REGION I
SAFETY EVALUATION REPORT
REVIEW OF FINAL STATUS SURVEY REPORT
FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE
BELTSVILLE LOW LEVEL RADIATION BURIAL SITE
LICENSE NO. 19-00915-03 DOCKET NO. 030-04530
BELTSVILLE, MARYLAND
November 13, 2017

1. Background

The United States Department of Agriculture (USDA) Beltsville Agricultural Research Center (BARC) site is located on an approximately 6,600-acre site in northwestern Prince George's County near Beltsville, Maryland. Research at the facility included work on soil, water, plant sciences, animal sciences, and human nutrition. Research at the facility laboratories was performed with various chemicals, solvents, and low-level radioactive materials and included animal studies. The USDA is authorized to conduct research and development with radioactive materials in accordance with its NRC License (License No. 19-00915-03, Docket No.030-04530). Various BARC laboratories generated radioactive waste that included materials such as gloves, paper, and syringes; sealed sources and electron capture detectors; glass and plastic liquid scintillation vials; aqueous and organic liquids; plastic bags containing decomposed small and large animal carcasses, bedding, and excreta; and other radioactively contaminated laboratory wastes.

The BARC Low Level Radioactive Burial Site (LLRBS) was established in 1949 and was used for disposal of low-level radioactive waste from research and development activities with radioactive materials until 1987. In 1987, the USDA initiated use of a commercial service to have radioactive waste transported and disposed offsite at a licensed disposal facility and no longer disposed of radioactive waste at the LLRBS or any other onsite location. The BARC LLRBS is an area less than one acre in a remote area of the USDA site. Other than a small shed, adjacent to the LLRBS, that was not used for radioactive waste storage or handling activities during LLRBS operation, there are no structures, systems, or equipment in the vicinity of the LLRBS. (NOTE: during decommissioning activities, exhumed sources and some small, intact containers of liquids were temporarily stored in drums in the shed prior to transfer to shipping containers for offsite disposal. The contractor referred to this building as the "Sort and Segregation Building"). The BARC LLRBS is made up of a total of 50 designated waste burial pits, of which, only 46 were reportedly used. The pits were approximately 10 feet wide by 12 feet long by 10 feet deep and separated by approximately five feet horizontally from one another. Each pit was reportedly backfilled to surface grade with at least 5 feet of clean soil. The radioactive isotopes used at the BARC facilities and disposed as radioactive waste material at the BARC LLRBS consisted of hydrogen-3 (tritium or H-3), carbon-14 (C-14), chlorine-36 (Cl-36), nickel-63 (Ni-63), strontium-90 (Sr-90), cesium-137 (Cs-137), lead-210 (Pb-210), and radium-226 (Ra-226). In addition, short-lived radioactive materials were also disposed at the LLRBS, and included phosphorus-32 (P-32) and sodium-24 (Na-24), but were not included as radionuclides of concern because they would have decayed to background levels. According to available records, the types of containers used to dispose of waste included cardboard boxes, plastic and glass containers, fiberboard drums, and metal 55-gallon drums. Inventory records of burials from 1949 through 1960 could not be located and thus the estimated radionuclide activities in the BARC LLRBS may to be greater than the tabulated values listed in the Decommissioning Plan (DP).

Onsite monitoring wells have been sampled as part of an ongoing groundwater monitoring program since 1998. Elevated concentrations of tritium have been historically identified in down gradient groundwater monitoring well samples, with some values exceeding the USEPA Maximum Contaminant Level for that radionuclide (20,000 pCi/l). Tritium concentrations since 2001 have been less than the USEPA Maximum Contaminant Level. Data from 2010 indicated a maximum concentration of 3600 pCi/l. Elevated tritium concentrations have not been identified in the far down gradient monitoring well samples. Carbon-14 was detected at only two down gradient monitoring wells within the last ten years. These wells are located adjacent to the LLRBS boundary, immediately down gradient to the burial pits. The concentrations of C-14 in monitoring well samples have remained at a factor of approximately ten below the 2000 pCi/l USEPA Maximum Contaminant Level.

As discussed above, some of the radionuclide burials were in the form of liquid scintillation solutions. These disposals may have been as small vials (20 milliliter or less) or the solutions may have been aggregated into larger containers. The types of organic liquids contained in the liquid scintillation fluids were not identified in records, but typically, organic solvents associated with liquid scintillation fluids include toluene and xylene. There was no indication of the volume of liquid scintillation fluids that may have been disposed. In addition to the organic solvents disposed as liquid scintillation solutions, the LLRBS burials included other non-radiological components consisting of organic chemicals - chloroform, benzene, and trichloroethylene and metals - arsenic, chromium, and vanadium. The remediation actions for the LLRBS should also be effective in addressing the non-radiological contaminants. However, regulatory authority regarding the acceptability of any residual quantities of the non-radiological contaminants in soil (and potentially groundwater) lies with the USEPA under its authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

2. Site Remediation

In January 2012, the USDA submitted a Revised Final Decommissioning Plan (DP) that incorporated NRC review comments based on our earlier Request for Additional Information. The DP was prepared by Cabrera Services, Inc., the contractor that had performed earlier site characterization activities. A Final Status Survey Plan was included as part of the DP. The DP used the guidance in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) for classification of impacted areas and design of the subsequent radiological surveys intended to meet the NRC's criteria for release for unrestricted use. The USDA used a consortium of two NRC-licensed decommissioning contractors, TerranearPMC and EnergySolutions Environmental Services, LLC (EnergySolutions) (collectively referred to as TES), to perform remediation activities and radiological surveys at the LLRBS. The EnergySolutions license was the reference license for performance. Revisions to the DP based on technical memoranda from the contractors were approved as amendments to the USDA license.

