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FINAL
OPERATIONAL RANGE ASSESSMENT PROGRAM REPORT
UNITED STATES ARMY GARRISON – WEST POINT, NEW YORK

To meet Department of Defense (DoD) requirements and support the U.S. Army's Sustainable Range Program, the Army is conducting the Operational Range Assessment Program (ORAP) to determine whether a release or substantial threat of release of munitions constituents of concern (MCOC) from an operational range to an off-range area creates a potentially unacceptable risk to human health or the environment. The Phase I ORAP assessment is a qualitative evaluation of operational range sources of MCOCs, potential off-range migration mechanisms, and the presence of human or sensitive ecological receptors. Conclusions from the Phase I place each operational range into one of two categories: Unlikely or Inconclusive. Unlikely range areas are those where, based on a review of the information available, there are no known MCOC releases or source-receptor interactions that could present an unacceptable risk to human health or the environment; these ranges are placed into a periodic, 5-year review cycle. Operational range areas categorized as "Inconclusive" are those where existing information either is insufficient to make a source-receptor interaction determination, or indicates the potential for such interaction to be occurring. Sites with ranges categorized as Inconclusive are recommended for further evaluation by conducting an ORAP Phase II assessment.

The ORAP Phase II assessment re-evaluates whether the source-receptor pathway identified during Phase I is complete, identifies any new information that may impact the Phase I's conclusions, and as necessary involves a quantitative assessment of environmental media to determine whether MCOC are potentially leaving the operational range footprint by an identified pathway (e.g., groundwater or surface water) and pose a potential risk to off-site receptors.

This ORAP Phase II Report assesses source-receptor pathways identified at U.S. Army Garrison – West Point (West Point), New York. EA Engineering, Science and Technology, Inc. (EA) conducted this evaluation under contract W9128F-10-D-0056 to the U.S. Army Corps of Engineers (USACE)-Baltimore District.

West Point occupies 16,077 acres along the western bank of the Hudson River in southeastern New York, approximately 50 mi north of New York City. West Point currently utilizes 134 operational ranges totaling 14,213 acres. The ranges include firing ranges, training and maneuver areas, and a dudded impact area in the central portion of the installation. An inactive dudded impact area is located near the northern installation boundary. The remaining 1,864 acres consist of non-operational area (including the cantonment area and U.S. Military Academy). The Phase I completed for West Point in 2008, categorized 5 of the 134 operational ranges as Inconclusive due to potential surface water and/or groundwater pathways. The five Inconclusive ranges consisted of four firing ranges and one firing point totaling 63 acres. During the conduct of the Phase II, and based on additional information gathered during the Phase I review and Phase II site reconnaissance, 22 additional ranges totaling 3,247 acres were re-categorized as Inconclusive, and the groundwater pathway was eliminated as a potential pathway for off-range MCOC migration.

Of the 22 ranges re-categorized as Inconclusive, 16 ranges were because of previous detections of explosives and metals in sediment and surface water samples collected on and downstream of the ranges; one range, the northern impact area, was because the brook draining this impact area is periodically used as a recreational area (i.e., wading/swimming) by residents in the cantonment area, and the lower reaches

of the brook are designated as trout spawning habitat; and five current maneuver and training areas within a historical impact area were due to the potential for historical MCOC sources.

The Phase I identified potential human receptors for groundwater as users of drinking water wells within 4 mi downgradient of the Inconclusive ranges at West Point. However, shallow groundwater flow in surficial deposits and weathered bedrock generally mimics topography, discharges to nearby surface water bodies, and is not expected to cross hydraulic barriers such as lakes and streams within West Point. All drinking water wells not within operational range areas and identified within 4 mi downgradient of the Inconclusive ranges at West Point are hydraulically separated by surface water (i.e., Highland Brook) from potential MCOC source areas. Therefore, the groundwater pathway was determined to be unlikely and a groundwater investigation was not included in the Phase II Assessment at West Point.

Based on the additional Inconclusive ranges and the elimination of groundwater as a potential pathway for off-range MCOC migration, the quantitative Phase II Assessment for West Point focused on surface water pathways for off-range migration of MCOCs from 27 operational ranges totaling 3,310 acres.

Phase II multi-season field sampling was conducted at West Point during April 2012 and August/September 2012. Wet and dry season surface water, sediment, and benthic macroinvertebrate sampling was conducted to identify potential seasonal variations in water quality transport characteristics. Diurnal variations in surface water quality were accounted for using 24-hour composite samples for most of the samples. The effects of precipitation and runoff on water quality were considered by collecting 2 hour composite samples at each stream location after a storm event during the dry season. Surface water and sediment samples were collected from seven locations at West Point: five locations downstream of potential MCOC source areas and two reference locations upstream. Benthic macroinvertebrate samples were collected at each stream sampling location if suitable sampling conditions were present. Sediment samples were collected as composited grab samples from all surface water sampling locations. Additionally, grab water samples were collected from two water treatment plants that receive potable water from surface water intakes downstream of potential MCOC source areas.

