REQUEST FOR ADDITIONAL INFORMATION FOR THE SAFETY EVALUATION REPORT AND ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED AMENDMENT OF MATERIALS LICENSE SUB-1435, JEFFERSON PROVING GROUND DEPLETED URANIUM IMPACT AREA

INTRODUCTION

The purpose of this request for additional information (RAI) presented below is to obtain additional data and information from the U.S. Army (Army) for the U.S. Nuclear Regulatory Commission (NRC) staff to complete the Safety Evaluation Report (SER) and environmental assessment (EA) in support of the NRC's evaluation of the Army's license amendment application requesting an amendment to license SUB-1435, dated December 21, 2016, for the Jefferson Proving Ground site (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17004A186).

The license amendment request (LAR) proposes a change of the license's authorized use from Possession Only for Decommissioning to Possession Only with an exemption from the decommissioning timeliness requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 40.42(h)(2). In its letter, the Army requests to delay decommissioning for an extended period of time, until the unexploded ordnance, in the vicinity of the depleted uranium (DU) penetrators, can safely be considered inert, or when technology becomes available to safety remove the DU penetrators from the site, without jeopardizing the workers who would be required to locate and excavate the penetrators.

The RAIs were developed by the NRC staff based on its review of the LAR and of other documentation provided by the Army as part of this amendment request, those previously submitted in a license amendment application, dated August 28, 2013, (ADAMS Accession No.ML13247A552), to the NRC, which included a Decommissioning Plan (DP) and an Environmental Report (ER) and subsequently withdrawn by the licensee on November 25, 2015, (ADAMS Accession No. ML16005A100), and other documentation independently obtained by the staff, such as during site visits and other information gathering meetings from work done on the 2013 LAR.

Note also that unless the Army requests otherwise in accordance with the NRC regulations in 10 CFR 2.390, reports, computer files, and other files and documentation that have been or will be provided to the NRC by the Army or its contractors and cited by the staff as references in the (SER or EA) will be added, as necessary, to ADAMS as publicly available.

All written reports, computer files, and other files and documentation submitted to the NRC by the Army or its contractors in response to the RAIs should be provided in electronic format that is compatible with entry by the NRC into ADAMS. The NRC document, "*Guidance for Electronic Submissions to the NRC"* (NRC, 2011)(ADAMS Accession No ML13031A056.pdf) provides instructions for submitting documents in formats compatible with ADAMS.

REQUEST FOR ADDITIONAL INFORMATION

Radiation Safety Plan (RSP)

RSP-1

Please submit an updated Radiation Safety Plan for the current license amendment request for Possession Only. The Radiation Safety Plan should provide more updated information than the previous Radiation Safety Plan referred to in the license amendment request. The current June 21, 2013, submitted Radiation Safety Plan states under Section 1.1.5 License Termination that the Army proposes to terminate its NRC license with Restricted Use for the DU impact area.

Basis

The LAR for NRC License SUB-1435, Jefferson Proving Ground, which requests a Possession Only License, references the current and submitted June 21, 2013 Radiation Safety Plan as replacing the Jefferson Proving Ground Security Plan dated December 10, 2003. The 2013 Radiation Safety Plan states license termination will be Restricted Use. An updated and revised Radiation Safety Plan for the Possession Only licensee was not submitted for approval.

Please submit a revised radiation safety plan specific to the proposed Possession Only license amendment request which clarifies the planned radiation safety protocols that will be used in future anticipated scenarios in which Army personnel are not on site and events occur, such as licensed material being identified outside of controlled areas or in possession of unauthorized individuals and which would require initial notification of the Army of exigent safety issues by the U.S. Fish and Wildlife Service, Indiana Air National Guard, or other entities that have agreed to respond to and notify the Army of such issues involving the licensed material at the site through Memorandums of Agreements or Understandings or contracts or other legally binding documents.

Environmental Radiation Monitoring Plan (ERMP)

ERMP-1

Additional information is needed to support the use of a value of 3 as the threshold for determining when the U-238 to U-234 activity ratio in a sample is indicative of depleted uranium. The Army should provide a technical basis for the chosen threshold value and provide references for the statements from the ERMP quoted in the basis. Alternatively, the Army could choose a different method for identifying DU and provide a technical basis for that method. For instance, the Army could select a different value of the ratio of U-238 to U-234 to serve as a threshold for further analysis, or propose a combination of a threshold value for the U-238 to U-234 ratio and an elevation in the total uranium measured. The technical basis provided should address the potential effect of alpha recoil and solubility differences between uranium and thorium, as explained in the JPG Site Conceptual Model in Section 2.1 of Appendix C of the ER, on the ratio of U-238 to U-234 in natural uranium and DU exposed to the natural environment.

