TECHNICAL EVALUATION REPORT
FOR
U.S. ARMY ENVIRONMENTAL COMMAND:
CONTAMINANTS OF CONCERN AND DERIVED CONCENTRATION GUIDELINE LEVELS
IN THE FINAL CHARACTERIZATION REPORT AREA 2 OF SWMU-11
DUGWAY PROVING GROUND, DUGWAY, UTAH

September 15, 2020

1.0 INTRODUCTION

1.1 U.S. Army Submittal and Request

By letter dated February 24, 2020 , the U.S. Army Environmental Command (Army) submitted its *Final Characterization Report Area 2 of SWMU-11 Dugway Proving Ground Dugway, Utah* to the U.S. Nuclear Regulatory Commission (NRC) (hereafter, Final Characterization Report; available in the NRC's Agencywide Documents Access and Management System [ADAMS] at Accession No. ML20083M819). The stated purpose of the Final Characterization Report is to:

(1) summarize the site conditions and prior investigations at Area 2 of Solid Waste Management Unit-11 (SWMU-11);
(2) review the existing data set to ensure it is adequate and useable; and
(3) develop derived concentration guideline levels (DCGLs) for soil in Trenches TR-5 and TR-6 at Area 2 of SWMU-11.

The Final Characterization Report was submitted for NRC review consistent with the Memorandum of Understanding (MOU) between the NRC and the U.S. Department of Defense (DoD) (hereafter the NRC/DoD MOU; ADAMS Accession No. ML16092A294). Previously, on October 22, 2019, the Army transmitted a draft of the Final Characterization Report (ADAMS Accession No. ML19296C279) for review and comment. On November 26, 2019 the NRC staff sent a preliminary Request for Additional Information (RAI) to the Army (ADAMS Accession No. ML19350A727), and a final RAI on December 16, 2019 (ADAMS Accession No. ML19330F774), which the Army responded to on February 24, 2020 accompanying the Final Characterization Report (ADAMS Accession No. ML20083M819). This Technical Evaluation Report (TER) focuses on the Army's methods for identifying radionuclides of concern (ROCs) and the development of DCGLs in the Final Characterization Report.

1.2 Background

On April 28, 2016, the NRC and the DoD entered an MOU that documents the roles, responsibilities, and relationship between the DoD and NRC regarding environmental response actions on DoD sites containing radioactive materials. As articulated in the NRC/DoD MOU, the MOU serves to avoid duplication of regulatory requirements and efforts imposed by obligations that are established by the Atomic Energy Act of 1954, as amended (AEA); associated NRC regulations; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the Defense Environmental Restoration Program (DERP). This agreement was based on an NRC staff recommendation to the Commission in SECY-14-0082, "Jurisdiction for Military Radium and U.S. Nuclear Regulatory Commission Oversight of U.S. Department of Defense (DoD) Remediation of Radioactive Material" (ADAMS Accession No. ML14097A005),

which recommended an MOU with the DoD to further reinforce the NRC's reliance on CERCLA and the U.S. Environmental Protection Agency's (EPA) oversight at the Alameda Naval Air Station, Hunters Point Shipyard (HPS), and McClellan Air Force Base and clarified the NRC's monitoring role at other DoD facilities. The NRC staff's recommendation was subsequently approved by the Commission in SRM-SECY-14-0082 (ADAMS Accession No. ML14356A070).

Because Dugway Proving Ground (DGP) is not under direct EPA oversight, NRC staff, consistent with the NRC/DoD MOU, have been monitoring DoD's activities, primarily by performing document and data reviews and providing DoD with written comments to ensure that NRC's dose criterion of 25 millirem per year (mrem/yr) (0.25 millisievert per year [mSv/yr]) is not exceeded.

SWMU-11 is located in the remote southwest portion of DPG and is divided into two distinct areas: Area 1 and Area 2. Area 1 of SWMU-11 consists of three closed trenches (TR-1, TR-2, and TR-3) and a fourth backfilled trench (TR-4). Area 1 of SWMU-11 was previously evaluated and closed under Resource Conservation and Recovery Act and corrective action requirements of the Utah Division of Waste Management and Radiation Control. Area 2 of SWMU-11 is the radiological disposal area and consists of two trenches (TR-5 and TR-6) and the area adjacent to the trenches. Area 2 previously contained a CONEX container; however, it was determined to be radiologically clear and was removed in 2017 (Marsh, 2017). Available evidence indicates that radiological materials were stored in the CONEX container and disposed in trenches TR-5 and TR-6 as early as the mid-1950s, although specific records regarding materials disposed at Area 2 of SWMU-11 are limited.

