Soil, Sediment, and Surface Water Sampling at Small Arms Ranges to Inform the Design of Best Management Practices

Presenters: Larry Jordan (ARCADIS/Malcolm Pirnie) Jennifer Wilber (Headquarters Marine Corps)

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Headquarters Marine Corps (HQMC) has been proactively assessing small arms ranges (SARs) as part of the Range Environmental Vulnerability Assessments (REVA)

Where we’ve been
- Previous activities completed at SARs as part of HQMC REVA program

What we did
- Description of activities completed as part of this SAR sampling program and preliminary findings

Where we’re going
- Description of on-going activities associated with Best Management Practices at SARs
Definition and Range Prioritization

• SARs - .50 cal ammunition and smaller
  – Ranges where metals are the primary constituents of concern

• Range Prioritization
  – All SARs in the Marine Corps inventory were qualitatively scored using the SAR Assessment Protocol (SARAP)
  – Primarily focused on factors affecting lead (Pb) mobility
    • Most abundant constituent in small arms
    • Mobility is highly dependant on site-specific factors
  – Provided a defensible way to evaluate and prioritize 131 SARs without having to sample everyone
  – Identified ranges that posed the greatest risk for Munitions Constituent (MC) release
  – Allowed for development of range recommendations focused on areas most in need of actions to track or remedy MC releases
  – Prioritization was conducted within each installation and across the entire inventory
  – Solely focused on environmental conditions
Small Arms Range Assessment

- SARs were assessed using SARAP Evaluation Forms
- Conceptual Site Model (CSM) was developed to qualitatively assess the ranges
- Lead – MC indicator for SARs

### Small Arms Range Protocol Evaluation Forms

**Table 1: Range Use and Range Management (Source) Element**

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Evaluation Characteristics</th>
<th>Score Criteria</th>
<th>Site Score</th>
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<tbody>
<tr>
<td><strong>Duration of Range Use</strong></td>
<td>Length of time the range has been used</td>
<td>5 if usage &gt; 30 years</td>
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<td></td>
<td></td>
<td>3 if usage is 10 to 30 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 if usage &lt; 10 years</td>
<td></td>
</tr>
<tr>
<td><strong>Bullet-Capturing Technology</strong></td>
<td>The presence and duration of bullet-capturing technologies</td>
<td>If [range usage duration = bullet capture duration], then apply a negative score so that the [range usage duration + bullet capture duration] = 1</td>
<td></td>
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<tr>
<td></td>
<td>Compare the duration of the range use to the duration of bullet-capturing technologies.</td>
<td>If [range usage duration – bullet capture duration] = 10 to 30 years, then apply a negative score so that the [range usage duration + bullet capture duration] = 3</td>
<td></td>
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<td></td>
<td></td>
<td>0 if [range usage duration – bullet capture duration] &gt; 30 years</td>
<td></td>
</tr>
<tr>
<td><strong>MC Loading Rates</strong></td>
<td>The amount and types of small arms ammunition expended on the range</td>
<td>5 if MC loading &gt; 1000 pounds/year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Estimate the MC loading by using a time weighted average of MC loading rates.</td>
<td>3 if MC loading = 100 to 1000 pounds/year</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 if MC loading &lt; 100 pounds/year</td>
<td></td>
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<tr>
<td><strong>Range Maintenance</strong></td>
<td>Frequency of any range maintenance activities involving the removal of lead from the ranges</td>
<td>5 if lead is removed less than every three years</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3 if lead is removed more than every three years but less than annually</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 if lead is removed at least annually</td>
<td></td>
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**Source Element Score**

Notes:
Qualitative Assessment and Prioritization Results

- Fifteen SARs (11% of total) were ranked as HIGH based on the results of the SARAP
  - Sampling was immediately completed to evaluate risk
  - Sampling of appropriate media as part of the REVA program showed that no releases have occurred

- 44% of ranges were ranked as MEDIUM
  - Four were selected for additional sampling (discussed below)
  - Targeted sampling effort to fill data gaps to better understand lead migration

- Low ranked ranges (45% of total) were considered to have no potential for adversely impacting off-range receptors
HQMC requested that a sampling program be completed at four SARs within the Marine Corps inventory.

SARs chosen were all very heavily utilized and represented a cross-section of range types and physical environments:

- Ranges were distributed throughout the United States
  - Covered both arid and rainy environments, various temperature regimes and soil types
  - Range types included various traditional SARs and a Helicopter Gunnery Range
- Sample location distribution would help show where lead is deposited and where it goes
  - Where should BMPs be placed for greatest effect?
Sampling Plans Included

- Collecting surface and subsurface soil samples from various portions of each of the ranges
  - Samples analyzed for MC and soil parameters which affect MC transport
- Collecting surface water and sediment samples from drainages
  - Samples analyzed for MC and parameters which affect MC transport
Small Arms Sampling Results

• MC is distributed in soils as expected
  – Highest concentrations are found immediately adjacent to target areas / berms
  – The range floors, back of berms, and areas downrange show concentrations above background
  – MC concentrations in subsurface soils show MC transport during infiltration
    • Concentrations fall off quickly during infiltration and when fine-grained soils were encountered
    • Additional work being completed to evaluate potential migration to groundwater at specific sites

• MC distribution in surface water / sediment heavily influenced by climatic factors and physical range characteristics
  – “First Flush” samples show highest MC concentrations
    • Subsequent storms showed order of magnitude drops in MC concentrations
  – Streams / drainages without a direct connection to potential source areas generally showed no impacts from MC
Example of drainage without a direct connection to a significant source area

- MC concentrations in sediment (SD) and surface water (SW) are well below applicable criteria
Next Steps

- Additional work will be completed at select ranges to understand MC migration in the subsurface
  - Additional activities will evaluate the groundwater pathway at ranges where vertical transport was considered a possibility
- BMP studies at a selection of ranges are ongoing
  - Data collected as part of this evaluation will be used to focus future BMP and range management efforts and will guide additional actions where required
- Five year reviews are underway
  - SARs will be re-evaluated for changes in loading, BMPs, etc.
Questions?