Basis

The Army's proposed method of identifying DU and any chosen threshold value or values directly affects the Army's ability to identify DU migration and compare DU in site effluents to the values in 10 CFR Part 20 Appendix B.

Section 13 of the Environmental Radiation Monitoring Plan (ERMP), “EMRP Methodology,” indicates that any sample with a U-238 to U-234 activity ratio exceeding 3.0 as measured by alpha spectroscopy will be re-analyzed by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) to determine whether the sample contains DU. The ERMP provides a citation of “NRC 2016” for this process; however, the ERMP bibliography does not provide reference information for the “NRC 2016” reference. Similarly, Section 10 of the ERMP refers to an activity ratio of 3 as “NRC’s criterion” for identifying DU but does not provide a citation for that statement. Section 12 of the ERMP appears to reference 10 CFR § 110.2 as the basis for using a U-238 to U-235 activity ratio of 3 or greater as a criterion for identifying DU; however, 10 CFR § 110.2 does not provide numerical cutoff values for identifying DU.

Different ratios could reasonably be used as a threshold value and have been used by the Army in the past. For example, in Section 3.4.2 of the DP for JPG, the Army states, “To determine whether the measured uranium present was due to the presence of DU or natural uranium, the U-238/U-234 ratio was determined by measuring the concentration of each of these isotopes. At the time of the Characterization Survey, a U-238/U-234 ratio of 2.0 or less was considered representative of natural uranium, whereas higher ratios are indicative of DU.” As indicated in Section 3.6.3 of the DP, the U-238 to U-235 ratio in background samples at JPG ranged from 0.5 to 1.3.

As explained in Section 2.1 of Appendix C of the ER, alpha recoil from U-238 decay and solubility differences between U-238 and Th-234 can enhance the amount of U-234 in water relative to U-238, suppressing the U-238 to U-234 ratio in water and enhancing it in solids. However, depending on the history of water flow and evaporation in a soil, sediment, or water sample, the U-238 to U-234 ratio could be depleted or enhanced in any of those media, resulting in the observed natural variation. Therefore, the technical justification for the chosen threshold of the U-238 to U-234 ratio should address the potential for depletion of U-238 in natural uranium or DU by alpha recoil or dissolution of Th-234 to lead to false-negative results.

ERMP-2

Additional information is needed to support the Army’s plan to composite “at least 10 subsamples” of sediments to assess whether the proposed composite sampling could lead to sample dilution, as described in Section 14.3 of NUREG-1505. Specifically, additional information is needed regarding (1) the basis for the Army’s selection of “at least 10” subsample locations, (2) Army plans to retain individual subsamples, and (3) the criterion that will be used to trigger evaluations of individual sub-samples.

Basis

The Army’s plan to use composite sampling directly affects the sensitivity of the Army’s methods for identifying DU in sediment.

The Army ERMP submitted with the license amendment application indicates that each sediment sample will be composed of subsamples from “at least 10 subsample locations.” No further information is provided regarding how composite sampling affects the comparison of analytical results to the U-238 to U-234 ratio. As described in Section 14.3 of NUREG-1505 (ADAMS Accession No. ML061870462) and explained in more detail in the document “Technical Bases and Guidance for the Use of Composite Soil Sampling for Demonstrating Compliance with Radiological Release Criteria” (ADAMS Accession No. ML13101A090), radiological threshold criteria should be adjusted to account for the potential effects of sample dilution when composite samples are taken. In this case, the concern is that taking multiple subsamples will lower the U-238 to U-234 ratio in the composite sample to below the Army's chosen threshold value (see RAI ERMP-1), even if some of the sub-samples, if analyzed individually, would have a higher U-238 to U-234 ratio indicative of the presence of DU. The detailed guidance document referenced above (ADAMS Accession No. ML13101A090) recommends (1) retaining sub-samples in case further analysis is needed, (2) establishing an adjusted limit that would trigger analysis of individual subsamples, and (3) using sub-samples of the same volume.