The USDA Radiation Safety Officer (RSO) had overall responsibility for the project and interface with the contractors. The USDA RSO had oversight support from experts from the U.S. Army, located at the Rock Island Arsenal in Illinois who administered the contract and procurement process and provided comprehensive health physics technical support, particularly in the areas of low level waste disposal and transportation.

2.1 Site Release Criteria

The NRC criteria for unrestricted release in 10 CFR 20.1402 are that the all-pathways dose from residual radioactivity that is distinguishable from background to an average member of the critical group is no more than 25 mrem/yr and is as low as reasonably achievable (ALARA). The USDA calculated site-specific Derived Concentration Guideline Level (DCGL or $DCGL_W$) values for soil that corresponded to a dose of 25 mrem/yr for each radionuclide of concern, based primarily on the resident farmer scenario, supplemented by a construction intrusion scenario for selected radionuclides of concern. The soil $DCGL_W$ values are presented in Table 2.1. A sum of fractions (SOF) approach was used to evaluate whether the total dose from all radionuclides of concern was less than the 25 mrem/yr criterion.

Table 2-1 Soil $DCGL_W$ values

Radionuclide of Concern	$DCGL_W$ (pCi/g)
Hydrogen-3 (H-3)	121.2
Carbon-14 (C-14)	22.4
Chlorine-36 (Cl-36)	18
Nickel-63 (Ni-63)	95,859
Strontium-90 (Sr-90)	4.9
Cesium-137 (Cs-137)	17.4
Lead-210 (Pb-210)	2.0
Radium-226 (Ra-226)	2.2

* Although Ra-226 and Pb-210 are in the same decay chain, they were not assumed to be in secular equilibrium amounts for the purpose of DCGL development because they were placed in the disposal area at different times.

Although decommissioning is typically associated with license termination, the USDA is not seeking termination of its NRC license at this time because they still conduct other permitted activities under its license. If the NRC staff concur that the data in the Final Status Survey Report (FSSR) confirms that the LLRBS meets the NRC's unrestricted release criteria (10 CFR 20.1402), the NRC would amend the USDA license to remove specific license conditions related to the LLRBS and note that the area meets the NRC's unrestricted release criteria. The USDA also has a separate license for a sealed source irradiator located at the Beltsville facility.

Because any potential dose from the residual radioactivity at the LLRBS site is based on pathways from the resident farmer scenario and/or intrusion into the remediated area for construction, the NRC concluded that an individual would not simultaneously receive a dose from other licensed activities on the USDA campus (either from the irradiator facility (approximately 1.5 miles away) or the research laboratories (approximately 0.5 miles away) due to the distance of these facilities from the LLRBS. Therefore the NRC's unrestricted release criteria could be applied independently to the LLRBS. The staff therefore concluded that it is reasonable to have the USDA administratively remove this permitted location of use from its list of permitted locations for the Beltsville license.

2.2 Site Remediation Approach

The USDA developed the DP based on available records of disposal and information gathered during site characterization. Because the top five feet of cover soil above the disposal had been clean fill, the top four feet of this material was considered to have little or no potential for delivering a dose above tuncerthe release criteria and was removed and placed in a designated laydown area (Class 3). The next one-foot thickness of soil directly above the pits was removed and placed in a separate laydown area (Class 1). Once the surface of the disposal pits was uncovered, the radioactive debris was loaded into a series of 20 yd^3 intermodal containers. Loaded intermodal containers were shipped via truck to a railyard in Baltimore and loaded onto railcars for transport and disposal at the EnergySolutions licensed disposal facility in Utah. Health physics technicians screened the debris as it was loaded to remove any actual radioactive sources to be packaged for specific disposal. Soil from between and/or adjacent to each disposal pit and the soil approximately one foot below each of the pits was removed and placed in the Class 1 laydown area. The result was one large excavation once all of the disposal pits were excavated and the interstitial and adjacent soil placed in the laydown areas.

Soil that surrounded the excavation was removed so that there was a safe slope into the excavation. This material was placed in the Class 3 laydown area. All soil in the Class 1 and Class 3 laydown areas was placed in their separate respective areas in six-inch lifts for subsequent gamma walkover scanning and sampling. Any actual radioactive sources that were found were placed in sealed containers and temporarily stored in the small shack adjacent to the excavation and separately disposed once excavation was completed. Because the waste had been placed in fairly well-defined pits, all of the excavated soil was considered for re-use as backfill material as long as surveys and sampling confirmed that release criteria had been met.

2.3 Final Status Survey (FSS) Design

In the DP, the USDA committed to conducting an FSS consistent with the approach presented in the MARSSIM. Appendix F of the DP includes a description of the planned FSS instrumentation, survey methodology, and quality assurance/quality control (QA/QC) methods. As previously indicated, the remediation contractors prepared technical memoranda to supplement the FSS Plan based on actual site conditions and to be more consistent with MARSSIM guidance. The NRC staff reviewed the FSS design information as part of its review of the DP and determined that the USDA FSS design was adequate to demonstrate compliance with radiological criteria for unrestricted use.

The licensee utilized the graded approach presented in MARSSIM for survey unit classification. This approach ultimately determines the FSS design for survey units. Table 2-2 below summarizes key design elements for each of the area classifications. The general classification of areas in accordance with the MARSSIM guidance is as follows: Class 1 – Areas where, prior to remediation, there existed residual radioactivity above the DCGL; Class – 2 Areas where, prior to remediation, there may have existed residual radioactivity but at levels below the DCGL; and Class - 3 Areas where there is a low likelihood of residual radioactivity. Only Class 1 and Class 3 Areas were identified for the LLRBS site.

Excavation of the disposal pits resulted in two Class 1 survey units that were surrounded by a single Class 3 survey unit. The Class 1 soil laydown area resulted in six Class 1 survey units that were located south of the excavation. The Class 3 soil laydown area resulted in a Class 3 survey unit with 43 separate six-inch layers of excavated soil. Each of the six-inch soil lifts (layers) was scanned for gamma activity in both the Class 1 and Class 3 survey units. Soil

samples were collected from each of the survey units in accordance with the survey design elements summarized in Table 2-2 below and analyzed for the radionuclides of concern at an offsite analytical laboratory.

