From: Mckenna, James J CIV (USA)
Sent: Tuesday, May 5, 2020 2:49 PM
To: 'Kurt Kochan'
Cc: Maly, Mary Ellen CIV USARMY IMCOM AEC (USA); jody. hawks; Losano-Ramsey, Ellen A.; Pace, Anthony; Rebecca Wright; pizarro.luis@epa.gov; Johnson, Chad M CIV USARMY JMC (USA); Lyons, Bridgett E CIV (USA); Nikki Herschler; Kyle Newman; Walworth, Nicole U CIV USARMY CENAB (USA)
Subject: RE: [Non-DoD Source] Draft Final QAPP v2 - March 2020 Former Trench Mortar Range MRS Project - Radford AAP
Attachments: Radford RFI QAPP- Responses to VDEQ Comments - 4 May 2020.xlsx; AppQ_BHHRA_SLERA-4May2020_R.docx

Importance: High

Kurt,

Our responses to the comments from your April 30, 2020 email below are in the attached files for your review and action.

We will revise and resubmit the subject QAPP upon receipt of your concurrence/approval.

If there questions or concerns let's discuss.

Thanks in advance for your support of the Radford AAP Installation Restoration Program,
Jim

From: Kurt Kochan <kurt.kochan@deq.virginia.gov>
Sent: Thursday, April 30, 2020 3:32 PM
To: Walworth, Nicole U CIV USARMY CENAB (USA) <nicole.u.walworth.civ@mail.mil>; Mckenna, James J CIV (US) <james.j.mckenna16.civ@mail.mil>
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Subject: [Non-DoD Source] Draft Final QAPP v2 - March 2020 Former Trench Mortar Range MRS Project - Radford AAP

Hi Nicole,

All response to comments are acceptable except the following. Please find DEQ response in red below.

11	Kurt Kochan	page 10	Appendix Q, Section 1.5.1	If the sediment pathway is open, then surface water ingestion could be as well.
12	Kurt Kochan		Appendix Q, Section 2.1.1	Carnivorous mammals and birds have been identified at RFAAP and should be included in the SLERA.

DEQ Comment to Response to DEQ Comment 12: Current and future incidental ingestion and dermal adsorption for the surface water pathway should be included in the HHRA for any receptors that have the potential to be exposed to any standing or flowing water.

DEQ Comment to Response to DEQ Comment 12: These receptors should still be included, though RFAAP may perform a refined SLERA. The refined SLERA can account for a site being a limited portion of the receptor's home range through the use of an area use factor.

Please let me know if you have any questions or comments. Thanks.

Kurt

Kurt W. Kochan
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From: Walworth, Nicole U CIV USARMY CENAB (USA) <nicole.u.walworth.civ@mail.mil < Caution-mailto:nicole.u.walworth.civ@mail.mil > >
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Subject: RE: Draft Final QAPP v2 - March 2020 Former Trench Mortar Range MRS Project - Radford AAP

Kurt - I uploaded the document so you should see something from DoD Safe. If you do not see it, please let me know. I hope you are staying safe during this crazy time.

Nicole Walworth
Mobile: (443) 469-1377

From: Mckenna, James J CIV (US)
Sent: Friday, March 20, 2020 9:33 AM
To: kurt.kochan@deq.virginia.gov < Caution-mailto:kurt.kochan@deq.virginia.gov >
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Subject: Draft Final QAPP v2 - March 2020 Former Trench Mortar Range MRS Project - Radford AAP

Kurt,

Nicole Walworth, Baltimore Corps of Engineers will be providing a SAFE link to the subject document to this email distribution. It has been revised to address DEQ comments.
A certification letter will follow.

Thanks in advance for your support of the Radford Army Ammunition Plant Installation Restoration and Munitions Response Programs.
Jim McKenna

APPENDIX Q - HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT METHODOLOGY

This project includes conducting human health and ecological risk assessments for the Former Gun and Trench Mortar Range MRS and Area A (section of the adjacent New River) at Radford Army Ammunition Plant (RFAAP) to determine whether respective site contaminants pose a current or potential risk to human health and the environment in the absence of any remedial action.

1. HUMAN HEALTH RISK ASSESSMENT

A baseline human health risk assessment (BHHRA) will be conducted to assess potential health impacts to humans, considering both the current and future uses at the MRS and within Area A. Although this MRS is covered under Resource Conservation and Recovery Act (RCRA), it is not expected that the Virginia Unified Risk Assessment Model (VURAM) will be used because it is set up primarily with default parameters, and WESTON anticipates the use of more appropriate site-specific parameters to calculate site risk for human receptors. Therefore, the BHHRA will be conducted in accordance with guidance provided in the U.S. Army Corps of Engineers (USACE) *Risk Assessment Handbook, Volume I: Human Health Evaluation* (USACE, 1999) and the U.S. Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS), as well as other appropriate USEPA and Virginia Department of Environmental Quality (VDEQ) guidelines for risk assessment. The objectives of the BHHRA are to estimate potential risk to people contacting site-related chemicals of potential concern (COPCs) under scenarios of current and plausible future land uses, provide an analysis of risks and help determine the need for remedial action(s) at the site, and identify specific media and areas associated with unacceptable risk as applicable. The BHHRA will consist of five main sections: Hazard Identification, Toxicity Assessment, Exposure Assessment, Risk Characterization, and Uncertainty Analysis.

1.1 HAZARD IDENTIFICATION

The hazard identification will involve the review of available site data, the evaluation of data usability and data validation, establishment of guidelines for data reduction, the evaluation of data for use in the risk assessment, and selection of COPCs. The following guidelines for data reduction will be used to produce the data summaries for each medium of concern for the BHHRA:

- If a chemical is reported in both a field sample and a method or field blank, it will be considered to be a positive identification if the chemical is present in the field sample at a concentration greater than 10 times (for common laboratory contaminants), or 5 times (for all other substances) the maximum concentration reported in the blank for that data set.