References

Oak Ridge Institute for Science and Education. "Technical Bases and Guidance for the Use of Composite Soil Sampling for Demonstrating Compliance with Radiological Release Criteria," Oak Ridge, Tennessee, 2012. (ADAMS Accession No ML13101A090).

U.S. Nuclear Regulatory Commission. "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys: Interim Draft Report for Comment and Use." NUREG-1505, Rev. 1. Washington, DC, 1998. (ADAMS Accession No ML061870462).

Souvenir Hunter Scenario (SHS)

SHS-1

Further analysis is needed to address the "aggressive handling" scenario the Army evaluated in the Souvenir Hunter attachment. Although the attachment indicates that the scenario is intended to account for exposure while an individual sands or grinds the penetrator, the value of the "air release fraction" parameter assumed in the RESRAD-Build model for that scenario does not appear to be consistent with that type of mechanical disturbance. The Army should provide justification of the air release fraction used in the aggressive handling scenario or modify the analysis to use a different value.

Basis

In the Souvenir Hunter attachment, the Army indicates that an individual is assumed to spend 10 hours per year "aggressively handling" a penetrator and another 730 hours in proximity to, but not handling the penetrator. The aggressive handling is assumed to result in deposition of particles on the floor, which can be re-suspended and inhaled. An incidental exposure scenario implemented in RESRAD-Build accounts for resuspension of particulates from the floor of the workshop during 730 hours spent in the workshop while not handling the penetrator. In addition, a "close contact inhalation" scenario is designed to account for the 10 hours aggressively handling the penetrator. However, the air release fraction used for the aggressive handling scenario is the same as the air release fraction used during the incidental exposure scenario and appears to account only for resuspension of particles from the floor. The basis given for the air release fraction is that the value corresponds to the NUREG/CR-6697 value for metal oxidation and the Department of Energy (DOE) Handbook (DOE, 2013) bounding value for a spill and impact of a contaminated surface. Neither of these values appears to be relevant to sanding or grinding assumed to occur during the 10 hours of aggressive handling.

The value of this parameter is risk-significant because the projected inhalation dose in the aggressive handling scenario is linearly related to the value of this parameter. For example, an NRC staff independent analysis indicated that changing the air release fraction to 0.07, which is the mean of the generic distribution for this parameter given in NUREG/CR-6697 and the RESRAD-Build default value, increases the projected inhalation dose due to 10 h of aggressive handling from 0.52 mrem/yr to 36 mrem/yr. Because the value of this parameter significantly impacts the projected dose and the technical basis for the parameter value used in the "close contact inhalation scenario" does not appear to be applicable to the description of the scenario it is used to represent, the Army should provide either (1) additional technical basis for this parameter value used in this scenario or (2) a technical justification for a revised value with a revised analysis for the "close contact inhalation" scenario.

<u>Groundwater (GW)</u>

<u>GW-1</u>

No decommissioning activities are proposed and the principle isotopes comprising DU are long-lived. As a consequence, the DU source term is expected to remain on site for the foreseeable future. During that time, DU may migrate from the surface to the groundwater. Therefore, information about the anticipated sampling frequency should address future plans as well as current practice.

Page 14 of the Army's ERMP indicates that groundwater sampling for DU will occur only when groundwater sampling is being conducted for other reasons (i.e., for reasons other than monitoring DU). The Army should provide information about any enforceable mechanisms (e.g., commitments to other agencies) that provide assurance of a minimum expected sampling frequency. Any proposal that no groundwater sampling for DU is necessary based on the projected dose from the groundwater pathway should be consistent with the responses to RAI GW-2 through GW-5 and (Dose Modeling) DS-1 through DS-4. In addition, estimates of the sampling frequency should cover the anticipated persistence of the source term on site. Alternatively, under a possession-only license, the Army could provide a plan to monitor groundwater for DU rather than relying on model projections to justify sampling groundwater only when sampling is conducted for other reasons.

Basis

The Army's ERMP indicates that groundwater sampling for DU will occur only when groundwater sampling is being conducted for other reasons. The staff cannot assess the adequacy of that proposal without additional information about the anticipated future frequency of groundwater sampling for DU.

<u>GW-2</u>

Clarification is needed of a statement in the ERMP that the Army has not measured most of the factors that influence DU transport to groundwater for the DU impact area. The Army should address the uncertainty in projections of dose from the groundwater pathway that result from the indicated lack of measurements of the relevant physical factors influencing DU transport in the groundwater pathway. If available, the Army should reference any relevant measurements.