A background reference area was established south of the Class 1 soil laydown area from which representative reference measurements were made and samples obtained for comparison to the measurements in the survey units. The background reference area is defined in MARSSIM as an area that has similar physical, chemical, radiological, and biological characteristics as the remediated area, but has not been contaminated by site activities. Because the radionuclides of concern were present in background, the non-parametric Wilcoxon Rank Sum (WRS) test was used as the statistical test to determine compliance with the criteria for release for unrestricted use.

Table 2-2 FSS Design

Area Classification	Survey Unit Size	Surface Scans	Soil Sampling Locations
Class 1	Up to 2,000 m^2	100 %	Random Start Systematic Spacing
Class 2	2,000 m^2 – 10,000 m^2	10 - 100 %	Random Start Systematic Spacing
Class 3	No Limit	Judgmental	Random

Because non-radiological contaminants were also present in the waste in the disposal pits, the USDA coordinated sampling and analysis for non-radiological parameters with the USEPA. In an October 2015 technical memorandum, the licensee's contractor proposed an approach for post-excavation sampling and analysis of soil and water samples to amend certain post-excavation sampling and analysis plans for radiological parameters and to evaluate USEPA-regulated contaminants. The post-excavation sampling and analysis included undisturbed surface soil from the excavation, groundwater from beneath the excavation, groundwater from existing and new monitoring wells downgradient of the excavation, and surface water from the Little Paint Branch Creek downgradient of the excavation. Soil and water would be analyzed for USEPA-regulated contaminants and for the radionuclides of concern. In the DP, the USDA had proposed post-excavation sampling and analysis to supplement what was needed to satisfy the MARSSIM guidance. The proposed changes consider the current configuration of the excavation. The NRC staff approved the changes as an amendment to the USDA license.

2.3.1 Gamma Walkover Surface Scans

The licensee performed scanning surveys in all survey units to meet the required coverage percentages presented in Table 2-2. To the extent practicable, 100 percent of the Class 3 areas were also scanned. The purpose of the scans was to identify elevated radiation levels that could indicate concentrations of gamma-emitting radionuclides of concern that exceeded the release criteria. The licensee used Global Positioning System (GPS) units to correlate data to survey scan maps that were used in determining bias sample collection locations.

The USDA contractors followed MARSSIM protocol for scanning, walking straight parallel lines at a rate of approximately 0.5 meters per second while moving the detector probe in a side-to-

side serpentine pattern, approximately two to four inches above the ground surface. Survey data were automatically logged into the GPS system at the rate of once per second.

2.3.2 Soil Sample Measurements

The licensee collected soil samples for laboratory analysis for the radionuclides of concern to quantify any residual soil contamination remaining in the survey units. At a minimum, sixteen samples were collected from the Class 1 survey units to meet the WRS test statistical comparison requirements for comparison to the background reference area samples. Additional samples were often collected from judgmental or biased locations identified during scans. Sample custody was maintained through storage in a locked trailer and use of chain of custody forms when samples were transmitted to the offsite laboratory for analysis.

For Class 1 survey units, a random-start systematic, triangular grid pattern was used. Soil and water samples were analyzed by the licensee's offsite analytical laboratory contractor. Sample analyses for Cs-137, Pb-210, and Ra-226 (and any other gamma-emitting radionuclides) were performed using gamma spectrometry. Analyses for H-3, C-14, Cl-36, Ni-63, and Sr-90 were all performed by isotope specific analyses. Soil samples were dried prior to analysis and data were reported as picoCuries per gram (pCi/g) dry weight. Analytical methods were sufficiently sensitive to meet the DCGLs for each radionuclide of concern. The offsite analytical laboratory conducted appropriate QA/QC activities that included using approved analytical procedures, calibration of laboratory instruments at specified frequencies, and analysis blanks, spikes, and duplicate samples.

2.3.3 Survey of "Sort and Segregation Building"

Although the "Sort and Segregation Building" (the small shed adjacent to the LLRBS) was not part of the LLRBS operations nor included in the DP, the USDA contractor performed a separate radiological survey of the building because it was temporarily used during the site remediation efforts for storing and segregation of sources and intact containers of liquids prior to packaging those materials for disposal. This survey was not included in the FSSR, but was reviewed during one of the NRC inspection visits. NRC inspectors also made confirmatory measurements in and around the building.

2.3.4 Data Analysis Approach

Because multiple radionuclides of concern were potentially present in any given sample, a sum of fractions (SOF) approach was used to correlate sample results to the DCGLs. Analytical data went through a validation and verification process to ensure its acceptability for use. For each sample, analytical results for each of the radionuclides of concern were compared to the respective DCGL for that nuclide and a ratio of the analytical result to the DCGL was computed. The ratios (fractions) were then summed for all radionuclides of concern. These data were then compared to the analytical results from the Background Reference Area. Determinations that the data support the release criterion used the guidance in MARSSIM Table 8.2 Summary of Statistical Tests. Based on the data for a given survey unit and the reference area, possible conclusions are that the survey unit meets the criteria for release, the survey unit does not meet the criteria for release, or the WRS test and elevated measurement comparison are needed to conclude that the survey unit meets the criteria for release.

2.4 NRC Evaluation of Final Status Survey Approach

The NRC staff reviewed the USDA's FSS approach and determined that the design approach is adequate to demonstrate compliance with radiological criteria for meeting the criteria for release for unrestricted use and is consistent with guidance in MARSSIM. During FSS activities, the licensee used the NRC-approved DP, as amended by licensee requests to the NRC.