- If a chemical is not positively identified in any sample for a given medium, because it is reported as a non-detect (indicated by a “U” qualifier), or because it is rejected by the data validator (indicated by an “R” qualifier), it will not be addressed for that medium. No data containing an “R” flag will be used in the BHHRA.

- Data with “J” qualifiers will be assumed to be positive identifications. “J” values are estimated chemical concentrations reported below the minimum confident quantitation limit or the sample quantitation limit (SQL). All data with “J” qualifiers will be assumed to be positive identifications for that medium and the corresponding reported concentrations will be used.

- Duplicate samples from the same sampling location will be considered as one data point. If a sample duplicate(s) is collected and analyzed, the average of the reported concentrations will be used for subsequent calculations unless there is a greater than 50% difference in soil and sediment concentrations and a 30% difference in water concentrations, in which case the higher of the two concentrations will be used. In the case of a detected sample and a non-detect duplicate, the detected concentration will be carried through subsequent calculations.

For all sample locations where soils will be sampled at multiple depths for a single location, the results from the various depths will be treated as individual data points in summarizing the data.

COPCs will be identified by comparing the maximum detected chemical concentration for each chemical by medium. In general, the list of chemical COPCs to be evaluated in the BHHRA includes the following:

- Positively detected in at least one sample in a given medium, including (a) chemicals with no qualifiers attached (excluding samples with unusually high detection limits) and (b) chemicals with qualifiers attached that indicate known identities but unknown or estimated concentrations (e.g., J-qualified data).

- A chemical will be excluded as a COPC for a medium if it is not detected in any samples from that medium.

- Frequency of detection (i.e., less than 5%) will be considered in the exclusion of a chemical as a COPC in conjunction with toxicity screening.

- Not normally considered as being toxic to humans. Calcium, magnesium, potassium, and sodium are considered to be essential nutrients and are toxic only at very high doses. These chemicals will not be retained as COPCs.

- Chemicals detected in media at concentrations in excess of risk-based concentrations (RBCs) which are associated with a cancer risk of 1E-06 (one-in-one-million) and a systemic HQ of 1. The USEPA has a national screening database found at: http://epa-prgs.ornl.gov/chemicals/index.shtml. These regional screening levels (RSLs) will be used for chemical comparison.

- Soil COPCs will be identified by comparing the maximum detected concentration of each chemical with the residential RSL. For COPC screening purposes, noncarcinogenic RSLs will be adjusted to correspond to a target hazard quotient (THQ) of 0.1 rather than 1. This will be done to ensure that chemicals with additive effects are not prematurely eliminated during screening. Where RSLs are available for carcinogenic and noncarcinogenic endpoints and both ingestion and inhalation exposure routes, the lower (i.e., most stringent) value will be used for the screening comparison.

- Currently, there are no RSLs for sediment exposure. Therefore, in order to select sediment COPCs, the maximum detected concentrations in sediment will be compared to the residential soil RSLs multiplied by a factor of 10 (TR – 1.0E-05; THQ – 1.0). VDEQ guidance states, "VRP Tier II screening values for sediment were obtained by multiplying residential soil RSL values by a factor of 10 to account for decreased exposure to sediments. For non-carcinogens, however, the target hazard quotient has been adjusted to 0.1 (the RSL has been divided by 10) so that additive toxicity will not result in a hazard index (HI) greater than one for multiple contaminants."

- If a risk-based screening level cannot be obtained or calculated for a chemical, that chemical will be carried forward and discussed qualitatively in the uncertainty analysis. However, when a chemical does not have a screening value available, efforts will be made to identify a suitable surrogate to use in the COPC selection process.

- USEPA has not assigned verified or provisional toxicity values (i.e., cancer slope factors [CSFs] and reference doses [RfDs]) to lead because the toxicity data available to date are inadequate for evaluation by current methodology. Therefore, lead risk will not be evaluated using the conventional risk assessment approach. USEPA's Integrated Exposure Uptake Biokinetic model (IEUBK) (USEPA, 2010) will be used to characterize lead risk to children aged 1 to 6 years. The Adult Lead Model (USEPA, 2003a) will be used to characterize lead risk to unborn infants based on environmental exposure of the mother to lead-contaminated media.

- Soil data will also be compared to existing the 95% upper tolerance limit (UTL) background level from Facility-Wide Background Study Report (IT Corporation, 2001). Chemicals that are above risk-based screening levels and background levels are identified as site-related COPCs and will be evaluated in the risk assessment. Chemicals that are above risk-based screening levels but below background levels are identified as non-site related COPCs and will be discussed in the Uncertainty Analysis (Tri-Service Environmental Risk Assessment Working Group [TSERAWG], 2011).

Upon identification of the COPCs, summary tables will be prepared by medium and will present the following information:

- List of COPCs.
- Arithmetic mean concentration of data.
- Median concentration of data.
- Distribution of data (normal, lognormal, neither).
- 95 percent upper confidence limit (95% UCL) of the arithmetic mean.
- Exposure point concentration (EPC).

1.2 TOXICITY ASSESSMENT

This section of the BHHRA will present a discussion of carcinogenic and noncarcinogenic toxicity characteristics of the COPCs and summarize the carcinogenic and noncarcinogenic toxicity criteria to be used in the risk characterization step. The toxicity criteria will be obtained using the following hierarchy:

- Tier 1 – USEPA's Integrated Risk Information System (IRIS) computerized database found at www.epa.gov/iris (USEPA, 2019b).

- Tier 2 – USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) developed by the Office of Research and Development/National Center for Environmental Assessment (NCEA)/Superfund Health Risk Technical Support Center (STSC).

- Tier 3 – Other Toxicity Values (can include, for example, NCEA values as presented on the USEPA RSLs Table (USEPA, 2019a), the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), and toxicity values developed by state agencies such as California EPA.

Only chronic RfDs will be used in estimating non-carcinogenic HQs and HIs.

