Soil Treatments to Limit Lead Mobility

By Mark Bricka, Environmental Engineer
U.S. Army Corps of Engineers, Vicksburg, Mississippi

I'm here to talk about lead mobility and some of the practical methodology the U.S. Army Corps of Engineers (Corps) uses to limit it. My background is military, so I'm speaking specifically for military ranges. A lot of this information can be applied to recreational shooting ranges, although some weaponry and activities are a bit different.

Military ranges are left with barium from tracer rounds, but that probably won't be an issue at most recreational shooting areas. Lead anemone likely is the biggest contaminant problem we all face.

At some ranges, high amounts of copper and lead in soil kill off plants. This leads to erosion and a large amount of sediment transported off the range. We also deal with vertical migration or solubilized lead carried to groundwater. Normally this doesn't happen, but it can happen. If it happens at your range, the Clean Water Act will kick in, and you'll have serious problems! You need to be aware of these different means of lead mobility. Based on my research, erosion causes more massive transport of lead, and if you've got transport of lead off the range, you've got problems.

What factors affect erosion? If your range is in an area that receives a lot of rainfall, you've got increased potential for lead mobility. You've also got to fight topography. If it's hilly and your range slopes, it makes sense that water will run off. Wet/dry cycles are another factor. If you have a lot of wetting and drying, munitions will go through different reactions that potentially cause more mobility. Approximate depth of groundwater is important. Most military ranges are about 100 years old, and contamination usually is not more than about 10 feet deep. If the groundwater on your range is down 90 feet, you're probably not going to impact that; if it's down only 4 feet, you probably have some impact.

Lead is associated with the soil. As it rains, bullets corrode. As it rains again, solubilized water moves down through the soil, and lead is reabsorbed. You then have a soil mass that can propagate through soil. This happens very slowly, but there is always a downward migration of lead as a result.

Not all lead can be attenuated, and as you add to the source, you eventually will exceed the absorption capacity of the soil. If you remove the source periodically, you can resolve some of these issues.

What factors affect core water concentration? This gets scientific, and I'll try to give you an overview. There are different forms of lead. Lead nitrates will have different mobilities associated

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Dr. Mark Bricka has been a Research Environmental Engineer with the U.S. Army Corps of Engineers since 1986. He is a team leader, developing and evaluating innovative technologies for treatment of heavy metal contaminated soil, and investigating the effectiveness of the treatments. Dr. Bricka also presents proposed research concepts to sponsors, to ensure research and development funding is available for the metals team to develop cheaper, quicker and better remediation methods.

with them than lead sulfides do. We can affect mobility chemically by adjusting soil pH. Basically, the lower the pH level, the more mobile lead is.

Soil chemistry refers to how much clay and organic matter exists in soil. The Corps uses galvanized metals to avoid galvanic corrosion. Whenever two metals connect with each other, there is potential for corrosion. For this reason, jacketed bullets are worse in the environment than non-jacketed bullets. The copper and nickel jackets contact with lead which solubilizes the lead, and the lead migrates off. Corrosion is a major factor with bullets.

Military ranges generally are segregated. In sampling skeet and trap ranges, the Corps found arsenic contamination. It's near-surface contamination. Those projectiles do not penetrate the soil very deeply, and very little corrosion occurs. That indicates that this material is not going to impact groundwater. Samples from a skeet range that had been closed for 20 years showed large lead particles. Some almost look like pristine pellets. Most of them also have an oxide coating which tends ro keep materials from being mobile.

Pistols have a relatively low muzzle velocity. As long as you aren't using steel targets, those projectiles also tend to stay in their original configuration, and less fracturing means less corrosion.

Rifles ranges pose the major problem. As munitions split up, the jacket is in contact with lead and more surface area is exposed, so corrosion increases. Soil samples from rifle ranges show very small lead particles.

What technologies can we use to tackle this? Smart range and berm designs are critical avoidance methods. If you think about what you're doing before doing it, you can prevent future cleanup costs. You don't want to spread lead because every pound of dirt you treat will cost.

Bullet traps can be an effective solution, but some problems are associated with them. They can keep your bullets from going downrange and concentrating. Some traps also pose a disposal problem. Solving one problem can create others!

"Saycon." is a shock-absorbing concrete that the military's been developing for close-quarter combat scenarios. It has proven fairly effective for backstop material. "Green bullets" are made from tungsten instead of lead. Tungsten bullets have ballistic properties similar to normal projectiles, without lead-associated environmental issues. The military is beginning demonstration validation studies on tungsten.

What do you do about lead contaminated soil? First, there are soil removal and treatment techniques. Physical separation is screening that removes particulates. Chemical extraction uses acids to dissolve lead out of soil. Both of these options are expensive. Solidification stabilization techniques mix concrete or cement with soil which decreases mobility. Phosphate- and sulfate-based materials also can be mixed with soil. Most of these processes involve soil excavation, treatment and replacement, and they are expensive.

Fidal remediation is not well tested. We don't know the ramifications of this treatment, but it uses plants to pull lead out of soil. In some cases, it's been effective, but the verdict's still out.

Fidal stabilization keeps soil (and lead) in place with resilient turf, so there isn't a problem unless lead begins affecting groundwater. This is a low-cost treatment, and you would only have to cleanup at long-term intervals or when you close the range.

The military is working on low-cost alternatives to postpone or reduce the need for cleanup. The Corps currently is testing topical application of chemicals such as phosphate additives and iron to reduce lead mobility, because soil properties will control the mobility of lead. Some results have been promising. We're noting a decrease in the amount of mobile lead, so this is where we're headed.

Again, smart range design should be practiced in all cases. When building a range, you need to talk to the public. Be smart about environmental and sound issues you may face. Develop a maintenance plan. Basically, lead can and likely is migrating off your range. It doesn't pose a problem on all ranges, but it certainly can. Screening and treatment technologies exist, but the problem lies in their cost. Continued research and development for more cost-effective cleanup methods are needed. Cleanup costs are going to break the national budget for military ranges, and I know you folks with smaller recreational ranges can't afford these expensive cleanups either.