Evaluation of Lead Migration at a Public Shooting Range in Arkansas

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Introduction

-Gun ranges are the number one source of lead in the environment and one of the most unregulated (Houlihan).

-Lead (metal) readily oxidises to hydrocerussite ($Pb_3(CO)_3(OH)_2$), which can then dissolve to Pb(aq) which can either stay in solution or sorb onto FeO, MnO, and CO_3 colloids. These reaction steps and rates are dependent on soil and water pH.

-Lead solubility depends on the acidity of the surrounding soil and meteoric water.

Objectives

-Evaluate the lead migration in the soil at a shooting range

- Identify possible lead transport beyond shooting range boundaries.

Field Work and Analytical Procedures

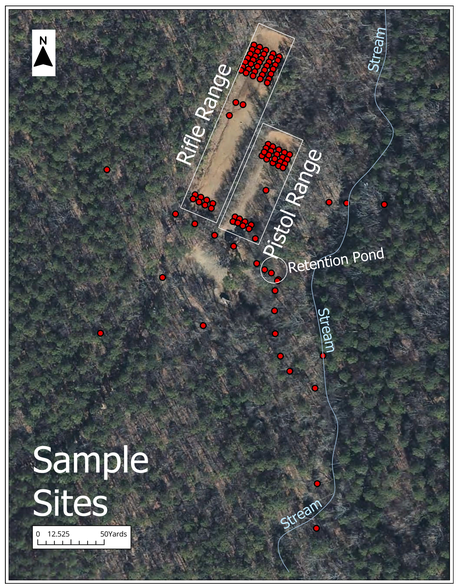
-Soil samples collected 1"-3" from the surface

-100 samples collected

-Samples were dried at 150 ° F (avg. time ~8hrs)

- To remove rock fragments and bullet fragments, dried soils were powdered and sieved at 4 and 2mm.

-Sieved soils were loaded in plastic analytical cups with 4µm prolene covers and analyzed with portable x-ray fluorescence



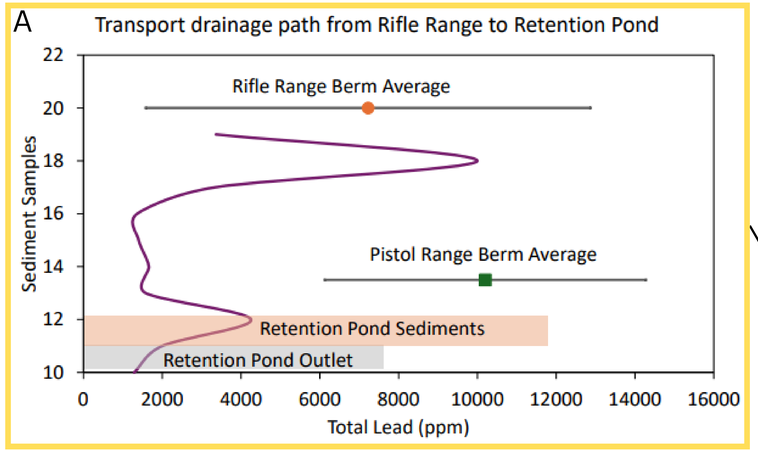
Rifle Range view from shooting benches

Pistol Range view from shooting benches

Portable X-ray fluorescence

Literature Cited Houlihan, Jane, and Richard Wiles. "Lead Pollution at Outdoor Firing Ranges." Environmental Working Group, static.ewg.org/reports/2001/LeadPollutionAtOutdoorFiringRanges.pdf. Accessed 7 Sept. 2024.