Toxicity criteria have not been developed for the dermal exposure route. Dermal RfDs will be derived for each chemical by multiplying the value used as the oral RfD by an appropriate gastrointestinal absorption value (ABS_{GI}). The ABS_{GI} is also known as the oral to dermal adjustment factor. Chemical-specific ABS_{GI} factors will be obtained from Exhibit 4-1 of USEPA RAGS Part E (USEPA, 2004). For organic chemicals in which chemical-specific ABS_{GI} factors are not available, the ABS_{GI} factor will be assumed to be 100%, indicating that organic chemicals are generally well absorbed (i.e., >50% across the gastrointestinal [GI] tract). Similarly, for inorganics in which chemical-specific ABS_{GI} factors are not available, the ABS_{GI} factor will also be assumed to be 100%.

Summary tables will be included that present the toxicity values for each of the COPCs and will include the source, the USEPA weight-of-evidence (for carcinogens), the route of administration, and the critical noncarcinogenic health effect.

When toxicity criteria are not available for some of the chemicals detected at the site, a surrogate (substitute) chemical will be selected to evaluate the potential impacts of a COPC lacking toxicity criteria. For instance, vanadium pentoxide will be used as a surrogate chemical for vanadium. Use of surrogate toxicity data will be documented in the BHHRA text.

1.3 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the nature, extent, and magnitude of potential exposure of human receptors to COPCs considering the current and reasonably anticipated future uses of the site. The exposure assessment includes an evaluation of the likelihood of such exposures occurring and provides the basis for development of acceptable exposure concentrations. The reasonable maximum exposure (RME) scenario will be evaluated for each receptor group. The exposure assessment involves several key steps:

- Evaluation of the exposure setting includes describing the local land and water uses and identifying the potentially exposed human populations.
- Development of the conceptual site model (CSM) includes identifying the source(s) of contamination, the transport and release mechanisms, the exposure media, the exposure routes, and the potentially exposed populations (both current and future), provided in **Figure 1**.
- EPCs will be calculated for the COPC, the exposure scenario, and medium. EPCs are the concentrations to which a receptor may come in contact with at an area. The EPC will be either the 95% UCL of the mean or the maximum detected concentration, whichever is lower. The 95% UCLs will be calculated following the most recent USEPA guidance and USEPA's ProUCL statistical software program (Version 5.1, USEPA 2015). Note that ProUCL Version 5.1 restricts the use of ProUCL for samples of a size of at least 5. For data sets with less than 5 samples, no decision statistics will be computed when not more than one detected observation is present in the data set. The maximum detected concentration will be used as the EPC for sample sizes smaller than 5 or for data sets with only one detected observation.
- Algorithms for calculating the exposure doses through exposure pathways to receptors will be presented in the risk assessment and will be consistent with USEPA and USACE risk assessment guidance and recommendations from USEPA Region 3.

- Exposure parameters with which to calculate the exposure doses will be identified for each scenario and exposure routes. Guidance documents such as the following will be used to identify exposure parameters:
  - RAGS Volume I, Human Health Evaluation Manual, Part A, Interim Final (USEPA, 1989).
  - The Exposure Factors Handbook and updates (USEPA, 1997a, 2011, 2017).
  - Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002).
  - Human Health Toxicity Values in Superfund Risk Assessments (USEPA, 2003b).
  - RAGS Vol. I, Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004).
  - RAGS Vol. I, Human Health Evaluation Manual, Part F, Supplemental Guidance for Inhalation Risk Assessment (USEPA, 2009).
  - Specific guidance from USEPA Region 3, VDEQ, and USACE.
  - Site-specific information and professional judgment.
- Exposure doses for both carcinogenic and noncarcinogenic effects will be calculated and presented in tabular format.

1.4 RISK CHARACTERIZATION

Carcinogenic risk and noncarcinogenic health effects in susceptible populations will be determined by combining chemical-specific toxicity criteria with quantitative information from the exposure assessment. These comparisons will determine whether site contamination may affect human health.

The objective of the risk characterization is to evaluate the carcinogenic risks and adverse noncarcinogenic health effects occurring as a result of exposure to COPCs. The potential for cancer risks and noncarcinogenic health effects of COPCs will be evaluated separately because of differences in the processes by which these health effects are believed to occur. Cancer risks will be calculated for those COPCs with evidence of carcinogenicity and for which cancer toxicity values are available. Noncarcinogenic health effects will be evaluated for the COPCs for which noncarcinogenic toxicity values are available.

USEPA has developed exposure algorithms for calculating contaminant intakes through the relevant exposure pathways and routes for a site. These algorithms are mathematical models that use a variety of parameters to quantify the intake of a contaminant. The development of chemical intakes is based on USEPA methodology presented in RAGS Parts A, B, E, and F (USEPA, 1989, 1991a, 2004, 2009) and Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03 (USEPA, 1991b). To evaluate direct contact exposure to COPCs in site soil and sediment (i.e., ingestion and dermal absorption), the exposure algorithms combine chemical concentrations with pathway- and route-specific parameters to produce daily chemical intakes in terms of the milligrams of chemical taken into the body per kilogram of body weight per day (mg/kg-day). The generic direct contact exposure algorithm is as follows:

$$I = EPC \times CR \times ET \times EF \times ED / (BW \times AT)$$

Where:

- I = intake; the amount of chemical at the exchange boundary (mg/kg body weight/day).
- EPC = exposure point concentration in specific media (e.g., milligrams of contaminant per kilogram of soil).
- CR = contact rate; the amount of contaminated medium contacted per unit time or event (e.g., mg/day).
- ET = exposure time; describes how long exposure occurs (hrs/day).
- EF = exposure frequency; describes how often exposure occurs (days/year).
- ED = exposure duration; describes how long exposure occurs (years).
- BW = body weight; the average body weight over the exposure period (kilograms).
- AT = averaging time; period over which exposure is averaged, which is equal to a 70-year lifetime when evaluating carcinogens (25,550 days), or averaged over the actual exposure duration for noncarcinogens.