The Army has conducted several site investigations of SWMU-11 beginning in 1996, with investigations focused on Area 2 beginning in 2005, that are summarized in the Final Characterization Report and evaluated for their usability to support the Army's planned feasibility study (FS). Additionally, the Army has used the results of these previous investigations to identify ROCs and develop associated DCGLs for both unrestricted and restricted use in the Final Characterization Report to support the Army's planned FS and the remaining investigation and remediation activities at Area 2 of SWMU-11, which are being addressed under CERCLA/DERP.

2.0 REGULATORY BASIS

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 20, Subpart E, "Radiological Criteria for License Termination," establishes the NRC's requirements for the release of a site. Consistent with the NRC/DoD MOU, NRC staff is performing monitoring activities to ensure that DoD's remedy meets the NRC's 25-mrem/yr (25-mSv/yr) dose criterion in 10 CFR 20.1402 for sites that will be released for unrestricted use or is consistent with the requirements in 10 CFR 20.1403(b) for sites that will be released for restricted use.[1] It is important to note that this site will be released under the CERCLA/DERP process, not under NRC's regulatory authority.[2]

[1] 10 CFR 20.1403(b) specifies that under restricted release legally enforceable institutional controls must provide reasonable assurance that the dose will not exceed 25 mrem/yr (0.25 mSv/yr).
[2] One of the key reasons for the NRC/DoD MOU was to avoid duplicative regulatory requirements and effort given the possible overlap between CERCLA, DERP, and the AEA.

3.0 EVALUATION

This TER describes the NRC staff's evaluation of the Army's Final Characterization Report for purposes of ensuring that the Army has adequately identified ROCs and developed associated DCGLs that conform with the radiological dose criterion of 25 mrem/yr (0.25 mSv/yr) and support the Army's planned FS. The TER also summarizes the NRC staff's evaluations of environmental considerations, consultations with the State of Utah, and NRC's commitments to consult with the U.S. Environmental Protection Agency in certain cases.

3.1 Demonstrating Conformity with Dose Criteria

NRC's consolidated decommissioning guidance in NUREG-1757, Vol. 1 and Vol. 2, "Consolidated Decommissioning Guidance" (ADAMS at Accession No. ML063000243 and ML063000252), discusses acceptable methods for demonstrating compliance with the radiological dose criterion. The NRC staff evaluated the Final Characterization Report in accordance with NUREG-1757 dose modeling criteria for future site use to confirm that there is reasonable assurance that the DCGLs developed by the Army are reasonable and will ensure that average concentrations of residual site contamination remaining after the Army's eventual remedial action would not result in an average member of the critical group receiving a combined dose from all pathways in excess of the NRC's 25-mrem/yr (0.25-mSv/yr) dose limit.

The Army identified and screened potential ROCs based on data gathered during previous site investigations. Then the Army developed DCGLs for modeled ROCs based on the dose criteria in 10 CFR 20.1402, for unrestricted use, and 20.1403, for restricted use.

Overall, the NRC staff noted that the Army's identification and screening of ROCs from previous site investigations may have included ROCs that may not actually be present or associated with site operation and may not have included ROCs associated with chemical agent detectors used at DGP. While inclusion of ROCs not associated with site operations is conservative, the NRC staff recommends the Army incorporate gross alpha/beta analyses of samples as an additional quality check during future characterization efforts to ensure that any significant radiological contaminants that may not have been included as ROCs are not overlooked during remedial activities. Details of the NRC staff's review of the Army's site investigations and ROC identification and screening are included in Sections 3.1.1 and 3.1.2 of this TER.

For the dose assessment, the NRC staff found the Army's source-term assumptions and exposure scenarios and pathways to be conservative. In its review, NRC staff noted some issues with the justification for select input parameters that could have a significant impact on the dose; however, the results of the uncertainty analyses with probabilistic distributions supports the Army's deterministic DCGLs. Details of the NRC staff's review of the Army's development of DCGLs is included in Section 3.1.3 of this TER.