Basis

Page 14 of the ERM indicates that the decision to perform groundwater monitoring only if groundwater samples are collected for another purpose was based, in large part, on the conclusion that the groundwater pathway is an extremely low-risk pathway. That conclusion, in turn, appears to be based on RESRAD-Offsite analyses submitted with a previous DP (ADAMS Accession Nos. ML13247A553; ML13247A555; ML13247A556), which includes numerous parameter values (e.g., precipitation, radionuclide sorption coefficients, soil porosity, and permeability) that depend on site-specific conditions. However, Page 13 of the ERMP states:

> "The DU concentration in groundwater depends on several factors, including distance of the groundwater from the soil surface, acidity/alkalinity of the soil and leaching water, soil porosity, amount of precipitation, and so on. The Army has not measured most of the influencing factors for this pathway for the DU impact Area."

For the staff to evaluate the Army's conclusion that the groundwater pathway is an extremely low-risk pathway, the staff must understand the uncertainty in the parameter values used in the RESRAD-Offsite model. The basis for many of the parameter values used in the RESRAD-Offsite model supporting the DP appears to rely on site-specific measurements, in apparent contradiction of the quoted statement from the ERMP. Therefore, the Army should clarify the statement to allow the staff to accurately assess the uncertainty in the conclusions of the RESRAD-Offsite model, which the Army referenced as a basis for concluding that the groundwater pathway is an "extremely low-risk" pathway.

GW-3

An explanation is needed for measured concentrations of uranium in wells MW-RS-7 and JPG-DU-02D which appear to be elevated significantly above background levels. The elevated measurements appear to be in conflict with the Army's RESRAD-Offsite model projection that DU should not yet have reached the aquifer (e.g., water table). Furthermore, the elevated readings appear to be in conflict with the ratio of U-238 to U-234 in the samples, which did not indicate the presence of DU. If analytical uncertainty in the U-238 to U-234 ratio or enhancement of U-234 in water samples (see ERMP-1) is thought to explain the inconsistency between the U-238 to U-234 ratio and the elevated total uranium measurements, the Army should explain whether these uncertainties affect the adequacy of the proposed methods for identifying DU described in the ERMP.

Basis

Appendix F of the ER (pages F-698 and F-716) indicates that ground water samples MW-RS-7 and JPG-DU-02D had measured uranium concentrations that appear to be significantly above background concentrations. Specifically, well JPG-DU-02D showed readings up to 21 pCi/L and well MW-RS-7 showed readings up to 47 pCi/L. Background levels ranged from 0.06 to 6.4 pCi/L. Both wells showed elevated readings for more than one quarterly sampling, which appears to limit the likelihood that the readings reflected sample contamination. However, Appendix F shows neither of these samples had a measured elevated ratio of U-238 to U-234, which would be indicative of contamination with DU. The Army should clarify whether it interprets the apparently elevated uranium concentrations in these wells to be attributable to naturally-occurring uranium or DU contamination. The information is needed to interpret the output of the Army's RESRAD-Offsite model analysis, which indicates that DU from penetrators should not yet have reached the aquifer. Since the Army's RESRAD-Offsite model analysis of the groundwater pathway was used as part of the basis for the Army's proposal to conduct only limited groundwater monitoring, the Army should ensure consistency of the RESRAD-Offsite model projections with observations or justify any differences.

For the NRC staff to evaluate the proposed ERMP, the staff also must understand whether the proposed method of measurement and use of the U-238 to U-234 ratio is a reliable method for identifying DU in site groundwater, soil, and sediment. Therefore, the Army should also address whether the low U-238 to U-234 ratio could be due to analytical uncertainties or to enhancement of U-234 in the liquid phase by alpha recoil and solubility effects, as explained in RAI ERMP-1 and in Section 2.1 of Appendix C of the ER.

GW-4

If the Army chooses to conduct only limited groundwater monitoring based on the conclusion that groundwater is an "extremely low-risk" pathway, the Army should account for all of the site features and processes that could affect the risk-significance of that pathway. Accordingly, the assessment of the potential dose from the groundwater pathway should address (1) the effects of wetlands in the DU impact area on DU transport to groundwater, (2) variation in the depth to groundwater in the impact area, and (3) features specific to the DU trench, including reduced overburden thickness and the potential for increased infiltration in the trench area due to water diversion into the trench. The evaluation of the impact of wetlands and the DU trench should account for the fraction of the source term located in those areas. Any evaluation of points (1) through (3) should also account for the issues described in RAI GW-5. Alternatively, under a possession-only license, the Army could provide a plan to monitor groundwater for DU rather than relying on model projections to justify sampling groundwater only when sampling is conducted for other reasons.