For the inhalation exposure route, the concentration of the chemical in air is used as the exposure metric (e.g., milligrams per cubic meter [mg/m^3]), as follows (USEPA, 2009):

$$EC = (CA \times ET \times EF \times ED)/AT$$

Where:

- EC = exposure concentration (mg/m^3)
- CA = contaminant concentration in air (mg/m^3)

ET = exposure time (hours/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

AT = averaging time (carcinogens: 70 years x 365 days/year x 24 hours/day; non-carcinogens: ED x 365 days/years x 24 hours/day)

The estimated intake for each COPC will be based on the EPC for the COPC and on site-specific exposure factors developed using USEPA Exposure Factors OSWER directive (USEPA, 2014), USEPA's *Exposure Factors Handbook: 2011 Edition* (USEPA, 2011), and those references previously cited in this section.

1.5 IDENTIFICATION OF LIMITATIONS/UNCERTAINTIES

The section will identify critical assumptions and uncertainties. The goal of the uncertainty analysis in a risk assessment is to provide to the appropriate decision makers (i.e., risk managers) information about the key assumptions, their inherent uncertainty and variability, and the impact of this uncertainty and variability on the estimates of risk. The primary sources of uncertainty in this risk assessment will be identified and the potential impacts to the risks (over- or under-estimate) will be described.

1.5.1 Potentially Exposed Populations

As identified in the Site Inspection (SI) report, potential human receptors include RFAAP workers, construction workers, and trespassers/visitors. Recreational users of Area A are also considered potential human receptors who will have the same exposure parameters as the trespasser/visitor.

The current activities at the MRS and Area A include visitors touring the MRS, work performed on the MRS by site workers, construction activities on the MRS by construction workers, trespassers who may illegally enter or hunt on the MRS, and recreational boaters who float within Area A portion of the New River. No residential housing exists nearby; therefore, it is unlikely that residential exposure to chemicals of potential concern occurs at the site. Receptors to be evaluated in the risk assessment could include site and construction workers, and visitors/trespassers (adults and children) of the New River that could be exposed to soil at the MRS and sediment within the New River. Additional personnel and areas of the site that could introduce risk will be evaluated. Future uses of the MRS and Area A are expected to include the current uses.

Potential human exposure pathways for soil and sediment exist at the site. A summary for each medium is discussed as follows:

- Soil: Surface soil exposure pathways at the MRS could include incidental ingestion, dermal absorption, and inhalation of dust for current and future site and construction workers, and current and future trespassers/visitors. Based on the assumption that subsurface soil may be excavated to the ground surface as a result of construction activities, the construction worker may also be exposed to subsurface soil inhalation of fugitive dust.

- Sediment within MRS: Surface sediment (intermittent drainage ditches) exposure pathways at the site could include incidental ingestion and dermal absorption for current and future site and construction workers, and current and future trespassers/visitors. Fugitive dust exposure may also be of concern to construction workers during development/excavation activities. Subsurface sediment exposure pathways could be evaluated for the same receptors previously mentioned for surface sediment, based on the assumption that subsurface sediment may be excavated to the ground surface as a result of construction activities.

- Sediment within Area A portion of the New River: Surface sediment exposure pathways could include incidental ingestion and dermal absorption for current and future trespassers/visitors. Subsurface sediment exposure is unlikely.

- Surface water within the MRS: Based on the intermittent nature of surface water within the MRS, typically only present in drainage ditches for short periods of time, impacts to surface water quality from site activities are not anticipated; however, incidental ingestion and dermal contact for any receptors that have the potential to be exposed to any flowing or standing water will be included in the HHRA ~~and there are no current or anticipated future uses of site surface water; therefore, no exposure to surface water is anticipated at the MRS~~.

- Surface water within Area A portion of the New River: Surface water exposure pathways could include incidental ingestion and dermal contact for any receptors that have the potential to be exposed to any flowing water; therefore, this pathway will be included in the HHRA. ~~However, due to the high flow rate of the New River, it is unlikely that contamination would accumulate; therefore, surface water exposure is unlikely.~~

- Groundwater: Based on the anticipated depth to groundwater, greater than 60 feet below ground surface, impacts to groundwater quality from site activities is not anticipated and there are no current of anticipated future uses of site groundwater; therefore, no exposure to groundwater is anticipated at the MRS.

Based on the above information, the following exposure pathways and routes could be included in the human health risk assessment of the MRS and Area A:

Surface and Subsurface Soil and Sediment within MRS:

- Current/future incidental ingestion and dermal absorption of surface soil by site workers.
- Current/future incidental ingestion and dermal absorption of surface soil by construction workers.
- Current/future incidental ingestion and dermal absorption of surface soil by visitors/trespassers.
- Future inhalation of fugitive dust by construction workers during excavation activities (from surface soil).

Sediment (within Area A):

- Current and future incidental ingestion and dermal absorption by visitors/trespassers.

2. SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment (ERA) for the MRS and Area A will follow guidance provided in USEPA's *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments,* USEPA/540-R-97-006 (USEPA, 1997b) and USACE's *Environmental Quality Risk Assessment Handbook, Volume II, Environmental Evaluation* (USACE, 2010). The general approach for conducting an ERA under this guidance follows the federal eight-step guidance document *Framework for Ecological Risk Assessment* (USEPA, 1992) process as discussed below.

- STEP 1: Screening-level problem formulation and ecological effects evaluation.
- STEP 2: Screening-level exposure estimate and risk calculation.
- STEP 3: Baseline risk assessment problem formulation.
- STEP 4: Study design and data quality objective process.
- STEP 5: Field verification of sampling design.
- STEP 6: Site investigation and analysis phase.
- STEP 7: Risk characterization.
- STEP 8: Risk management.

In addition, the SLERA will follow applicable guidance from the Biological Technical Assistance Group (BTAG) of USEPA Region 3, which has posted suggested screening benchmarks on its website.

