.

The second home is #2105 Mountain Cove Road, and sits higher than the range by an estimated 10-15 feet. (We refer to this as the "hillside" home). It is farther away from the range at ~1275 feet, but because of the terrain geometry it has a better line of sight to the entire firing area.

All other surrounding homes are more than 2200 feet way from the range, and lie behind ridges. They have no direct view of this firing range.

Noise Ordinance

The Boise city noise ordinance (Boise Municipal Code 6-20) only deals with noise in terms of a nuisance. No specific numerical noise level limits are described in the code. The city ordinance primarily addresses amplified sound or music, and uses the phrase "plainly audible within any place of residence" to establish whether a violation occurs (section 6-20-03).

Section 6-20-06 lists exemptions, and includes the following clause:

> "B. Sounds caused by activities upon an outdoor municipal, school, religious or publicly owned property or facility, provided that such activities are authorized by the owner of such property or its agent".

Paragraph B indicates that since this shooting range is owned and operated by the city it is therefore exempt from the noise ordinance, because they have authorized the police department to conduct these firing and training activities there.

The Ada County noise ordinance similarly focuses on amplified sounds or noisemaking devices, and also uses the "plainly audible at residences" criteria rather than numerical decibel limits. It has exemptions similar to the Boise ordinance.

In this case, the firing sounds are plainly audible at both homes. There are other naturally occurring noises in the vicinity, some having comparable overall levels at the homes. The gunshots are plainly audible and clearly noticeable at both homes.

When there is no applicable local standard for judging noise, the next option is to assume typical noise standards that would be used by most communities, even though neither Boise nor Ada County have adopted specific noise limits. The levels contained in model noise ordinances and typical community noise ordinances are:

	daytime	nighttime
residential	Leq 60 dBA	50 dBA
commercial	Leq 70 dBA	60 dBA
industrial	Leq 80 dBA	80 dBA

In noise ordinances, nighttime is normally considered to be from 10:00 pm to 7:00 am.

Firearms Noise Criteria

The US Army builds and operates many shooting ranges worldwide, and they have developed a standard for evaluating annoyance from firearms noise. Noise criteria are described in Document AR-200 (1997) and are based on many noise studies on existing firing ranges, and considerable academic research. AR-200 indicates that sound levels up to 87 dB peak are considered "normally acceptable" for noise-sensitive land uses such as residential zones. That threshold is based on fewer than 15% of the population being annoyed by gunshot noise, and 1% being highly annoyed. Higher levels of 88-104 dB peak are considered “normally incompatible” with noise sensitive land uses, with up to 13% of the population categorized as “highly annoyed”. Levels above 104 dB peak are considered to be incompatible with residential and other noise-sensitive land uses.

Peak sound level requires some explanation to be understood. A sound level of 87 dB *peak* appears to be a very high number, but it is not. We are all exposed to peak levels of that magnitude and much higher many times per day in the course of daily life. The four primary ways to measure time-varying sound levels are: peak, impulse, fast, and slow. These are the standard settings available on most sound level meters.

Sound meters use various time constants or averaging periods when measuring sound. The “slow” setting uses a 1 second response time or averaging period. “Fast” uses 1/8 second or 125 milliseconds, which could also be thought of as eight samples per second. “Impulse” uses 35 milliseconds, or about four times faster than the “fast” setting, roughly 40 samples per second. “Peak” uses the highest value seen, even if occurring only for less than 1/1000 of a second.

Different time settings on the sound meter will yield different resolution and results, with faster settings better capturing the transient profile of quicker events. Impulse sound measurements for firearms are typically 20 decibels lower than peak values, and “fast” values are 6-8 decibels lower than impulse levels for the same gunshot. The net effect is that peak levels of 87 dB are comparable to many commonly occurring sounds in the area that might measure roughly 60-65 decibels using either the “slow” or “fast” setting on the sound meter.

For example, when dealing with firearms noise the following levels are generally observed with different time weightings. A .22 caliber pistol measured at fifteen feet to the side or the muzzle produces the following sound levels:

133 dB peak
113 dB impulse
107 dB fast
102 dB slow

These are all different ways to quantify the same noise event.

When dealing with subjective perception of sounds, the fast or impulse number usually works best. Human response to noise is a subjective and variable matter. There is no definitive number where everyone accepts the noise, and above that threshold there are complaints. Similarly, there is no given number that everyone agrees is acceptable all the time.