Basis

Section 2.5.1 and Figure 2-9 of the DP describe wetlands present in the DU impact area. However, the dose analysis submitted with the DP, which the Army relies in its amendment request to justify limited groundwater sampling, does not address the potential impacts of wetlands on the groundwater pathway. For example, the Army has not addressed the potential dissolution of DU in standing water, potentially saturated overburden materials, and the hydraulic connection of water in wetlands to site groundwater. In addition, Figure ES-6 of the DP, indicates that in some locations, groundwater is approximately 1 m (i.e., 2 to 4 ft.) from the land surface. However, the depth to groundwater (i.e., contaminated zone + unsaturated zone 1 + unsaturated zone 2) considered in the deterministic dose analysis was 3.35 m (11 ft.).

The range of depths to groundwater considered in the sensitivity analysis should account for current variation observed on the site and also reasonably foreseeable ranges in depth to groundwater (e.g., in wet years). However, the depth to groundwater considered in the sensitivity analysis (i.e., contaminated zone + 1 unsaturated zone) ranged from 1.15 to 4.6 m (3.8 to 15 ft.) and therefore did not include the shallower depths observed on site. The range used in the probabilistic uncertainty analysis did not vary the total depth to groundwater (i.e., contaminated zone + unsaturated zone 1 + unsaturated zone 2) because the depth of the first unsaturated zone was inversely correlated to the depth of the contaminated zone such that the total depth to groundwater was constant at 3.35 m (11 ft.). The depth to groundwater affects the projected risk-significance of the groundwater pathway because it affects when DU is projected to reach the groundwater. In the amendment request, the Army based decisions on groundwater sampling on the results of a dose model that did not include a significant amount of the DU reaching the groundwater during the analysis period. That result, and the projected risk-significance of the groundwater pathway, could change if the shorter modeled distance to groundwater, consistent with data from the site, caused DU to be projected to reach the groundwater during the analysis timeframe.

Section 1.4 of the DP states that firing along the 500 center line led to formation of a trench 1 m (3.4 feet) deep, 5 to 8 m (16 to 26 feet) wide, and 1200 m (3940 feet) long. Although it covers a small fraction of the DU impact area, the trench was formed by penetrator impacts and is therefore expected to contain a significant fraction of the DU in the impact area. The Army should assess the potential for water to be diverted into and possibly collect in the trench, where it could increase localized infiltration rates. Although this increase would not necessarily significantly affect the infiltration rate averaged over the entire DU impact area, it could enhance DU migration because of the co-location of increased infiltration rates and presence of a significant fraction of the DU.

Any re-evaluation of the groundwater pathway in response to this RAI also should account for the issues described in RAI GW-5, because the amount of infiltration is expected to affect the transport of radionuclides from the contaminated zone to groundwater.

GW-5

Additional justification is needed for assumptions affecting the infiltration rate calculated in that RESRAD-Offsite analysis to support limited groundwater sampling. Specifically, the Army should address the uncertainty in precipitation, the evaporation coefficient, and the runoff coefficient and the resulting uncertainty in the calculated infiltration rate. The Army should compare the resulting value of the infiltration rate to the range typical of southern Indiana and explain whether it expects infiltration at JPG to be within that range. Alternatively, the Army could propose different values for the parameters affecting the infiltration rate in the RESRAD-Offsite model and submit a revised analysis. As another alternative, the Army could provide a plan to monitor groundwater for DU rather than relying on model projections to justify sampling groundwater only when sampling is conducted for other reasons.

Basis

The RESRAD-Offsite code does not have a direct parameter input for infiltration. Instead, it calculates infiltration from precipitation, evaporation, and runoff. Section 2.4.1 of the DP indicates that the annual average precipitation at JPG is expected to be 119 cm (47 in), of which 56 percent is expected to be lost to evapotranspiration, 36 percent is expected to be surface run-off, and 8 percent (9.7 cm [3.8 in]) is expected to become ground water recharge (i.e., infiltration). The DP references the report “Well Construction and Surface Water Data Report” (SAIC, 2008) for this water budget analysis. However, that reference describes the water budget developed therein as a “first cut” of the water budget (see SAIC, 2008 Section 3.4). The SAIC report explains that the data from the JPG stream gauging stations did not have a long enough data record to provide stable results from the models used to determine the water budget and that data from a nearby water basin were used instead.