3.1.1 Site Investigations

The Army reports in the Final Characterization Report that specific historical records regarding radiological materials disposed at SWMU-11 are limited and may have included contaminated rags and papers, low-level radioactive waste from repackaging of materials for sea disposal, waste from laboratory activities in other areas of DPG, and radium-containing parts and devices that were common on military installations. The Army relied upon data from previous site investigations to identify ROCs. The Army has conducted several site investigations of SWMU- and Area 2, specifically, that are evaluated for their usability to support the Army's planned FS

and to identify ROCs. Given the Army is currently characterizing the site to support the planned FS, the NRC staff focused its review of the site investigations on their adequacy for identifying ROCs.

To identify and screen ROCs, the Army has primarily relied upon the results of a site investigation completed in 2016. The 2016 investigation included 15 boring locations (including 10 at TR-5 and 5 at TR-6)—cores were scanned, and downhole gamma logging was used. In addition, 34 soil samples and 1 debris sample were collected for confirmatory laboratory analyses. Staff noted that the Army's draft description provided limited information on the methods used in prior investigations, and radionuclides identified from those investigations appeared inconsistent with the knowledge of operational history or the presence, or lack thereof, of associated radionuclides. In the RAI on ROCs, dated December 16, 2019 (ADAMS Accession No. ML19330F774), the NRC staff requested that the Army provide additional information to confirm that the previous site investigation methods were adequate to identify all significant radionuclides and that selected radionuclides identified by the Army's analyses were not artifacts of the analyses. In response, the Army provided additional details regarding the quality of the data from the 2016 and previous investigations. The Army also identified the laboratory analyses conducted for the 2016 soil, compared results from previous investigations to the 2016 data, and concluded that the 2016 laboratory data are conservative and complete (i.e., that it is unlikely potentially significant radionuclides were not identified).

As discussed in more detail in Section 3.1.2 of this TER, it appeared there have been several false positive detections (e.g., Th-229 and U-232), which may be artifacts of the Army's analytical methods. NRC recommends that future sampling and analysis re-examine analytical laboratory library selection and reporting protocols to ensure that data quality objectives support final decisions. The site investigations summarized in the Final Characterization Report appear to have resulted in identifying ROCs that may not be present or associated with site operation, which is conservative, though it may be more prudent to dedicate resources to primary ROCs, like Ra-226, that are dose-drivers directly linked to site operations.

However, the site investigations do not appear to have evaluated the potential presence of radionuclides associated with certain chemical agent detectors (i.e., Am-241 and Ni-63). In response to an NRC staff question on radionuclides associated with certain chemical agent detectors, the Army provided additional information, dated July 2, 2020, (ADAMS Accession No. ML20197A291) that included an historical site assessment, radionuclide inventory, and history of chemical agent detectors employed by the Army. Together, the Army indicated that these records provide a basis that the likelihood of Ni-63 and Am-241 disposal is low because the operational history of Area 2 predates use of these radionuclides in chemical agent detectors at DPG. The Army also indicated previous site investigations evaluated Am-241 but did not include results in prior reports because it was not detected. Although the likelihood that the presence of these radionuclides at Area 2 appears to be low, NRC staff recommends that future sample analyses include gross alpha/beta analyses to verify that any significant activity radionuclides are not overlooked at Area 2 and future investigations are adequate to identify all significant radionuclides.

3.1.2 Radionuclides of Concern

The Army screened radionuclides identified in their historical site assessment and previous site investigations based on dose and excluded radionuclides whose maximum concentration in soil or debris was less than a concentration considered protective of a residential land-use scenario and dose limit of 10 mrem/yr (0.1 mSv/yr). These values were calculated using the EPA's Dose

Compliance Concentration (DCC) online calculator. Additionally, the Army compared the soil and debris concentrations to twice the average background.[3] The ROCs identified by the Army's screening process are listed in Table 1.