Ambient Sound Levels

The existing background or ambient sound levels in the area were investigated, so that there was another basis for comparison apart from the local noise ordinance or the Army peak noise criteria.

Ambient noise measurements were taken on Thursday June 13, 2013. This was a training day for a number of officers, up to eight at a time, but there were also plenty of periods where firing did not occur, such as during the lunch break. Data collected included the Lpeak, Leq, Lmax, Lmin, L01, L10, L50 and L90 levels.

Equivalent Level (Leq) is the standard quantity used to describe time-varying sounds. Leq is an integrated running sum of the energy contained in a variable sound level. While not mathematically precise, it can be thought of as the “average” level for the period in question.

Measurements were taken at both homes, #2000 and #2105 Mountain Cove Road with the cooperation of the landowners. Measurements were taken in front of the homes on a direct line toward the range. Data was collected during periods both with and without gunshots. Weather was sunny with temperatures between 63-72°F. Wind varied from 0-12 mph throughout the day.

Field notes also identify the individual pre-existing noise sources. Some specific momentary yet recurring noise events and their levels at the homes were:

cars on Mountain Cove Road	40-48 dBA	
aircraft overflights	52-63 dBA	91 dB peak
birds and animal noises	40-53 dBA	86 dB peak
wind in the trees	47-54 dBA	78 dB peak
shots at homes	64-68 dBA	88-93 dB peak
helicopter passing overhead	68 dBA	

The purpose of these ambient measurements is to document the types and magnitudes of noises that already occur regularly in the area, apart from the sounds that are produced by the firing range. As can be seen from the data, there is a notable amount of pre-existing noise present around these two homes. Even though this is a fairly quiet rural area, it is not silent. There are still numerous noise events and noise sources affecting the properties, apart from the range.

Aircraft noise events ranged from 52-63 dBA and included both distant jets and fairly distant general aviation flyovers. One of the loudest noises of the day occurred when a helicopter flew almost directly over the homes, headed toward downtown. Wind noise in the trees varied from 47 dBA at 5 mph to 54 dBA for occasional gusts estimated at 12 mph.

Based on several data sets without any firing, the typical environmental noise levels at these two homes are:

Lpeak	80-88 dB
Lmax	66-72
Leq	47-48
Lmin	36

It is challenging to quantify the “typical” ambient noise level since it naturally varies from hour to hour, depending on what occurs during that period.

Firing Range Use

The range will be used with the .223 rifle, .45 ACP pistol, and occasionally with 12 gauge shotguns. These are all standard law enforcement calibers used in training and on duty. The .223 rifle is a general purpose rifle used by most officers, and is routinely carried in patrol cars. Semi-auto pistols in .45 caliber are the standard duty sidearm carried by the department.

The range currently has a total of 35 lanes or firing points, and the use is typically 10-20 shooters any one time. The proposed modifications will increase that to 38 lanes, and will reorient the range a few degrees, facing a bit more southeast than it currently does. Addition of three more lanes will raise the overall sound levels by less than 1 dB, a change which is not noticeable or perceptible by most people (and barely measurable under field conditions).

During training, there are routinely long periods without any firing, punctuated by short intervals of fairly intense group gunfire sounds.

The typical series of qualification firing averaged 87 decibels over an entire hour, when measured 30 feet behind the firing line. This includes a variety of weapons and shooting scenarios. For 10% of the time, which is likely representative of the total firing time during any given hour when the range is in use, the level was 89 dB.

Gunshot Sound Levels at Nearby Homes

The levels measured on the range itself are interesting, but the key consideration is the gunshot levels measured near each affected home. At the "valley" home (#2000 Mountain Cove Road) the gunshot levels were typically:

Lpeak	79-88 dB
Lmax	63-68 dBA
Leq	53-54 dBA, averaged over 90-100 seconds

At #2105 Mountain Cove Road (the "hillside" home) the gunshot levels were typically:

Lpeak	91-97 dB
Lmax	65-70 dBA
Leq	53-55 dBA, averaged over ~90 seconds

There is some variation in the observed levels mostly because of the number of shooters. Variability also occurs because of the firearms being used and the specific course of fire. More shooters and more rapid firing translates into higher noise levels.