Comparison to regional data suggests that the infiltration value calculated based on the SAIC (2008) report may be low. Specifically, the Army’s calculated value for infiltration for the site

(9.7 cm [3.8 in]) is just below the lower end of the range of values that the Army reports as the average infiltration rate for southern Indiana in Section 2.4.1 of the DP (i.e., 10.1 to 20.3 cm/yr [4 to 8 in/yr]). Given the uncertainties described in the SAIC (2008) report, and the resulting infiltration value being outside of the range for southern Indiana, the Army should provide additional justification for the parameter value used. If the justification relies on the results of sensitivity or uncertainty analyses, the issues described in RAI Dose Model (DS-1 and DS-2) should be addressed, as applicable.

Dose Model (DS)

DS-1

To support the Army choice to limit groundwater monitoring based on the conclusion that groundwater is an “extremely low-risk” pathway in model projections, additional information is needed related to the sensitivity of the projected groundwater pathway dose to model assumptions and parameter values. As described in the basis, a revised sensitivity analysis is needed to address (1) scenarios relevant to a possession-only license, (2) appropriate correlations between parameters, and (3) appropriate parameter ranges. This analysis is needed to support the conclusion that the Army has identified and provided adequate model support for parameters that have a significant effect on projected dose. Alternatively, under a possession-only license, the Army could provide a plan to monitor groundwater for DU rather than relying on model projections to justify sampling groundwater only when sampling is conducted for other reasons.

Basis

Although the ERMP references the RESRAD-Offsite model submitted with the DP as justification for concluding that the groundwater pathway is low-risk, the sensitivity analysis submitted with the DP to support that RESRAD-Offsite model only considers the dose to an on-site resident. For a possession-only license, the most relevant receptors are the offsite residential farmer, on-site sportsman / recreationalist, on-site industrial worker, and an individual who discovers and handles a penetrator. The sensitivity of these projected doses to model assumptions and parameters are expected to differ from the sensitivities of the projected dose to an on-site residential farmer because the principle exposure pathways differ.

In addition, a revised sensitivity analysis is needed to account for the inverse correlation between the modeled contaminated zone thickness and uranium isotope concentrations. Section 3.8.3 of Appendix C of the DP explains that in the sensitivity analysis the Army conducted for the on-site residential farmer scenario, only the depth of contamination met the criterion for being a parameter to which dose was sensitive. The Army explained:

> “It should be noted that the radionuclide concentration and contaminated zone thickness were not correlated in the sensitivity analysis. Thus, increasing the contaminated zone thickness increased the total radionuclide inventory in the soil. This likely accounted for the direct relationship between contaminated zone thickness and calculated dose. Had the contaminated zone thickness and radionuclide concentration been inversely correlated, as in the dose analysis discussed in the remainder of this appendix, it is likely that the dose would have remained nearly the same or decreased as the contaminated zone thickness was increased (and the radionuclide concentration decreased).”

Thus, the lack of correlation between the modeled uranium concentrations and contaminated zone thickness likely caused inaccurate results in the sensitivity analysis. The lack of correlation between the modeled radionuclide concentration and contaminated zone thickness likely over-emphasized the importance of the contaminated zone thickness and may have obscured the sensitivity of dose to other parameters.

The sensitivity of dose to other parameters also could have been obscured by the ranges over which they were varied. In the description of the sensitivity analysis, the Army did not explain why a generic factor of two variation would be adequate to represent the uncertainty in certain physical parameters. For example, a generic factor of 2 was applied to distribution coefficients, although site-specific data from the JPG Kd study show much larger ranges (e.g., a factor of 20 for loess and till soils shown in Figures 9-3 and 9-4 of Appendix D of the ER).

Additional information is needed on the sensitivity of dose to variations in parameter values in other scenarios, with appropriate ranges, and appropriate parameter correlations to evaluate the conclusion that the Army has identified parameters important to dose. An understanding of the parameters having the most effect on dose is necessary to evaluate the level of justification provided for the parameter values. Appropriate justification of parameter values is needed if the Army bases it groundwater monitoring plan on modeling results indicating the relative level of risk of the groundwater pathway.