The objective of the SLERA is to conservatively evaluate if there is a possibility of potential adverse ecological impacts at the site and to determine whether there is a need to go forward with a baseline ecological risk assessment (BERA). It should be noted that, like SLERAs, BERAs are incapable of producing risk estimates. Thus, HQs produced in both report types do not result in probabilities of toxicological effects arising.

SLERA Steps 1 through 3a are described in the following sections.

2.1 STEP 1 - SCREENING LEVEL PROBLEM FORMULATION AND ECOLOGICAL EFFECTS EVALUATION

For the screening-level problem formulation, the developed ecological CSM will be refined for the sites and will address the following five issues:

- Characterization of the environmental setting and known or suspected contaminants.
- Fate and transport mechanisms that might exist at the site.
- Mechanisms of ecotoxicity associated with chemical and likely categories of receptors that could be affected.
- Complete exposure pathways.
- Selection of appropriate endpoints to screen for potential adverse ecological impact.

The basis for ecological conceptual site model will be the CSM developed for the RCRA Facility Investigation (RFI) with additional information on potential ecological receptors present that may pose complete exposure pathways for environmental contamination.

2.1.1 Potential Ecological Receptors

As previously mentioned in Section 10.5.7 of the QAPP, the U.S. Fish and Wildlife Service (USFWS) does not list any critical habitat for threatened or endangered species within the boundaries of, or in the nearby vicinity of, the Former Gun and Mortar Range MRS (RFAAP-002-R-01). The MRS is highly developed and is not likely to provide viable ecological habitat.

Table 1 presents the potentially present ecological receptors that were identified in a previous SLERA performed at the RFAAP for the Virginia Department of Environmental Quality (VDEQ) (Franklin Engineering Group, 2001).

Table 1 Common Ecological Receptors Present at Radford Army Ammunition Plant

Receptor Category	Receptor Species	Critical Ecological Attributes	Exposure Scenario
Soil Invertebrates	Arachnida, Diplopoda, Insecta, Chilopoda	Soil invertebrates provide an important food source for many higher trophic level species. As decomposers/detritivores, they play a critical role in nutrient cycling. They also aid in soil aeration and infiltration by increasing macro and micro porosity.	Uptake and burrowing in contaminated soil. Bioaccumulation of MC from contaminated soil.
Herbivorous Mammals	Meadow vole, white-tailed deer, eastern fox squirrel, eastern chipmunk, eastern gray squirrel, woodchuck, meadow jumping mouse	Herbivorous mammals are an important prey item for many higher trophic level predators. They provide an important link for energy transfer between primary producers and higher trophic level consumers. In addition, these organisms generally comprise the majority of the terrestrial tissue biomass, and are important in seed dispersal and pollination for many plant species.	Burrowing in MC contaminated soil. Consumption of plants that have absorbed and bioaccumulated MC from contaminated soil.
Herbivorous Birds	Mourning dove, Canada goose, wild turkey, chipping sparrow, northern cardinal	Herbivorous birds are an important prey item for many higher trophic level predators. They are important in seed dispersal for many plants in both terrestrial and aquatic ecosystems. Aquatic herbivorous birds may also play an important role in egg dispersion for fish and invertebrate species.	Consumption of plant seeds that have absorbed and bioaccumulated MC from contaminated soil.
Carnivorous Mammals	Red fox, Swift fox, River otter, Bobcat, Long-tailed weasel, American badger, Grey fox, American mink	Carnivorous mammals provide an important functional role to the environment by regulating lower trophic level prey populations.	Incidental ingestion of MC from contaminated soil while feeding. Consumption of animals that have bioaccumulated MC from soil.
Carnivorous Birds	Red-tailed hawk, American kestrel, Great-horned owl, Barn owl, Burrowing owl, White-tailed hawk, Golden eagle, Mississippi kite, Prairie hawk	Carnivorous Birds provide an important functional role to the environment by regulating lower trophic level prey populations.	Incidental ingestion of MC from contaminated soil while feeding. Consumption of animals that have bioaccumulated MC from contaminated soil.
Omnivorous Mammals	Least shrew, Virginia opossum, striped skunk, northern short-tailed shrew	Omnivorous mammals are an important prey item for higher trophic level predators, and influence lower trophic level populations through predation. They play an important role in seed dispersal for many types of terrestrial vegetation and aquatic plants.	Burrowing in MC contaminated soil. Consumption of plants and animals that have absorbed and bioaccumulated MC from contaminated soil.
Omnivorous Birds	American robin, mallard, Carolina wren, blue jay, American crow, yellow warbler, pileated woodpecker	Omnivorous birds are an important prey item for higher trophic level predators. They play an important role in seed dispersal and pollination for many types of terrestrial vegetation and aquatic plants. In addition, aquatic species provide egg dispersal for some fish and invertebrate species.	Consumption of plants and animals that have absorbed and bioaccumulated MC from contaminated soil.

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The species identified in **Table 1** have the potential to come into contact with MC-contaminated surface soil and sediment. Because metals were previously detected in surface soil and sediment above ecological screening levels, surface soil/sediment dermal contact, incidental ingestion, and inhalation exposure pathways are considered complete.

The soil invertebrate group is known to spend the majority of its time burrowing in the ground, and the mammals listed in **Table 1** either dig their own burrows or inhabit dens abandoned by other animals. Additional exposure for mammals and birds could come from the consumption of MC bioaccumulated in plants, insects, or other animals.

2.1.2 Selection of Receptor Species

To assess the potential effects of contaminants released on the ecological resources of the Site, a conceptual site model (CSM) of the potential exposure to ecological receptors is provided (**Figure 1**). Receptor species were identified through an evaluation of the previous SLERAs conducted at various RFAAP sites.