Based on its review of the analytical methods and instruments used, the NRC staff has determined that the instruments used to collect the data were appropriate and calibrations of the instruments used to collect the data were current. Radioactive sources used for calibration were National Institute of Standards and Technology traceable and instrument response was checked before instrument use each day, at a minimum. Therefore, the NRC staff finds that the survey methods used to collect the data were appropriate for the media and type of radiation being measured.

The NRC staff finds that the survey unit classifications are consistent with guidance in MARSSIM. For conservatism and based on discussions with the NRC, the USDA raised the classification on the survey unit that surrounded the excavation from non-impacted to Class 3 because it directly bordered the Class 1 survey units of the excavation and may have been impacted through movement of contaminants via the groundwater pathway. NRC staff considered that the location selected for the background reference area was appropriate because it met the characteristics for a background reference area specified in MARSSIM. Data analysis used for the systematic samples was consistent with the guidance in MARSSIM (Table 8.2).

In its consideration of approving the USDA's DP for the LLRBS, NRC staff compared the DCGLs developed by the USDA to the values in the NRC/USEPA Memorandum of Understanding (MOU) on "Consultation and Finality on Decommissioning and Decontamination of Contaminated Sites." Under this MOU, the USEPA agreed to continue its Comprehensive Environmental Response, Compensation, and Liability Act deferral policy of not listing sites on the USEPA National Priorities List that are subject to NRC's licensing authority. The MOU provides that, unless an NRC-licensed site exceeds certain trigger criteria contained in the MOU, USEPA agrees to a policy of deferral to NRC decision-making on decommissioning without the need for consultation.

For sites that trigger the criteria in the MOU, the NRC will consult with the USEPA at two points in the decommissioning process; prior to NRC DP approval (Level 1 consultation) and following completion of the FSS (Level 2 consultation). The DCGLs developed by the USDA for three of the radionuclides of concern (Cl-36, Ni-63, and Cs-137) exceeded the values in MOU Table 1 – Consultation Triggers for Residential and Commercial/Industrial Soil Contamination. The NRC staff initiated a Level 1 consultation for the USDA site in a March 22, 2012, letter to the USEPA. In the communication to the USEPA, NRC staff indicated that they will review the FSS data, and based on that review, will inform the USEPA if a Level 2 is required.

3. Final Status Survey Results

The USDA provided the results of its FSS for the LLRBS in an FSSR dated March 1, 2017.

3.1 Gamma Walkover Survey Results

Gamma walkover surveys were conducted over the Background Reference Area and all of the impacted survey units. Class 1 scanning protocols (100 % surface coverage) were used for all areas without regard to classification. The objective of the scan surveys was to identify small areas of elevated activity that were not identified through the systematic soil sampling. Using the GPS information, scan data were plotted on maps to visually identify count rates and to demonstrate that the required coverages were achieved.

Data from the gamma walkover scan of the Background Reference Area were used to generate the values to be used for the scans of the survey units. Data obtained from the Background Reference Area included minimum, maximum, mean, and standard deviation of the count rates. From this data, an Investigation Level was determined (three standard deviations greater than the mean). Values in excess of the Investigation Level were flagged for further evaluation by visual observation, field survey instrument measurements, and locations for potential biased soil sampling and analysis.

For the two Class 1 survey units of the excavation and the Class 3 survey unit surrounding the excavation, scan surveys identified count rates greater than the Investigation Level, but subsequent evaluations did not identify any additional waste material. Biased soil samples were collected at the locations exhibiting the highest readings during the scan surveys.

For each of the six Class 1 stockpile survey units, gamma walkover scan surveys were conducted after placement of each six-inch thick soil lift. The scan surveys identified count rates greater than the Investigation Level in survey units 1, 2, 5, and 6. No additional waste material was identified during these surveys. Scan surveys in survey units 3 and 4 did not identify any count rates exceeding the Investigation Level and no additional waste material was identified. Biased soil samples were collected at the locations exhibiting the highest readings during the scan surveys. In survey units 1 and 2, the WRS test and the Elevated Measurement Comparison were performed based on the Sum of Fractions analytical results from the soil samples. Higher density scans surrounding the locations where the net Sum of Fractions data were elevated did not identify any significant elevated count rates.

For the 43 six-inch soil lifts in the Class 3 stockpile survey unit, gamma walkover scan surveys were conducted after placement of each six-inch thick soil lift. The scan surveys identified count rates greater than the Investigation Level in nine of the survey areas. Scan surveys in twenty-nine of the survey areas did not identify count rates exceeding the Investigation Level. No additional waste material was identified during these surveys. Biased soil samples were collected at the location exhibiting the highest reading during the scan survey.

In survey units 3, 4, 8, 26, and 27, walkover gamma scans and visual observations identified sources that were inadvertently transferred to the survey unit. The sources and a quantity of soil were removed and disposed as radioactive waste from each identified location. Higher density scans that were performed surrounding these locations following removal of the material did not identify any further elevated count rates. The evaluations were performed in accordance with BARC Work Instruction – BWI-01, "Field Sampling for License Termination" and did not result in areas being re-classed to a higher classification.

3.2 Soil Sample Results

The FSSR contains quantitative Sum of Fractions analytical results from soil samples collected in each survey unit. The licensee's conclusions regarding these analytical results is that the results demonstrate that the $DCGL_W$ for each survey unit has been satisfied. Appendices to the FSSR contain tabulated quantitative results for each radionuclide of concern for each of the sample locations. Data are provided for the statistically required samples, biased samples, and post excavation supplemental samples collected. Sample locations were documented on maps of each survey unit or area. Data tables include a sample identification, analyte, result, result uncertainty, detection sensitivity, and gross and net Sum of Fractions.