DS-2

Uncertainty analyses were included with the RESRAD-Offsite model submitted with the DP, which the Army cited as a basis for limiting groundwater monitoring. Additional justification is need about the parameters that were held constant in the analysis, the ranges of some of the parameters that were varied in those analyses, and the lack of correlations between certain parameters.

Accordingly, the Army should provide a revised uncertainty analysis with a systematic explanation for which parameters are represented probabilistically in the analysis, the ranges for the parameter values, and correlations between parameters. This explanation should consider generic information such as that provided in NUREG-6697 as well as site-specific information, such as the results of the Army's FEHM 1-dimensional soil column analysis submitted with the ER. For parameters for which site-specific data do not exist (e.g., plant transfer factors) generic ranges such as those provided in NUREG-6697 are acceptable. The analysis also should address whether higher infiltration rates and larger initial contaminated zone thicknesses, in conjunction with the uncertainties in distribution coefficients and hydraulic conductivities already included in the probabilistic analysis, could lead to higher projected doses to an off-site resident.

This information is needed to support the conclusion that the Army has adequately characterized the uncertainty in the system, which is needed if the Army bases the groundwater monitoring plan on modeling results indicating the relative level of risk of the groundwater pathway. Alternatively, under a possession-only license, the Army could provide a plan to monitor groundwater for DU rather than relying on model projections to justify sampling groundwater only when sampling is conducted for other reasons.

Basis

In Appendix C of the DP the Army describes a systematic approach for determining which parameters should be included in the sensitivity analysis. Although it was not stated directly, it appears the same reasoning was used to exclude certain parameters from the uncertainty analysis. In the sensitivity analysis, with one exception, the Army included parameters that met the following two criteria: (1) the parameter was identified as a Priority 1 parameter in NUREG- 6697 (NUREG-6697 Attachment B Table 4.2); and, (2) the Army had site-specific data for the parameter value. The exception to these two criteria was that the Army also included the contaminated zone thickness, which is identified as a Priority 2 physical parameter in NUREG-6697, as a probabilistic parameter in the uncertainty analysis. Of the ten Priority 1 parameters identified in NUREG-6697, the Army excluded three from the sensitivity analysis: (1) density of the cover material; (2) depth of roots; and, (3) plant transfer factors. The density of the cover material appears to have been excluded appropriately because there is no cover material at the site (i.e., contamination extends to the surface). However, additional justification should provide for the exclusion of the depth of roots and plant transfer factors from the uncertainty analysis.

The Army explained that although NUREG-6697 identified the depth of roots and plant transfer factors as Priority 1 parameters, the Army excluded them because no changes to the default values could be made for a hypothetical agricultural scenario. That is, because there were no crops currently growing on-site, the Army did not expect to change the default value for the depth of roots or plant transfer factors to tailor the values to any particular crop. Although the staff understands site-specific data are not available, the lack of site-specific data is not an adequate basis for excluding these parameters from the uncertainty analysis. Generic distributions are available in NUREG-6697 for the purpose of assessing the effect of uncertainty in these parameters when site-specific data are unavailable. These parameters are expected to be particularly important for the dose analysis at JPG because plant uptake is one of the two primary exposure pathways determining the peak dose to an off-site residential farmer.

Although the Priority 1 parameters in NUREG-6697 are a good starting point for planning sensitivity and uncertainty analyses, site-specific information that suggests other parameters could have a significant effect on dose also should be considered. For example, it appears to be important to model variation in the ground water depth at JPG because alternate assumptions about the depth to ground water within the observed range of ground water variation had a significant effect on the results from the FEHM 1-dimensional soil column model submitted with the DP (see Appendix B of the ER). Although the Army included a probabilistic distribution for the thickness of the unsaturated zone in its RESRAD-Offsite uncertainty analysis, the distribution only accounted for the modeled variation in the contaminated zone, it did not account for the larger variation in the depth to ground water. That is, the distribution was developed by regarding the depth to ground water as fixed at 3.35 m (11 ft.), and subtracting the 2 limits of the modeled contaminated zone thickness (i.e., 0.3 and 1.0 m) to calculate the limits of the distribution for the unsaturated zone thickness. That process does not account for the variation of the depth to groundwater at the site. For example, page ES-9/10 of the DP indicates that in some locations, the depth to groundwater is approximately 1 m (2 to 4 ft.) below the ground surface.