Table 1. Radionuclides of Concern				
Actinium-228	Cobalt-56	Protactinium-234m	Thorium-227	Uranium-232
Bismuth-212	Iron-59	Plutonium-242	Thorium-229	Uranium-234
Bismuth-214	Lead-210	Polonium-210	Thorium-230	Uranium-235
Carbon-14	Lead-214	Radium-226	Thorium-232	Uranium-238
Cesium-137	Niobium-94	Strontium-90	Thorium-234	

The NRC staff note that the DCC code produces results that differ from results produced by NRC's DandD code, which was used to develop soil screening DCGLs that are presented in Table H.2 of NUREG-1757, Vol.2. However, based on NRC's independent analysis, the difference is largely due to different conceptual models used to develop the respective values. When comparing similar conceptual models and dose constraints, both DCC and DandD produce similar results, except for the following radionuclides: H-3, C-14, K-40, Cs-137, Eu-155, Po-210, and Th-229. Of these exceptions, only H-3, K-40, and Eu-155 were excluded as ROCs by the Army using the results of the DCC code. Looking at these three excluded radionuclides, only K-40 would have not been excluded using NRC's DandD and a 10-mrem dose constraint (rather than Army's DCC) results. Because K-40 is a naturally occurring radionuclide and likely not the result of site operations, the NRC staff finds the screening methodology using DCC adequate.

The NRC staff also note that the Army's use of twice background as a screening approach for ROCs lacks an adequate justification. NRC staff requested additional justification for this approach in a RAI on December 16, 2019 (ADAMS Accession No. ML19330F774). In its response, the Army indicated it is a common approach to evaluate naturally occurring metals and radionuclides in CERCLA risk assessments. The NRC staff notes from its analysis of the Army's results that only K-40 was screened based on this approach. As mentioned above, K-40 is naturally occurring and not likely the result of site operations. Therefore, the NRC staff note that using the twice-background screening approach is not expected to have a significant effect on the results. NRC staff also noted that background concentrations from clearly different datasets were used to screen later data (i.e., data from Parsons (2009) was used to screen Cabrera (2016) data). NRC staff notes that this could be an important issue when assessing certain ROCs such as those in the Thorium series. Defensible background concentrations, if used, should be established prior to final status determination.

The Final Characterization Report identifies a relatively large number of radionuclides as ROCs. The list has grown over time as more samples were collected and a broader suite of analytes were considered for laboratory analysis. For example, the 2005 Parsons radiological survey work plan identifies ROCs H-3, C-14, Co-60, and Ra-226 (Parsons, 2009). Strontium-90 was detected during the execution of that plan, then Cabrera's 2016 (Cabrera, 2016) investigation added several more ROCs based on "detections" from the analytical laboratory. The final list of ROCs is primarily based on the 2016 investigation (see Section 3.1.1 of this document). The list includes the more traditional ROCs provided in the Final Characterization Report, presenting only long-lived radionuclides (secular equilibrium with short-lived progeny is assumed):

[3] Only potassium-40 was excluded as a ROC due to the twice-background comparison

- Activation and fission products C-14, Cs-137, and Sr-90
- Thorium series ROCs Th-232, Ra-228, and Th-228;
- Actinium series ROCs U-235, Pa-231, and Ac-227; and
- Uranium series ROCs U-238, U-234, Th-230, R-226, and Pb-210.

The following ROCs are also listed, and each presents potential challenges moving into later phases of the project life cycle:

- Th-229
- U-232
- Pu-242
- Nb-94

Thorium-229 and U-232 are both associated with U-233, a fissile radionuclide produced by bombarding Th-232 with neutrons. Though U-233 is not on the analyte list nor would it be expected as a contaminant at SWMU-11, both Th-229 and U-232 are listed as ROCs. Radiological materials associated with U-233 are known for high gamma-radiation levels and thorium-series decay products. However, only low levels of thorium-series radionuclides have been identified. It is unclear to NRC staff why the samples were analyzed for Th-229 or U-232. The NRC staff suspects that detecting U-232 in all 34 soil samples (maximum of 3.91 pCi/g [0.145 Bq/g]) when there is no corroborating evidence that U-232 or U-233 should be present at DPG is highly unlikely. Similarly, NRC staff suspects that detections of Nb-94 and Pu-242 are also artifacts of the analytical methods because the Army's investigation reports disregard some fission products and report no other information about plutonium. The Final Characterization Report implies that isotopic plutonium analysis was performed although the data are not presented. The Final Characterization Report retains these as ROCs, which is conservative, though Army may want to reconsider the analyte list prior to final status survey evaluations due to cost.