The two Class 1 survey units of the excavation, the Class 3 survey unit surrounding the excavation, the Class 3 soil stockpile Survey Unit, and Survey Units 3, 4, 5, and 6 of the Class 1 soil stockpile area all met the release criterion without further analysis because the difference between the largest survey unit measurement Sum of Fractions and the smallest background reference area measurement Sum of Fractions was less than the $DCGL_W$ (See MARSSIM Table 8.2). In Survey Units 1 and 2 of the Class 1 soil stockpile area, the difference between the largest survey unit measurement Sum of Fractions and the smallest background reference area measurement Sum of Fractions was greater than the $DCGL_W$ and the difference of the survey unit mean and the background reference area mean was less than the $DCGL_W$. For these two survey units, the WRS Test and the Elevated Measurement Comparison were performed to determine that both survey units passed. The results of the WRS test and the Elevated Measurement Comparison indicated that the survey units met the release criterion, (the median Sum of Fractions concentration in the survey units did not exceed the Background Reference Area Sum of Fractions by more than the $DCGL_W$).

Supplemental soil samples were collected from the top six-inch interval of undisturbed soil at twelve locations within the excavation as part of the post excavation sampling plan amendment to the DP. As indicated previously, the samples were analyzed for the radionuclides of concern (as well as non-radiological parameters). Although no specific data evaluation for these sample results was specified in the DP, the contractor evaluated the data as if were an additional single survey unit. Because the difference between the largest survey unit measurement Sum of Fractions and the smallest background reference area measurement Sum of Fractions was less than the $DCGL_W$, the USDA concluded that the survey unit met the release criterion.

3.3 NRC Evaluation of FSS Results

The NRC staff reviewed the results of the final status survey to assess whether the licensee's procedures as implemented and that their documentation and interpretation of the results satisfied the commitments in the DP.

3.3.1 NRC Evaluation of Gamma Walkover Survey Results

The NRC staff reviewed the Gamma Walkover Survey data for the soil survey units. The figures were representative of high density (up to 100 percent coverage) scans having been performed for Class 1 survey units. Where possible, the USDA also performed high density (up to 100 percent coverage) scans for Class 3 survey units, limited by the sloped terrain of the Class 3 survey unit surrounding the excavation. The decommissioning plan required 100 percent and judgmental coverage for Class 1 and Class 3 survey units, respectively. Review of the mapped data plots indicated that, overall, these required coverages were achieved.

From the scanning of the Background Reference Area, the USDA contractors determined mean and standard deviations of the background count rates for use in comparison to the survey units and locating biased sampling locations. These data appeared to be appropriately used for identifying biased sampling locations and evaluating elevated count rates in the survey units.

In the FSSR data table summary for the Class 3 stockpile soil survey unit, NRC staff noted that survey technicians identified anomalous objects in five of the forty-three six-inch soil lifts during the gamma walkover. In the data table summary, the USDA contractor staff indicated that the anomalous material was removed and disposed, along with a quantity of surrounding soil. Follow-up measurements, visual analysis, and additional biased sampling were conducted to confirm no anomalous material remained. NRC staff held follow-up discussions with USDA staff and contractors to understand the scope of these additional measurements and visual observations. The USDA contractor staff indicated that they used the guidance in their BARC Work Instruction – BWI-01, "Field Sampling for License Termination" for performing follow-up observations and measurements. NRC staff reviewed the guidance in the contractor procedure and found that the efforts performed were likely to be sufficient to identify any further anomalous material and reclassification to a higher class was not required.

3.3.2 NRC Evaluation of Soil Results

The NRC staff reviewed the systematic soil sample, biased soil sample, and supplemental sampling of undisturbed soil sample results, as well as the subsequent data evaluation. Staff concluded that the sampling and data evaluation is acceptable because it was done in accordance with guidance in MARSSIM and as discussed in the DP. Biased samples were taken from all significant anomalies, so the NRC staff concluded that the biased sampling performed by the USDA was appropriate for assessing potential elevated areas as summarized in the FSSR data tables.

In an amendment to the DP, the NRC approved a request to perform supplemental post-excavation sampling and analysis of undisturbed surface soil from the excavation, groundwater from beneath the excavation, groundwater from existing and new monitoring wells downgradient of the excavation, and surface water downgradient of the excavation. The DP change was intended to amend certain post-excavation sampling and analysis plans for radiological parameters beneath the disposal pits to further demonstrate that sufficient measures had been taken to remove the radioactive debris and contaminated soil and that groundwater was no longer being impacted. NRC staff recognized that this supplemental sampling and analysis was in addition to what was needed to satisfy the MARSSIM guidance. Because non-radiological contaminants were also present in the waste in the disposal pits, the USDA coordinated sampling and analysis for non-radiological parameters with the USEPA. However, as previously indicated, the NRC does not regulate non-radiological contaminants and is not evaluating the results of the soil and water samples for the non-radiological parameters.

Although no specific data analysis was proposed for the supplemental sample results, the USDA contractor provided an evaluation as if the samples were a separate survey unit. Their analysis indicated that the survey unit meets the release criterion. Although NRC staff agrees that the data for this area does not appear to exceed our release criterion, staff further concludes, in part, that the conclusion from the statistical test for this area is not appropriate because the survey unit size (2,900 m^2) exceeds the recommended size for a Class 1 survey unit (2,000 m^2). The data should have been presented without the statistical test. The USDA has already demonstrated that the two Class 1 survey units comprising the excavated area had met the release criterion.

3.3.3 NRC Evaluation of Groundwater and Surface Water Sampling Results

The post-excavation sampling and analysis DP amendment included sampling and analysis of groundwater from beneath the excavation, groundwater from existing and new monitoring wells downgradient of the excavation, and surface water downgradient of the excavation. This sampling and analysis plan is outside the scope of MARSSIM guidance and no specific comparisons or statistical testing were considered in the plan.

Although NRC staff does not consider the groundwater or surface water sources to be effluents, staff compared the measured concentrations to the values in 10 CFR 20, Appendix B, Table 2, Col. 2, and noted that radionuclide concentrations reported in the data tables did not exceed the tabulated values. Additionally, the NRC staff noted that although groundwater concentrations were previously elevated in some locations, the concentrations of C-14 and tritium in the downgradient groundwater wells were not detectable or were substantially less than the historical concentrations. No radionuclides were identified in any of the surface water samples. The NRC staff further notes that the data from the water samples are gross results and there is no background water sample data for comparison.