Range Structure

The range already uses natural ridges and terrain to contain shots, with bullets impacting into a graded berm on the southeast end of the range.

The latest plan under consideration builds an enclosure around the northernmost firing line (50 yards, and closest to the homes). The enclosure consists of an 8 foot high wall along the rear, plus an overhead structure, and end walls where appropriate. The nature of sound barriers is that they need to interrupt the direct line of sight between the sound source (gunshots) and the sound receivers (homes).

The enclosure configuration planned will be effective at reducing noise occurring at the 50 yard firing line. It will also help reduce gunshot noise levels at the lower "valley" home regardless of firing position, because it will still interrupt sight lines.

However, as the shooters move forward to 25 yards and 7 yards, the enclosure will no longer be effective for the hillside home. We asked the training officers if they would consider doing all firing from the 50 yard point and using secondary targets at shorter intermediate distances. This would maximize the effectiveness of the enclosure / barrier. They believe that this change would be disruptive to their normal training procedures and would be an inefficient use of range time. It would also change the bullet drop locations and potentially affect the safety of range operations.

Noise Impact / Mitigation Measures

Since the gunshot levels measured at the hillside home were above the Army criteria of 87 dB peak, we conclude that there is currently some relatively minor noise impact (3-10 dB peak, and about 3-4 dB Leq) at that home.

For an outdoor range, noise mitigation is difficult. The primary tool is a high noise barrier surrounding the range, including the firing line. A barrier must fully interrupt line of sight between the homes and the firearms to be effective. Often there is not enough room for a barrier or berm, and building a barrier high enough has its own set of challenges.

Given the geometry of the higher “hillside” home, a barrier would need to be impractically high around the range, on the order of 18 feet tall. For comparison the current storage building on site is a surplus railroad box car about 12 feet high. Barriers need not be masonry or concrete to work adequately. Plywood of 3/4” thickness, 18 gauge sheet metal, or materials of similar weight will work well too.

Even an 18 foot barrier would become less effective as the shooters move downrange away from the 50 yard firing line, and get farther from the enclosure. By the time officers get to the 7 yard firing line, there will be virtually no benefit provided for the hillside home by an enclosure / barrier back at the 50 yard firing line,

Echoes from the surrounding hills are also a factor. Audible echoes are present from the “bowl” created by the range’s location. Echoes cannot be affected by a barrier on the range itself, so the potential usefulness of a very high and very expensive barrier will be rather limited.

Conclusions

The criteria most often used to assess gunshot noise impact is a level of 87 dB *peak* at residences. This is the Army criteria.

If there were specific numerical limits contained in the local noise ordinance, the most likely limit would allow an average of up to Leq 60 dBA for any given hour during the daytime hours at residences. Data shows that bursts of gunfire raises the Leq from 48 to roughly Leq 54 dBA during the 90 seconds or so that such clusters of fire occur. That level would comply with a typical numerical ordinance. Averaged over an entire hour, there would be almost no discernable difference in the Leq value with and without gunfire noise. The ambient noise generally varies more than that from hour to hour.

The ambient noises in the area are observed to be Leq 48 dBA on average, with specific recurring noise events like aircraft flyovers, vehicle traffic, wind noise, dog barks and birds that momentarily range from 40-63 dBA.

Firearms noise was measured at Lmax = 64-70 dBA and Lpeak = 91-97 dB at the "hillside" home. Levels were slightly lower at the "valley" home, demonstrating the effectiveness of terrain as a noise barrier.

This does not mean that the gunfire sounds are not clearly audible, but there are other noises in the area apart from the range. Firing sounds are intermittent and do not raise the average levels appreciably.