Receptors have been selected based on their ecological relevance, exposure potential, sensitivity, social or economic importance, and the availability of natural history information. The ecological receptors described in the following subsections will be evaluated through food-chain modeling in the SLERA. ~~Carnivorous mammals and birds are not included in the SLERA because the potentially impacted area (about 3 acres) is too small compared to a carnivore's home range to contribute a significant portion of the diet. The MRS is highly developed and is not likely to provide viable ecological habitat, so the SLERA focuses on receptors groups that have the potential to be highly exposed to site soil.~~

2.1.2.1 Red-Tailed Hawk

The Red-tailed hawk (*Buteo jamaicensis*) was chosen as a representative avian carnivorous species in terrestrial habitats. The Red-tailed hawk is the most common and widespread American bird-of-prey (Bull and Farrand, 1977). Their habitat is variable although they are commonly found in wooded areas near open land. They are also found in other habitats including plains, prairie groves, and deserts in the western United States (National Geographic Society [NGS], 1987). The Red-tailed hawk is an opportunistic feeder which hunts from a perch or on the wing for food items such as small mammals (e.g., mice, chipmunks, and rabbits), birds (usually ground-dwelling species), reptiles, insects, and occasionally larger prey items (Burton, 1989).

2.1.2.2 Red Fox

The red fox (*Vulpes vulpes*) was selected to represent the carnivorous mammal guild in the terrestrial habitats. The red fox inhabits brushy successional areas such as old fields, borders of pastures, and rolling farmlands (Merritt, 1987). The red fox is mainly nocturnal, although it does forage at dawn and dusk. It uses earthen dens commonly situated on sunny, well-drained slopes. The fox will also nest in hollow logs, rocky caverns, and sometimes, deserted outbuildings (Merritt, 1987). The red fox is an opportunist and preys upon small mammals (e.g., rabbits, meadow voles, and white-footed mice), birds (including eggs), invertebrates, frogs, snakes, vegetable matter, and carrion. Seasonal preferences reflect the availability of food items, with berries, fruits, insects, and spiders the common food items in autumn, and small mammals and rabbits hunted in the winter (Merritt, 1987).

2.1.2.3 Meadow Vole

The meadow vole (*Microtus pennsylvanicus*) will be selected as a surrogate species for assessment of potential food-chain bioaccumulation from soils into an herbivorous mammal. The meadow vole inhabits grassy areas (upland and wetland) and obtains a significant portion of its herbivorous diet from the site. The vole resides in every area of the United States and Canada where there is good grass cover, ranges in size from about 9 to 13 centimeters (cm) in length, and weighs between 17 and 52 grams (USEPA, 1993). The meadow vole has a limited foraging range, which increases its potential to be exposed (directly or indirectly) to contaminants of potential ecological concern (COPECs) in on-site surface soil. The vole has an average home range of 0.026 acre, with summer ranges larger than winter ranges. The vole does not hibernate and is active year-round. Population densities can range up to several hundred per hectare (USEPA, 1993).

2.1.2.4 Mourning Dove

The mourning dove (*Zenaida macroura*), will be selected as a surrogate species for assessment of potential food-chain bioaccumulation from soils into an herbivorous passerine bird. Mourning doves are common at the site and regularly ingest grit in their diet. Mourning doves are highly adaptable birds and are found in a wide variety of habitats. They are more common in open woodlands and forest edges near grasslands and fields. The average mass of a dove ranges from 96.0 to 170.0 grams (3.38 to 5.99 ounces). The average lifespan is 1 year. Mourning doves range over areas of up to 5 miles each day, but usually less. The mourning dove diet consists of primarily plant material (99% or more; almost all of which is seeds), with just a trace of animal matter, including small insects (http://www.dof.virginia.gov/manage/hunt/mourning-dove.htm). Grass seeds, from both native and cultivated plants, are preferred dove foods. Doves get their food from the surface of the ground. With weak feet and poor scratching ability, foods need to be on open ground and plainly visible. Doves require a small amount of grit (small pieces of sand or gravel) and water to aid in digestion.

2.1.2.5 American Robin

The American robin (*Turdus migratorius*) will be selected to represent the omnivorous bird guild in the terrestrial habitats. The American robin is a member of the thrush family, and inhabits forests, wetlands, swamps, and habitat edges where forested areas meet agricultural and range land (USEPA, 1993). The American robin requires access to freshwater, protected nesting sites, and productive forage in areas for breeding. Breeding habitats include moist forests, swamps, open woodlands, orchards, parks, and lawns. Robins may forage on the ground, along habitat edges, stream edges, or above ground in shrubs and the lower branches of trees (USEPA, 1993). Robins eat invertebrates, seeds, and fruit (USEPA, 1993). Directly preceding and during the breeding season, robins' diet consists of greater than 90% (by volume) invertebrates and some fruit. During the rest of the year, their diet consists of 80-99% (by volume) of fruits. Fruits commonly eaten include plums, dogwood, sumac, hackberries, blackberries, cherries, greenbriers, raspberries, and juniper. Invertebrates commonly taken include beetles, caterpillars, moths, grasshoppers, spiders, millipedes, and earthworms (USEPA, 1993).

2.1.2.6 Northern Short-Tailed Shrew

The northern short-tailed shrew (*Blarina brevicauda*) will be selected to represent the omnivorous mammal guild in the habitats. The short-tailed shrew may be found in a variety of habitats with a well-developed layer of leaf litter and humus, including grasslands, brushy thickets, meadows, old fields, and deciduous, coniferous, and mixed forest (Merritt, 1987). The short-tailed shrew's diet includes invertebrates (e.g., spiders, centipedes, slugs, snails, and earthworms), salamanders, mice, voles, and occasionally birds. It has a preference for animal food, but also eats fungi and plant material such as roots, nuts, fruits, and berries. In winter, insect larvae and pupae serve as important food sources (Merritt, 1987). A short-tailed shrew is considered as a conservative surrogate receptor for omnivorous mammals in the SLERA because it eats up to three times its body weight daily and because of its small home range. Though primarily insectivorous, shrews do eat some plant material and they incidentally ingest soil while foraging and digging underground nests or runways.