4. Dose Assessment Methodology

Using the RESRAD computer code, the USDA calculated site-specific DCGL values for soil that corresponded to a dose of 25 mrem/yr for each radionuclide of concern, based on a compilation of resident farmer and intrusion scenarios. A sum of fractions approach was then used to evaluate whether the total dose from all radionuclides of concern was less than the 25 mrem/yr criterion.

For each sample location within a survey unit where the net sum of fractions exceeded unity, the USDA contractor performed an Elevated Measurement Comparison (EMC) based on actual radionuclide concentrations and a maximum bounded area for the contaminated area. The maximum bounded area was determined by conservatively assuming that the area surrounding the sample location that was elevated was uniformly contaminated back to the location of all surrounding samples that were not elevated. The RESRAD computer code was then used for dose modeling using the parameters for the elevated area and all other input parameters from the DCGL development. The dose rate associated with each area of elevated activity was then summed with the dose rate associated with the remainder of the survey unit. The results were then compared to the 25 mrem/yr dose criterion to demonstrate that the criterion was not exceeded. This evaluation approach was used for each of the areas where the net sum of fractions exceeded unity and in the locations identified as elevated in the ORAU confirmatory survey report (discussed in Section 5.2 below).

4.1 Dose Assessment Results

During the FSS, the USDA identified two locations in survey unit C1-SSU-01 and one area in survey unit C1-SSU-02 where the net sum of fractions exceeded unity. All other survey units met the condition where the difference between the largest survey unit measurement Sum of Fractions and the smallest background reference area measurement Sum of Fractions was less than the $DCGL_W$ and thus met the release criterion without further analysis. An Elevated Measurement Comparison (EMC), was performed as described above in addition to the WRS test (discussed in Section 3.2 above) for the three locations in survey unit C1-SSU-01 and survey unit C1-SSU-02.

Dose assessments for the two elevated activity locations in survey unit C1-SSU-01 were 5.972 and 3.869 mrem/yr, both at time = 369 years. The dose assessment for the balance of survey unit C1-SSU-01 was 5.384 mrem/yr at time = 0.832 years. The maximum dose rate from all pathways for survey unit C1-SSU-01 is 15.225 mrem/yr, which is less than the release criterion of 25 mrem/yr. The dose assessment for the elevated activity location in survey unit C1-SSU-02 was 3.463 mrem/yr at time = 369 years. The dose assessment for the balance of survey unit C1-SSU-02 was 1.953 mrem/yr at time 0.832 years. The maximum dose rate from all pathways for survey unit C1-SSU-02 is 5.416 mrem/yr, which is less than the release criterion of 25 mrem/yr.

For the elevated sample location in C1-SSU-04-SO-01 identified in the ORAU confirmatory survey report, the dose assessment was 5.33 mrem/yr, at time = 0 years. The dose assessment for the balance of survey unit C1-SSU-04 was 5.962 mrem/yr at time 0.832 years. The maximum dose rate from all pathways for survey unit C1-SSU-04 is 11.292 mrem/yr, which is less than the release criterion of 25 mrem/yr. For the elevated sample location in C1-SSU-05-SO-03 identified in the ORAU confirmatory survey report, the dose assessment was 4.322 mrem/yr, at time = 0 years. The dose assessment for the balance of survey unit C1-SSU-05 was 1.878 mrem/yr at time 0 years. The maximum dose rate from all pathways for survey unit C1-SSU-05 is 6.2 mrem/yr, which is less than the release criterion of 25 mrem/yr.

4.2 NRC Evaluation of Dose Assessment

In the NRC's approval of the DP, the NRC staff use of the compiled resident farmer and construction intrusion scenarios provided a conservative approach to valuation of potential exposures from residual material at the site and the resultant DCGLs and use of the sum of fractions because of multiple radionuclides of concern were an appropriate dose assessment approach to demonstrate compliance with the license termination criteria in 10 CFR 20.1402. Because the contaminants were present in background, the USDA established an appropriate Background Reference Area to support the comparison of measurements performed in the survey unit and the WRS test and Elevated Measurement Comparisons to demonstrate compliance with the release criterion. Although not explicitly evaluated during the DP review, NRC staff reviewed the dose assessment methodology used by the USDA and described in the FSSR for evaluating elevated areas in two of the Class 1 survey units. This methodology was found to be acceptable because it followed the approach described in MARSSIM and used the same parameters that were used during derivation of the DCGLS, with the exception of the parameters related to the radionuclide concentrations and the physical size of the elevated area.

For the above reasons, the NRC staff concludes that the dose assessments were performed appropriately for each survey unit. Because each of the survey unit doses is less than 25 mrem/yr, the NRC staff concludes that the dose assessments performed by USDA demonstrate that the final residual radioactivity at the USDA LLRBS is less than the 25 mrem/yr annual dose criterion for unrestricted release in 10 CFR 20.1402.

5. NRC Inspections and Confirmatory Measurements

Inspectors from Region I performed a number of inspections and confirmatory assessments during the time period that the USDA was performing remediation activities. Additionally, NRC's contractor, Oak Ridge Associated Universities (ORAU), also performed confirmatory walkover gamma scan surveys, collected soil samples, and analyzed the collected soil samples and selected archived soil samples collected by the USDA contractor. The ORAU data are

presented in a February 2015 report that is discussed in Section 5.2 below. NRC inspectors also participated in weekly project conference calls and ad hoc discussions regarding site events.

5.1 NRC Inspections

Summaries of the NRC inspections performed over the course of the USDA remediation project are provided below.