Surface water samples were analyzed for explosives, perchlorate, metals (i.e., antimony, copper, lead, zinc, and tungsten); and water quality parameters. Sediment samples were analyzed for explosives, metals, total organic carbon, and simultaneously extracted metals/acid-volatile sulfides. Due to limited flow and dry conditions experienced during the dry season sampling event, benthic macroinvertebrate samples could not be collected at two of the downstream sampling locations. All analytical data from each sample location at West Point was selected for statistical analysis. The statistical analysis process included comparison to reference locations using a *t*-test ($\alpha = 0.05$) and calculation of 95 percent upper confidence limit of the mean (UCLM) for comparisons to screening levels.

No explosives or perchlorate were detected in surface water or sediment samples at concentrations that exceeded potable (surface water) or freshwater (surface water and sediment) screening levels. However, cyclotrimethylenetrinitramine (RDX) was detected in surface water at the sampling location along Popolopen Brook in both the wet and dry season sampling events, indicating that migration of RDX from Inconclusive ranges upstream is occurring. As the observed RDX concentrations are below potable and freshwater screening levels, off-range migration of RDX does not currently present an unacceptable risk to downstream receptors. Additionally, no RDX was detected at the water treatment plant that receives potable water from a surface water intake downstream from the sampling location.

No metals were detected in surface water at concentrations that exceeded potable screening levels. For all downstream sampling locations, average downstream concentrations of metals in surface water were not statistically greater than average reference concentrations and/or the 95 percent UCLM concentrations did not exceed associated freshwater screening levels. For three of the five downstream sampling locations,

average downstream concentrations of metals in sediment were not statistically greater than average reference concentrations and/or the 95 percent UCLM concentrations did not exceed associated freshwater screening levels. For two downstream sampling locations (i.e., Long Pond and Crow's Nest Brook), the 95 percent UCLM for metals in sediment exceeded freshwater screening levels and average downstream concentrations were statistically greater than average reference concentrations.

At the downstream sampling location at Long Pond the 95 percent UCLM copper concentration in sediment exceeded the freshwater screening level and the average copper concentration was statistically greater than reference. The elevated 95 percent UCLM copper concentrations in sediment were attributable to copper loading caused by the periodic application of copper sulfate to control algae growth in the pond. Therefore, copper in sediment at the location is not associated with potential MCOC sources within upstream Inconclusive range areas.

The 95 percent UCLM concentrations for copper, lead, and zinc in sediment at the sampling location along Crow's Nest Brook exceeded associated screening levels and the average concentrations for the three metals were statistically greater than reference. The 95 percent UCLM concentrations for copper, lead, and zinc were below U.S. Environmental Protection Agency regional screening levels for direct human exposure to soil indicating no unacceptable risks for recreational human receptors (i.e., residents wading/swimming in the brook).

Calculating the sum of simultaneously extracted metals/acid-volatile sulfides ratios (ΣSEM/AVS), normalized to the fraction of organic carbon can help determine whether there is enough organic carbon present in sediment to reduce the toxicity of divalent metals (i.e., copper, lead, and zinc) to benthic organisms. Organic carbon normalized ΣSEM/AVS ratios for each sampling location at West Point indicates that adverse biological effects to benthic organisms are not expected from divalent metals.

Benthic macroinvertebrate results indicate that the streams at West Point support a healthy benthic community. Although diversity index values for two downstream locations (i.e., Crown Brook and Popolopen Brook) were statistically lower than associated reference locations, the diversity index values observed suggest that the two locations are intermediate to high quality streams. Dry season sampling results exhibited a decline in the benthic community relative to the wet season results. Dry conditions during 2012 likely contributed to this difference.