2.2 STEP 2 - SCREENING-LEVEL EXPOSURE ESTIMATE AND RISK CALCULATION

Step 2 will consist of evaluating soil and sediment data against ecological screening benchmarks. In Step 2, chemical exposure levels to screen for potential adverse ecological impact will be estimated. For all complete exposure pathways, the maximum detected site-related chemical concentration will be used as the exposure point concentration used to compare with ecological benchmarks. Results of the screening will be used to identify COPECs.

All bioaccumulative compounds will be assessed in the food chain exposure evaluation. Compounds listed on Table 4-2 in *Bioaccumulative Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs* (EPA-823-R-00-001, February 2000) will be carried through to the food chain exposure evaluation.

Soil screening benchmarks will be used to screen soil for potential adverse ecological impact to plants and soil-dwelling organisms and food chain risk for birds and mammals. The following includes a hierarchy of sources that will be used to obtain soil screening benchmarks:

- USEPA 2003-2008 Ecological Soil Screening Levels (Eco-SSLs); the lowest of plant, soil invertebrate, avian, and mammalian values (USEPA, last updated 10/22/2016) https://www.epa.gov/chemical-research/ecological-soil-screening-level.
- Los Alamos National Laboratory (LANL) ECORISK Database, Release 4.1. https://www.lanl.gov/environment/protection/eco-risk-assessment.php (LANL, 2017).

Sediment screening benchmarks will be used to screen sediment for adverse ecological impacts to benthic organisms. The following includes a list of sources that will be used to obtain sediment screening benchmarks:

- USEPA Region 3 Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Benchmarks https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_sediment_benchmarks_8-06.pdf (USEPA, 2006).
- LANL ECORISK Database, Release 4.1. https://www.lanl.gov/environment/protection/eco-risk-assessment.php (LANL, 2017).

The LANL ecological screening levels (ESLs) for sediment (avian and mammalian aerial insectivores) and soil (birds and mammals), and the USEPA Eco-SSLs (birds and mammals) will be used to determine food chain COPECs.

2.3 STEP 3A - REFINEMENT OF COPECs

Based on USEPA guidance (USEPA, 2001, 1998, 1997b), USEPA Step 3a provides for iteration of hazard estimates by applying additional site-specific information to further refine the COPECs to those requiring remedial evaluation and/or additional evaluation by conducting a BERA. Step 3A (refinement of COPECs) incorporates elements of a baseline risk assessment (USEPA Step 3) and is the final outcome of the SLERA, which represents a scientific management decision point (SMDP). In most cases, the Step 3A refined hazard estimate provides the basis for defining potential site risk drivers with the overall goal of identifying and prioritizing additional data needs (i.e., BERA and/or early remedial action decisions for the site).

2.4 SCIENTIFIC/MANAGEMENT DECISION POINT

A summary will be written of the SLERA, including the range of chemical concentrations detected, the number of chemicals exceeding their benchmarks, the degree of the exceedance of the benchmark (or benchmarks), the appropriateness of the benchmarks themselves, and the refinement of COPECs. The results will be evaluated to ensure that the information provided assists the risk manager in making one of the following decisions:

- That there is adequate information to conclude that the potential adverse ecological impacts are negligible; therefore, there is no need for remediation on the basis of ecological adverse effects.

- That the information is not adequate to make a decision at this point, and the ecological risk assessment process will continue to Step 3 (a BERA).
- That the information points to a potential for adverse ecological effects and a more thorough assessment is warranted.

The USEPA guidance, *Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (USEPA, 1999), will be consulted to assist in this aspect. The SLERA will incorporate background data from each medium, but consistent with USEPA Region 3 policy, the background data will not be used to eliminate COPECs. Instead, all constituents will be evaluated against ecological screening guidelines to determine total site risk. Comparisons with the background data will provide useful comparisons to determine whether overall site risks are primarily associated with DoD-related contamination or other sources. In making risk management decisions, DoD funding cannot be used to address contamination that is unrelated to former DoD activities.

The result of the SLERA will be a deliverable that identifies COPECs for different media discussed. The SLERA will also include a description of available ecological habitat at the site, an evaluation of exposure pathways, and identification of potential receptors. The SMDP to be addressed at the end of the SLERA will be whether sufficient risk attributable to former DoD activities (as opposed to non-point sources or other regional contamination) is identified to warrant proceeding with a BERA.

After the completion of Step 3a, the risk managers at USEPA and VDEQ will be consulted to determine whether the SLERA is sufficient to conclude there are no adverse ecological impacts, or if a more detailed BERA must be completed (Steps 3-7), or that there is a potential for adverse ecological effects and a more detailed ecological risk assessment is needed that will incorporate more site-specific information.

The QAPP assumes that a SLERA will be conducted for the MRS and Area A. If a BERA is deemed necessary, an amended QAPP will be submitted at a later date.

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Figure 1 Conceptual Site Model for Munitions Constituents Exposure at the Former Gun and Mortar Range MRS