Section 3.4.2 of Appendix C of the DP states that “a conservative range of 0.3 to 1 m was selected as the probabilistic RESRAD range for the contaminated zone depth because it leads to higher calculated source term concentration ranges and subsequently higher doses.” However, the sensitivity analysis results in Table 3-4 of Appendix B of the DP show that in the RESRAD-Offsite sensitivity analysis, dose increased, rather than decreased, with increasing thickness of the contaminated zone. The staff understands that this result is likely due to the lack of correlation between the contaminated zone thickness and concentration in the contaminated zone in the sensitivity analysis, which caused an unrealistic change in the source term as the contaminated zone depth varied, as explained in the DP. However, the Army has not provided any alternate analyses to demonstrate that limiting modeled initial depth of the contaminated zone is conservative (see RAI DS-1).

Although a higher initial concentration at the surface would be expected to increase the dose from plant ingestion and direct radiation, a deeper initial contaminated zone would shorten the time for contamination to reach groundwater and increase the amount of DU projected to reach the aquifer during the analysis period. Furthermore, a range of contaminated zone thicknesses extending beyond 1 m appears to be supported by information submitted by the Army. Table 3-8 in the DP indicates that elevated uranium ratios were found in each of the 18 samples collected between 0.6 and 1.4 m (2 and 4.5 feet) BGS at sampling locations near penetrators. In Section 3.7.2 of the DP the Army concludes that that "DU has migrated to 4.5 ft. [1.4 m] BGS and possibly even deeper." Section 3.4.2 of Appendix C of the DP gives a potential uncertainty range of up to 15 m (50 feet) BGS. Therefore, it appears that a larger range of values for the contaminated zone thickness should be tested.

Because the time required for contaminants to reach the aquifer would also be expected to be influenced by the hydraulic conductivity, infiltration rate, thickness of the unsaturated zone, and sorption coefficients in the contaminated and unsaturated zones, uncertainty in the projected dose contribution from ground water pathways can only be understood by considering reasonable ranges of variations of each of these parameters. Uncertainty in the sorption coefficients and hydraulic conductivity were considered in the Army's RESRAD-Offsite uncertainty analysis; however, the parameters affecting the modeled ground water infiltration rate (i.e., annual average precipitation, evapotranspiration coefficient, run-off coefficient) were held constant in the analysis. Furthermore, although sorption coefficients were included in the analysis, coefficients for different uranium isotopes are expected to be correlated with one another and were not correlated in the uncertainty analysis provided with the DP.

As discussed in GW-5, the annual average precipitation, evapotranspiration coefficient, run-off coefficient are uncertain and the resulting infiltration rate calculated from the deterministic values used in the RESRAD-Offsite model is below the range of average infiltration rates for the region. Furthermore, results of an Army sensitivity analysis performed with the FEHM model (Table 4-6 of Appendix B the ER) show projected contaminant migration to groundwater is sensitive to the infiltration rate. Because of this sensitivity and the uncertainty in the water budget described in the SAIC (2008) report, the Army should include parameters affecting the infiltration rate in its uncertainty analysis as probabilistic values instead of deterministic parameters.

This understanding of model uncertainties is needed if the Army bases it groundwater monitoring plan on modeling results indicating the relative level of risk of the groundwater pathway.

Land Uses (LU)

LU-1

The NRC staff is preparing an environmental assessment (EA) pursuant to NRC requirements in 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Programs” and using the guidance in NUREG-1748, “Environmental Review Guidance for Licensing Actions Associated with Nuclear Material Safety and Safeguards Programs.” In accordance with the guidance, to complete the EA description of the affected environment and address the potential impacts associated with current and future land uses, the NRC needs updated information on the transfer of land south of the firing line at JPG from Army to private ownership.

Basis

In the Army’s 2013 environmental report for decommissioning the DU Impact Area (U.S. Army, 2013), the Army stated that 10.0 km^2 [2,485 ac] of land south of the firing line have been transferred from the Army control to private ownership and that negotiations were in progress to transfer an additional 4.9 km^2 [1,212 ac] of land south of the firing line to private ownership. During a NRC site visit to JPG in January 2015, the Army indicated that the transfer of the additional 4.9 km^2 [1,212 ac] of land to private ownership was scheduled for completion by June 2015 (NRC, 2015).

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