In summary, the NRC staff finds there is sufficient evidence to retain long-lived decay products from natural series (thorium, actinium, and uranium) plus some fission/activation products (tritium, C-14, Cs-137, and Sr-90). However, inclusion of Th-229, U-232, Pu-242, and Nb-94 in the ROCs may be artifacts of the Army laboratory's analytical methods, though their inclusion as ROCs is conservative. Additionally, as discussed in Section 3.1.1 of this TER, the Army did not include radionuclides commonly associated with certain chemical agent detectors, i.e., Ni-63 or Am-241, as ROCs. As discussed in Section 3.1.1 of this TER, the NRC staff recommends that future investigations at Area 2 include gross alpha/beta analyses to ensure that no radionuclides that contribute significant activity in samples are excluded from consideration.

3.1.3 Dose Assessments

To calculate the DCGLs, the Army assumed the contaminated volume of each trench was spread over a depth of 15 centimeters at the surface and considered both residential farming and industrial worker scenarios using a suite of deterministic input parameter values based on a hierarchy of sources, including default values, NRC guidance, literature values, and site-specific information. The Army calculated DCGLs using the RESRAD-ONSITE computer code. Table 2 lists the DCGLs for the modeled ROCs at Area 2 for Trenches 5 and 6.

Table 2. Derived Concentration Guideline Levels for Modeled Radionuclides of Concern*

Radionuclide	TR-5		TR-6	
	Residential†, pCi/g (Bq/g)	Industrial‡, pCi/g (Bq/g)	Residential†, pCi/g (Bq/g)	Industrial‡, pCi/g (Bq/g)
C-14	1,753 (65)	6.68×10^7 (2.47×10^6)	2,070 (77)	7.15×10^7 (2.64×10^6)
Cs-137	33 (1.2)	172 (6.4)	33 (1.2)	173 (6.4)
Nb-94	12 (0.4)	61 (2.3)	12 (0.4)	61 (2.3)
Pb-210	27 (1.0)	3,188 (188)	30 (1.1)	3,499 (129)
Pu-242	234 (8.7)	4,284 (159)	254 (9.4)	4,564 (169)
Ra-226	7.4 (0.3)	55 (2.0)	7.7 (0.3)	55 (2.0)
Sr-90	47 (1.7)	19,916 (737)	52 (1.9)	20,239 (749)
Th-229	44 (1.6)	285 (11)	45 (1.7)	288 (11)
Th-230	31 (1.1)	200 (7.4)	32 (1.2)	201 (7.4)
Th-232	6.2 (0.2)	38 (1.4)	6.3 (0.2)	38 (1.4)
U-232	14 (0.5)	72 (2.7)	14 (0.5)	73 (2.7)
U-234	1,261 (47)	23,552 (871)	1,353 (50)	24,414 (903)
U-235	128 (4.7)	687 (25)	129 (4.8)	691 (26)
U-238	488 (18)	3,329 (123)	502 (19)	3,358 (124)

NOTES:

* The Army developed DCGLs for certain long-lived ROCs. Shorter-lived ROCs that would not persist in the waste without a long-lived parent were either not modeled (i.e., Co-56, Fe-59, Nb-95) or were included in the decay chains of long-lived parent radionuclides (i.e., Ac-228, Bi-212, Bi-214, Pb-212, Pb-214, Pa-234m, Po-210, Th-234, and Th-227).

† The Army developed DCGLs for a residential user based on the unrestricted use dose criterion in 10 CFR 20.1402 (i.e., 25 mrem/yr [0.25 mSv/yr]).

‡ The Army developed DCGLs for an industrial user based on the restricted use dose criterion in 10 CFR 20.1403 (i.e., 100 mrem/yr [0.1 mSv/yr]).

NRC staff evaluated the Army's development of DCGLs in accordance with NUREG-1757, Vol. 2 (ADAMS at Accession No. ML063000252), dose modeling criteria for future site use to confirm that there is reasonable assurance that the average concentrations of residual site contamination would not result in an average member of the critical group receiving a combined dose from all pathways in excess of the 25-mrem/yr (0.25-mSv/yr) limit. Areas of review included the following:

- Source term assumptions
- Exposure scenarios and pathways, including critical group(s)
- Mathematical models and input parameters
- Calculations of radiological impacts on individuals, including sensitivity and uncertainty analyses

Source Term Assumptions

The Army defines the source term assuming the entire volume of contaminated soil is exhumed and spread over the ground surface, resulting in a 6-inch (15-centimeter) contaminated soil layer. The Army assumes contamination is homogeneous rather than discrete sources or artifacts. The NRC staff finds both Army assumptions are conservative and should result in higher than expected doses, thus conservatively low DCGLs.