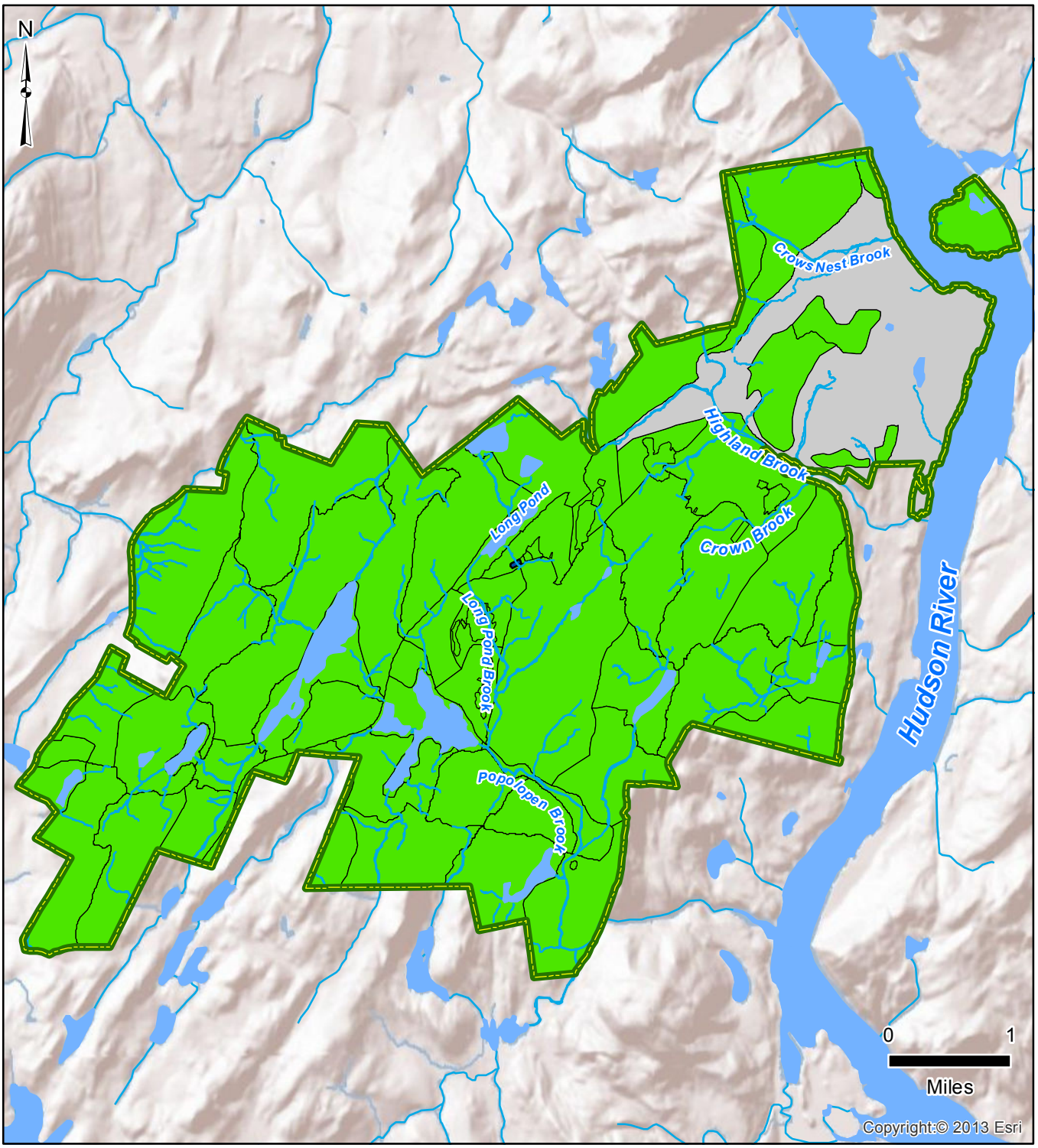
Based on the elevated concentrations of metal MCOC in Crow's Nest Brook sediment, a Screening Level Ecological Risk Assessment was conducted to further evaluate risks to ecological receptors from exposure to elevated concentrations of copper, lead, and zinc. The Screening Level Ecological Risk Assessment determined that the MCOC in Crow's Nest Brook are not expected to present a potential risk to benthic or piscivorous wildlife ecological receptors. Benthic organisms are not found to be at risk from MCOC in Crow's Nest Brook because even though onsite concentrations of copper, lead, and zinc exceeded screening levels and were statistically greater than reference, they did not exceed Probable Effects Concentrations; and organic carbon content indicated that toxic effects from metals in sediment were not expected. Additionally, results of the benthic macroinvertebrate sampling suggest that there is no impairment to the benthic community. Piscivorous birds and mammals were not found to be at risk from copper, lead, or zinc in Crow's Nest Brook because although onsite concentrations and estimated doses exceed those estimated for reference, they do not exceed Toxicity Reference Values protective of wildlife. Therefore, it is unlikely that metals MCOC associated with Inconclusive ranges upstream of the Crow's Nest Brook sampling location present an unacceptable risk to ecological receptors.

In summary, the ORAP Phase II assessment for West Point concludes that no MCOC are migrating from operational ranges at concentrations that pose an unacceptable risk to off-range human or ecological receptors. The operational ranges at West Point are categorized as Unlikely and placed into a periodic review program (**Figure 1**).

Operational Range Assessment Program
Phase II Quantitative Assessment
United States Army Garrison - West Point, New York

EA Engineering, Science, and Technology, Inc.

Figure 1
Summary of Phase II Conclusions



Installation Data
- Installation Boundary

Range Category
- Operational Range - Periodic Review
- Excluded

Hydrology
- River/Stream
- Water Body

Data Sources:
West Point ITAM 2011
ArcGIS Map Service 2010

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