Project Name: Radford AAP, Former Gun & Trench Mortar Range (RFAAP-002-R-01) QAPP for RCRA Facility Investigation							
Draft Final QAPP - Responses to VDEQ Comments							
Project Location: Radford, Virginia							
Contract No.: W912DR-15-D-0022							
4 May 2020							
Comment	**Commenter**	**Page(s)**	**Section**	**VDEQ Comment**	**Response**	**Additional VDEQ Comments**	**Response**
1	Kurt Kochan		Worksheet 11	"Identify the Goals of the Study:" The goals listed here include decision points, which are covered in a separate section. I recommend making the goals more general. For example, the first bullet should be "determine the presence or location of any burial pits/trenches." The second bullet should be "achieve 95% confidence in determining…" etc.	The text was revised as suggested and the decision points, if not already listed, were included under DQO Element 5. Develop the Project Data Collection and Analysis Approach.		
2	Kurt Kochan	Page 35	Worksheet 11	first bullet: Lead has already been determined to be present above screening and background concentrations. The purpose of the proposed sampling is to evaluate the nature and extent of that contamination, whether it is related to range activities, and whether it drives actionable risk.	The text was revised as suggested.		
3	Kurt Kochan		Worksheet 11, Section 4	VSP inputs should be removed from defining the boundaries of the study. VSP carries many assumptions, and is primarily a tool for identifying impact areas and burial pits. Additional data may be required to identify the nature and extent of low use or buffer areas depending on the results of the investigation. The actual boundaries of the study are covered in the first 3 bullets of this section. Care should be taken to acknowledge that the nature and extent of MEC and MC have yet to be defined and the study boundaries should be flexible enough to accomplish that goal.	The text was revised as suggested.		
4	Kurt Kochan		Worksheet 11, Section 6	Performance criteria should be limited to whether the project goals were met and if data quality objectives were achieved that could support a decision. There should be firm statements about what threshold of MPC etc. are required to actually make a decision.	The bullets have been revised to be more definitive and consistent with the information provided in the EPA QAPP and EPA QAPP for AGC guidance documents.		
5	Kurt Kochan		Worksheet 15, Table 15.1	It is unclear what the facility wide background values of 2543 mg/kg selenium and 108 for vanadium are based on. Are these maximum values or the UTL from the background study?	A note was added to Table 15.1, "The background levels consist of the 95% upper tolerance limit (UTL) background level from Facility-Wide Background Study Report (IT Corporation, 2001)."		
6	Kurt Kochan		Worksheet 17	Note that as currently proposed, the EM31 data will only be relevant to identify burial pits and very high density areas of debris. No inferences about the nature of identified anomalies or potential MEC densities (particularly for low use areas) can be made with any confidence using this approach. The potential exists for sporadic MEC to be located through the study area, and other data will be required to characterize their nature and extent.	Noted. Section 17.7 indicates that data will be used to locate suspected burial trenches. There is no intended implication that EM31 data will be used to infer nature of anomalies caused by potential MEC. No change was made to the text.		
7	Kurt Kochan	page 105	Worksheet 22, Table 22-6	Coverage, detection, and recovery: "Based on root cause analysis and corrective action" seems to imply limited resurveying might be acceptable in the event a seed is missed. If a seed is missed, the entire area covered during that day's work should be resurveyed.	In the event of a missed seed a Root Cause Analysis will be initiated to determine the true cause of the failure. That RCA will result in a Corrective Action (CA) per our DAGCAP accredited program. There are scenarios where re-surveying may not be included in the recommended CA. For example, errors could be made during the placement of seeds. In that case, the CA would be designed to remedy the root cause of the failure to ensure that the failure will not happen again (i.e. seeds are placed correctly). No change was made to the text.		
8	Kurt Kochan	Page 3	Appendix Q	last bullet: Please cite EPA CERCLA guidance regarding background and not the VDEQ VRP guidance. Also please provide more information regarding the statistical approach by which site data will be compared to background.	Text was revised.		
9	Kurt Kochan	page 8	Appendix Q, Section 1.4	Please note that many exposure defaults have been updated by EPA in a 2014 memo. Where applicable these values should be used over those in the Exposure Factors Handbook.	Text was revised to include the USEPA Exposure Factors OSWER directive (USEPA, 2014).		
10	Kurt Kochan		Appendix Q, Section 1.5.1	Incidental soil inhalation is also a relevant pathway to receptors other than construction workers and fugitive dust from construction. This pathway includes entrained dust and other indoor exposures and should be included in the risk assessment.	Incidental soil inhalation was included for all human health receptors in the CSM. Text was updated to include incidental soil inhalation. The bullet was revised: Surface soil exposure pathways at the MRS could include incidental ingestion, dermal absorption, and inhalation of dust for current and future site and construction workers, and current and future trespassers/visitors. Based on the assumption that subsurface soil may be excavated to the ground surface as a result of construction activities, the construction worker may also be exposure to subsurface soil inhalation of fugitive dust.		
11	Kurt Kochan	page 10	Appendix Q, Section 1.5.1	If the sediment pathway is open, then surface water ingestion could be as well.	The text was revised to include, surface water exposure pathways for within the MRS and within the Area A portion of the River, but were determine to be unlikely.	Current and future incidental ingestion and dermal adsorption for the surface water pathway should be included in the HHRA for any receptors that have the potential to be exposed to any standing or flowing water.	4th and 5th bullets in Section 1.5.1 have been revised to included suggested language in the VDEQ comment.
12	Kurt Kochan		Appendix Q, Section 2.1.1	Carnivorous mammals and birds have been identified at RFAAP and should be included in the SLERA.	Carnivorous mammals and birds are not included in the SLERA because the potentially impacted area (about 3 acres) is too small compared to a carnivore's home range to contribute a significant portion of the diet. The MRS is highly developed and is not likely to provide viable ecological habitat, so the SLERA focuses on receptors groups that have the potential to be highly exposed to site soil. This information has been added to Section 2.1.2.	These receptors should still be included, though RFAAP may perform a refined SLERA. The refined SLERA can account for a site being a limited portion of the receptor's home range through the use of an area use factor.	Carnivorous mammal (red fox) and bird (red-tailed hawk) have been added to the selected receptor species in Section 2.1.2 as well as requiring revision to Table 1.

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Contract No.: W912DR-15-D-0022							
4 May 2020							
Comment	Commenter	Page(s)	Section	VDEQ Comment	Response	Additional VDEQ Comments	Response
13	Kurt Kochan		Appendix Q, Section 2.2.1	According to the EPA Wildlife Exposure Handbook, short-tailed shrews are insectivorous and are therefore not representative of omnivorous mammals. Raccoons may be more representative of this guild.	A short-tailed shrew is considered as a conservative surrogate receptor for omnivorous mammals in the SLERA because it eat ups to three times its body weight daily and because of its small home range. Though primarily insectivorous, they do eat some plant material and they incidentally ingest soil while foraging and digging underground nests or runways. This information has been added to Section 2.1.2.4.		