Scenario Analysis

For exposure scenarios, the Army includes both a resident farmer and an industrial worker. The Army considers a resident farmer as the critical group assuming an unrestricted release with no land use controls (LUCs). Exposure pathways for the resident farmer include direct radiation, inhalation of re-suspended dust, incidental soil ingestion, ingestion of foodstuff (crops, meat, and dairy products), and well water. The Army considers an industrial worker as the critical group assuming a restricted release scenario with LUCs. Exposure pathways for the industrial worker include direct radiation, inhalation of re-suspended dust, incidental soil ingestion, and ingestion of well water. The NRC staff finds both critical groups are reasonably conservative for this site for their respective release alternatives given the critical-group conceptual models presume a subsistence farm or industrial facility will be constructed in the direct center of exhumed trench materials and the Army calculates doses from a comprehensive set of exposure pathways for each respective critical group. Because the Army has not yet selected a remedy, the necessity for LUCs has not been established. However, these scenarios represent reasonably conservative critical groups for described unrestricted and restricted release conditions at DPG.

Mathematical Model

The Army used the RESRAD-ONSITE model (version 7.2 presumed given the specific version is not provided). The NRC staff considers the RESRAD mathematical model appropriate for dose assessments (after Version 6) given adequately justified input parameters. Section 4.4 of the Final Characterization Report describes the hierarchy used to select model input parameters, uncluding the following:

- Behavorial and Metabolic parameters: The Army assigned the mean of the probability distrubution function from NUREG/CR-5512, Vol. 3, "Residual Radioactive Contamination from Decommissioning – Paramter Analysis" (ADAMS Accession No. ML082460902).

- Physical parameters: The Army's preferred method for assigning values is based on site-specific values measured on site or from literature values based on site soil type. If site-specific information was not available, the Army used a parameter priority ranking method from NUREG/CR-6697, "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes" (ADAMS Accession No. ML010090252):

    - Priority 1: Greatest effect on dose, assigned median or mean values from the probability distribution function in NUREG/CR-6697, Attachment C
    - Priority 2: Assigned median or mean values from the probability distribution function in NUREG/CR-6697, Attachment C
    - Priority 3: Least effect on dose, assigned deterministic default values

The Army tabulated its justification for selected parameters in Appendix B of the Final Characterization Report, including references, where appropriate. The NRC staff notes that the parameter priority ranking used in NUREG/CR-6697 may not be appropriate at DPG since the ranking approach was used to prioritize the development of RESRAD input parameters by the code's developer and significance to dose was only one factor of several, including, for example, availability of data, that the RESRAD developer used to determine which input parameters to develop probabilistic distributions for first. The NRC staff notes a more appropriate approach would have resembled the approach described in NUREG/CR-6676, "Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes" (ADAMS Accession No. ML003741920; e.g., see Tables 7.2-7.4).

Based on the NRC staff's independent analysis, using the approach described in NUREG/CR-6676, the gamma shielding factor is expected to be a significant input parameter at Area 2 of SWMU-11 at DPG. The NRC staff notes that the Army selected a value of 0.21, which is the least conservative of possible values evaluated in NUREG/CR-6697 (for a frame house). However, the Army did not provide justification for the selected value. Regardless, the NRC staff note that additional justification for the external gamma shielding factor is not necessary based on the NRC's review of the Army's sensitivity and uncertainty analyses, which are discussed further below. The NRC staff found that the Army's selection of values for other significant parameters were adequate because the values were either adequately justified based on the hierarchy of sources (e.g., fruit, grain, and vegetable consumption rate, which is a behavioral parameter) or were from reasonably conservative percentiles of their respective probability distributions (e.g., plant transfer factors, distribution coefficients, and depth of roots).

Sensitivity and Uncertainty Analyses

The Army summarizes its sensitivity and uncertainty analyses in Appendix C of the Final Characterization Report for Ra-226. The Army evaluated the sensitivity of Ra-226 dose to many of the input parameters that NRC staff would expect to have a significant impact on doses (e.g., external gamma shielding factor, distribution coefficients, consumption rates) from complete exposure pathways. The Army also performed uncertainty analyses by setting sensitive parameter input values to upper or lower quantiles of the respective parameter's distribution, depending on the sensitivity, as well as a full probabilistic evaluation for Ra-226.