On July 1-2, July 24-25, August 14-15, and November 5-6, 2013; and April 9, June 2, June 24, July 30, and September 24-26, 2014, NRC Region I inspectors conducted a series of safety inspections at the USDA LLRBS (ML15009A061). Additional information in documents provided by USDA contractors was also examined as part of these inspections. The inspections reviewed the USDA's and their contractors' decommissioning activities associated with the exhumation of radioactive waste from disposal pits, re-packaging for transport to licensed facilities for disposal or treatment, and conduct of radiological surveys. The inspections consisted of observations by the inspectors, interviews with USDA and contractor personnel, and a review of work plans and records. The inspectors observed that the management and staff were knowledgeable and cognizant of their roles and responsibilities regarding the project and safety. The NRC also contracted with Oak Ridge Associated Universities (ORAU) to perform confirmatory surveys and sample analysis. The results from the ORAU independent survey and sampling activities are discussed separately below. In addition, the inspectors conducted weekly telephone conference calls with the USDA staff and contractors to discuss the status of decommissioning activities during weeks that inspectors were not present on the site. Based on the results of the inspections, no findings of safety significance were identified. Workers and site visitors received site safety briefings commensurate with the activities in progress. In addition, daily morning safety meetings were held to emphasize any relevant hazards and a "lessons-learned" safety and project status de-briefing was conducted at the end of each day. The inspectors reviewed records for training of workers and verified that each worker had completed OSHA hazards training, respiratory use training, and respirator fit-testing required by the DP, when applicable.

A Radiation Work Permit (RWP) system was used to access the controlled areas of the project. Each RWP provided a description of the measures required for access to and egress from the controlled areas, summarized the tasks to be performed, and described personal protective equipment requirements for the tasks described in the RWP. Individuals requiring access to areas controlled by an RWP were provided with an RWP briefing from the remediation project radiation safety staff prior to initially accessing the controlled area. The inspectors reviewed selected RWP access/egress documents and noted that the controls and protective clothing requirements were commensurate with the extent of activities conducted. All reported occupational doses (recorded from direct-reading dosimeters) were minimal. The perimeter of the burial site footprint was fenced to prevent any inadvertent access to the areas being excavated. Areas were appropriately posted for the radiological conditions in accordance with the requirements in 10 CFR Part 20.

During excavation activities, water sprays were often used to control dust generation. Air samplers, which were located at each perimeter corner of the excavation area, were operated during the soil excavation activities. Air sample filters were counted in the onsite laboratory. No elevated results were noted in excess of typical background levels. Results from a series of environmental dosimeters placed around the perimeter of the excavation were not different than background radiation levels.

In one of the burial pits, the inspectors noted that approximately 30 unidentified gas cylinders were uncovered. Because the discovery of the gas cylinders was outside the scope of the waste typically uncovered, the USDA contractors developed a specific work procedure to inspect, evaluate, and dispose of the cylinders. The USDA determined that the cylinders were not intact (i.e. holes or openings were found in each of the cylinders and none were pressurized) and all could be shipped to the burial facility along with the remainder of the excavated waste within the scope of the burial facility's waste acceptance criteria.

The inspectors reviewed the preparation and loading of several intermodal waste containers. Containers were initially prepared with plastic liners and moisture absorbent to prevent leaking during transport. Filled containers were sealed and tamper indication seals applied. Filled containers had appropriate markings, signage, and shipping papers for transport. All 169 intermodal containers had been shipped to the disposal site in Utah by August 15, 2014. Signed copies of manifests returned to the shipper indicated that the wastes had been received at the burial facility in good condition, no discrepancies had been reported, and the waste had met the facility's waste acceptance criteria.

During an inspection on April 13, 2015, NRC inspectors confirmed that the few remaining waste drums had been removed from the onsite storage building (ML15132A635) and shipped for disposal or processing. The inspectors also reviewed the licensee's contractor's radiological survey of the building and also conducted a confirmatory survey of the building. The survey results confirmed the licensee's survey result that there was no detectable radiological levels in excess of natural background present in or around the building. No findings of safety significance were identified.

On May 16-17, 2016, NRC Region I inspectors observed soil and groundwater sampling in accordance with the supplemental soil and water sampling plan (ML16146A559). Contractors used a Geoprobe device to collect soil samples and allow for the collection of groundwater. Samples were submitted for analysis for the radionuclides of concern and results subsequently reported in the FSSR. No violations or findings of significance were identified.

5.2 ORAU Confirmatory Surveys

At the request of the NRC, ORAU conducted confirmatory survey activities during the period of September 23-26, 2014 at the USDA LLRBS. The survey activities included document reviews, gamma walk-over scans, direct soil sampling, and sampling from selected archived soil samples. Sampling and/or measurements were conducted on the two excavation Class 1 survey units, the Class 3 excavation survey unit, and the Class 1 and Class 3 soil stockpile survey units. The objective of the confirmatory survey was to provide independent contractor field data to use in evaluating the accuracy and adequacy of the USDA FSS. Surveys were generally performed in accordance with an NRC-approved work-plan; however, the work-plan had to be modified during the course of sampling due to weather impacts (rain) and presence of stored radioactive sources in the shed adjacent to one of the soil stockpiles. The NRC requested that the focus of the confirmatory surveys be directed to sample for H-3 and C-14, because they were the two major radionuclides of concern in the waste, and gamma-emitting radionuclides. All ORAU confirmatory surveys and sampling were conducted after the completion of the USDA contractor measurements and sampling had been completed.

5.2.1 Gamma Walk-Over Scans

ORAU performed high density surface scans on the Class 1 survey units and a medium density scan on the Class 3 soil stockpile survey unit. A full walk-over scan of the Class 3 survey unit surrounding the excavation was not performed due to weather impacts on the sloped survey unit. Because the stockpile soil was placed in a series of six-inch thick lifts, the walk-over scans on the two soil stockpiles primarily indicated the condition of only the top survey unit. Scans were performed using 2-inch × 2-inch sodium iodide, thallium-activated [NaI(Tl)] detectors coupled to rate-meter-scalers with audible indicators. ORAU field personnel relied on the audio output to identify any locations of elevated direct gamma radiation that might indicate the presence of residual contamination. The gamma detectors were coupled to GPS systems that enabled real-time gamma count rate and position data to be captured. Elevated direct gamma radiation levels that were identified during the scanning phase were marked with flags for further investigation during the soil sampling phase.