Results



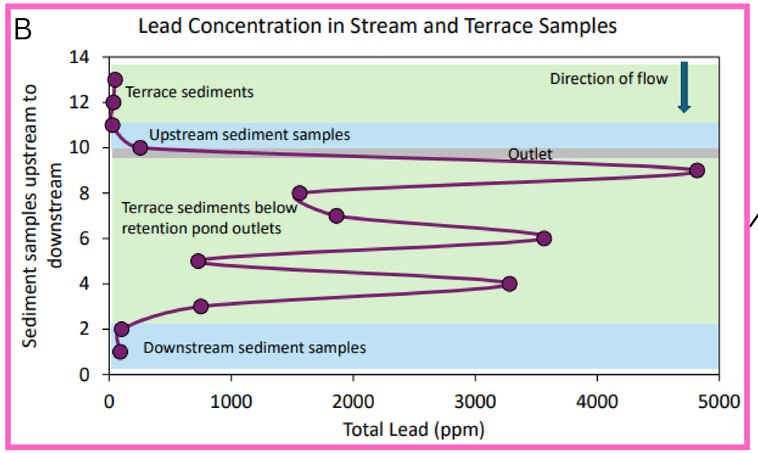
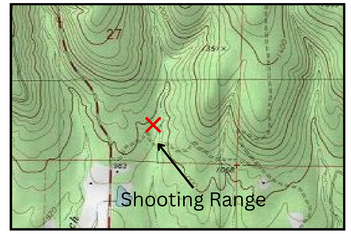
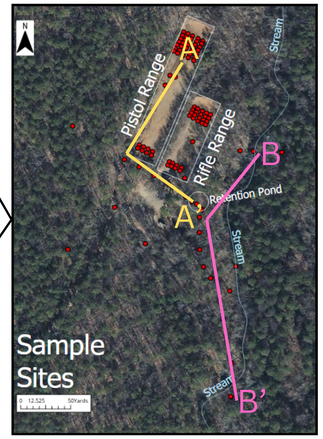


Figure A. shows A-A' profile of [Pb] along the yellow line on linked image. Figure B. shows B-B' profile of [Pb] along the pink line on linked image.

Surrounding Topography





Lead Concentrations on Pistol and Rifle Range

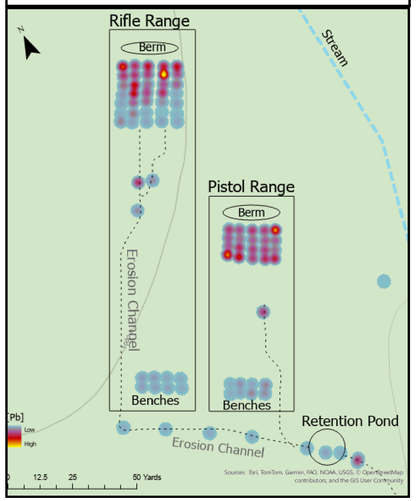
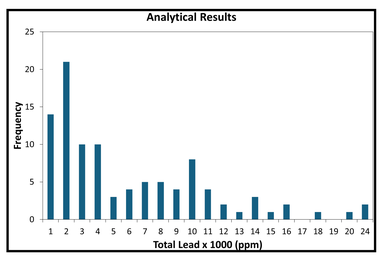


Figure C. Shows a heat map of lead concentrations on the rifle range and pistol range along with the man made stream leading into the retention pond

Data Summary

<u>Shooting range</u>
Min [Pb]:90ppm
Max [Pb]:23140ppm
Avg [Pb]:5240ppm

<u>Background</u>
Background avg [Pb]:40.4 ppm
Standard Deviation:16 ppm



Implications

-Pb distribution on the shooting range is generally as expected with higher [Pb] at the base of the berms and attenuates up range.

-Enrichment factors as high as 572(23140 ppm)(located near the berm of the rifle range) within the rifle range.

-[Pb] spikes were observed in the erosion channels (Figure A).

-Lead appears to be moving beyond the retention pond along the terrace feeding into the stream (Figure B) with enrichment factor as high as 81(3281 ppm) near the stream.

-The correlation between erosion channels and high [Pb] suggest mechanical transportation

Enrichment Factor (EF)= measured [Pb]/Avg background

Future Directions

-The concentration of lead can be monitored over time to track its temporal movement and distribution within the system.

-Gather surrounding soil characteristics to predict solubility of the heavy metals.