The Army noted that its probabilistic calculation produced a dose in line with the deterministic result, providing additional support for the Army's DCGLs.

The NRC staff performed independent probabilistic analysis for the suite of modeled ROCs and confirmed that the Army's deterministic DCGLs are consistent with the results from the probabilistic analyses. The NRC staff's independent results confirm the reasonableness of the Army's DCGLs. As such, the Army does not need to provide additional justifications for parameters at Area 2 of SWMU-11 at DPG (e.g., external gamma shielding factor noted earlier).

3.2 Environmental Considerations

The scope of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," is limited to the NRC's domestic licensing and related regulatory functions. Area 2 of SWMU-11 at DPG is not an NRC-licensed site, and there is no application for an NRC license or any other NRC regulatory action. In contrast, NRC is reviewing DoD reports and providing written comments to DoD, per the NRC/DoD MOU, and NRC is not overseeing the site remediation. Further, NRC staff is not approving the Army's documents; rather, NRC staff is ensuring that DoD's cleanup will not result in NRC's unrestricted-use dose criterion being exceeded or is consistent with the requirements specified in 10 CFR 20.1403(b) for restricted release. For these reasons, NRC is not taking a Federal action. As a result, NRC staff does not need to comply with the National Environmental Policy Act (NEPA) for its activities under the MOU. Accordingly, and consistent with the NRC staff's procedures for managing sites under the NRC/DoD MOU (ADAMS Accession No. ML15090A588), the NRC does not need to prepare an Environmental Assessment regarding these remediation activities.

3.3 State Consultations

NRC staff discussed this technical evaluation with the State of Utah.

3.4 Evaluation of NRC/EPA MOU Consultation Triggers

Since this site is undergoing release under CERCLA, and the EPA was consulted prior to the finalization of the NRC/DoD MOU, the NRC staff concludes that consultation with the EPA per the NRC/EPA MOU (ADAMS Accession No. ML022830208) is not necessary for this specific review.

4.0 CONCLUSIONS

The NRC staff reviewed the Final Characterization Report to evaluate the adequacy of the Army's identification of ROCs and determination of DCGLs for both unrestricted and restricted release alternatives. The NRC staff identified potential quality issues in data used to identify ROCs. The list of ROC includes several radionuclides that may be artifacts of previous analytical methods and are thus conservatively included but could be disregarded to minimize analytical cost. Also, the possibility of certain radionuclides not included in the ROC listing exists given the site operational history (e.g., Am-241 and Ni-63 in certain chemical agent detectors). For this reason, the NRC staff recommends that gross alpha/beta analyses be included in sample analyses during future site investigations to identify significant activity from radionuclides not in the analytical suite of ROCs and which could have a significant impact on dose to the public. Also, the NRC staff recommends that the Army improve the defensibility of background concentrations prior to final status determination.

Finally, the Army calculated DCGLs for modeled ROCs using deterministic methods supported by sensitivity and uncertainty analyses. Overall, the NRC staff finds the Army's methods to calculate DCGLs for the modeled ROCs acceptable, leading reviewers to the conclusion that there is reasonable assurance that residual radioactivity remaining in Area 2 of SWMU-11 that conforms to the respective DCGLs after the Army's remedial action would meet the 25-mrem/yr (0.25-mSv/yr) dose criterion for unrestricted use in 10 CFR 20.1402 or restricted use in 10 CFR 20.1403. This conclusion is based on the NRC staff's findings that:

- The Army utilized conservative receptors for the respective release scenarios with a comprehensive set of corresponding exposure pathways and appropriate mathematical models.

- The Army selected input parameter values that are based on a generally acceptable hierarchy of sources. For the external gamma shielding factor, for which the NRC staff noted an exception to this finding, the NRC staff found the exception is not expected to have a significant impact on DCGLs because the deterministically determined DCGLs are consistent with the results from the Army's and NRC staff's independent probabilistic analyses, which included a fuller range of shielding factor values.

5.0 REFERENCES

Cabrera, 2016. *Final Report: Area 2 Solid Waste Management Unit (SWMU) 11 Trenches TR-5 and TR-6, Dugway Proving Ground, Dugway, Utah*. September 2016.

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