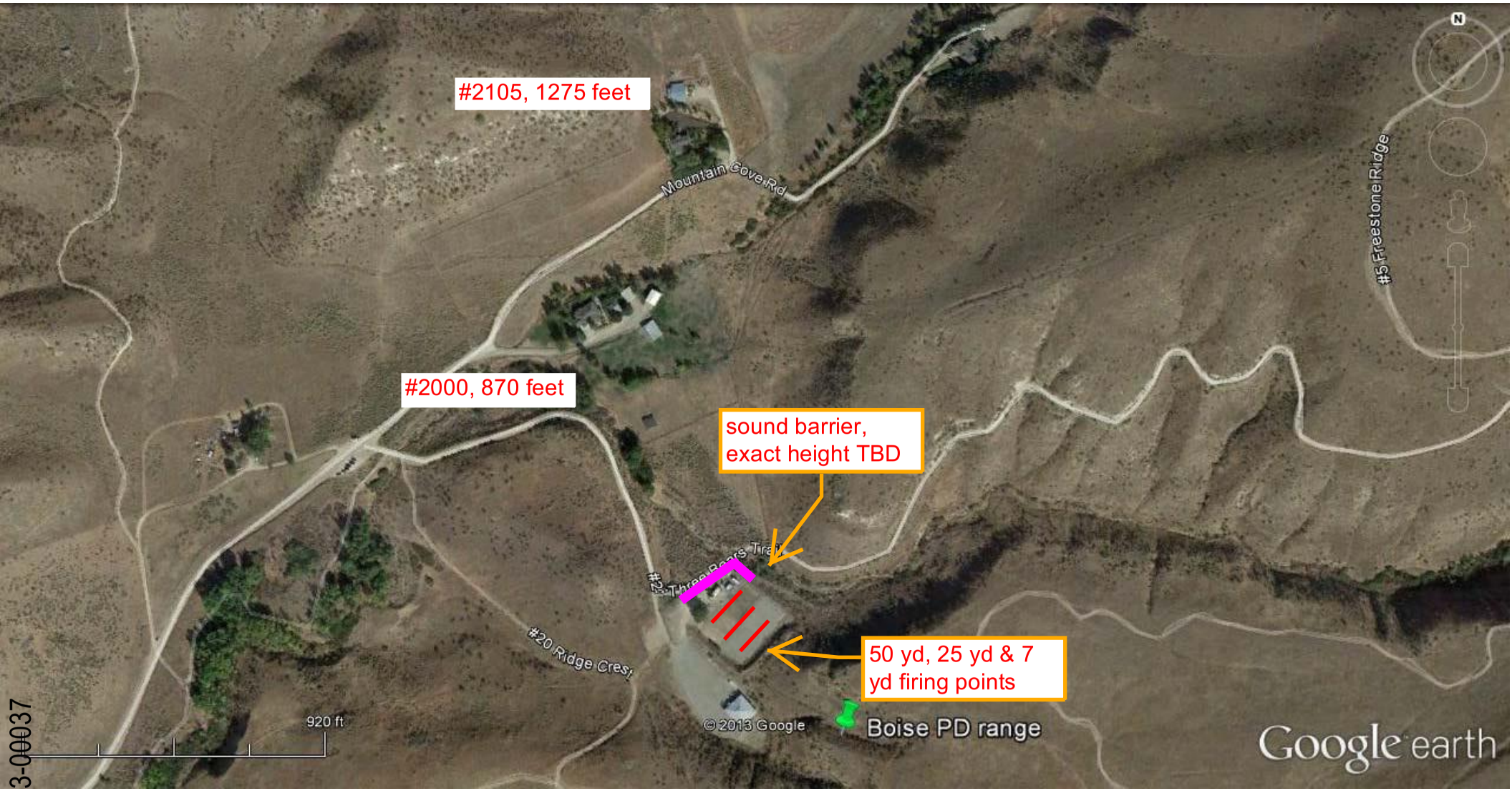
Peak levels at the hillside home (#2105) exceed the US Army range design criteria, but not by a dramatic amount. These observed levels would not generally violate a typical numerically-based local noise ordinance with typical sound level limits. At the valley home (#2000) peak levels are almost always at or below the 87 dB threshold.

The range will be reworked and will add three new firing lines, bringing the total to 38 firing points. A small number of extra lanes will not cause any meaningful increase in the current noise levels. It is typical to use 10-20 firing points at any given time.

Based on this information, no new adverse noise impacts are expected as a result of the planned modifications to the structure and continuing use of this existing police firing range.

It has been deemed impractical to confine the firing point to an enclosure near the 50 yard line. That would allow for the most effect from a barrier / enclosure, but would impede the training and potentially affect range safety due to changes in bullet impact zones.

Because of its elevation relative to the range, it will be difficult to build a barrier or enclosure that will substantially improve the sound levels at the hillside home, #2105 Mountain Cove Road.



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