5.2.2 Soil Sampling

ORAU staff collected soil samples in the two Class 1 excavation survey units. Fifteen soil samples were collected from the top 15 centimeters from each survey unit using a random grid pattern. The samples were then grouped into sets of five, resulting in three composite samples from each of the survey units. Due to weather delays and conditions, only samples from the downgradient slopes (east and south) of the Class 3 survey unit that surrounded the excavation were collected. These locations were selected to determine if any of the radionuclides of concern had migrated downgradient from the burial pits.

Concentrations of the radionuclides of concern in the two stockpile survey units were evaluated by obtaining samples from selected archived samples taken by the licensee's contractor as part of the FSS. Additionally, because gamma walk-over surveys could not be performed on portions of the western edge of the Class 1 soil stockpile survey unit because of elevated background levels from stored radioactive sources, a series of soil sample in that area were collected and analyzed. Soil samples from the Background Reference Area were also collected and analyzed to verify the background concentrations of the naturally occurring radionuclides of concern.

Soil samples were collected and analyzed in accordance with standard ORAU analytical procedures. Direct beta measurements were also made on an aliquot of the sample prior to final packaging. Sample integrity was maintained through double bagging all samples and chain of custody protocols were followed. Samples were analyzed at the ORAU Radiological Environmental Analytical Laboratory in Oak Ridge, Tennessee.

5.2.3 Summary of Confirmatory Survey Findings and Results

ORAU's confirmatory report indicated that the majority of the gamma surface scans were not distinguishable from background. Stored radioactive sources along the western edge of the Class 1 soil stockpile area influenced the count rate in that area, but the confirmatory soil samples in that area indicated that the concentrations of the radionuclides of concern were near background levels. Soil sample analyses indicated that the concentrations of the radionuclides of concern were a small fraction of the DCGLs for the excavation survey units and the Class 3 soil stockpile survey unit.

The ORAU laboratory analyses for three of the selected archived samples from the Class 1 soil stockpile survey unit indicated elevated radionuclide concentrations, primarily tritium. One sample was elevated above background, but did not exceed the tritium DCGL or the Sum of Fractions DCGL. A second sample had an elevated tritium concentration that was not greater than the tritium DCGL, but the ORAU calculation indicated that the gross Sum of Fractions was 1.25 (greater than 1.0). Using the ORAU data for this sample and the USDA data from the Background Reference Area for the radionuclides of concern, NRC staff calculations determined that the net Sum of Fractions DCGL for that sample was less than 1.0 when the average concentrations of the radionuclides of concern in the Background Reference Area were subtracted from the ORAU data. A third sample exceeded the DCGL for tritium (approximately 2.5 times greater than the tritium DCGL) as well as the Sum of Fractions DCGL. This sample result is discussed further below.

As part of the NRC-approved work plan, ORAU had intended to compare their analytical results of the samples split with TES with the data generated by TES for the same samples. However, the TES data were not available by the time the ORAU confirmatory report was issued and ORAU and NRC agreed that the NRC staff would make these comparisons. NRC staff reviewed the data from the split samples provided by TES and generally found the data in the FSSR to be in very good agreement with the ORAU analytical data, with the exception of TES sample ID BLT-SSU-04-C1-SO-01. TES reported that this sample result for tritium had met the tritium DCGL; however, as indicated above, the ORAU result was approximately 2.5 times greater than the tritium DCGL.

NRC staff reviewed the USDA and ORAU tritium results for the above sample. The review found that the USDA result although elevated, was still less than the DCGL for tritium. Discussions with ORAU and USDA contractor laboratory representatives found that all quality checks associated with this sample had been found to be acceptable. The ORAU laboratory representative conjectured that the non-agreement in the two laboratory results may be due to sample inhomogeneity because a very small sample aliquot from the sample is used for the tritium analysis. Using the methodology described in MARSSIM for evaluation of elevated sample results, the USDA contractor concluded that even with this elevated sample result, the survey unit still met the NRC release criteria. The USDA's contractor's dose assessment was discussed earlier in Section 4.1.

In the "Summary" section of ORAU's confirmatory report, ORAU indicated that, "Based on the results of the confirmatory surveys and provided that SU-4 (SSU-04-C1 in the USDA nomenclature) satisfies the $DCGL_{EMC}$ calculation for the elevated concentrations of H-3, C-14 and Cs-137 or contamination above the guidelines is removed, ORAU is of the opinion that TES has accurately and adequately demonstrated that SUs 1-5 of the LLRBS site satisfy the site criteria for release from radiological controls."

5.3 NRC Conclusions Based on Inspections and Confirmatory Survey Findings

As is summarized above, the NRC Region I inspectors performed a number of inspections and confirmatory assessments during the time the period that the USDA was performing remediation activities. The inspectors observed that the decommissioning and FSS activities were being conducted in accordance with the DP and MARSSIM guidance. The inspections reviewed the USDA's and their contractors' decommissioning activities associated with the exhumation of radioactive waste from disposal pits, including, but not limited to, packaging waste for transport for disposal or treatment, conduct of radiological surveys and sampling, training, respiratory

protection, air sampling, sample chain of custody, and occupational radiation exposure. No violations or findings of safety significance were identified

During their confirmatory surveys, ORAU identified two locations where the gross Sum of Fractions were greater than the $DCGL_w$ value. In one of the locations, NRC staff determined that the net Sum of Fractions did not exceed 1.0 once the concentrations of the radionuclides of concern in the Background Reference Area were subtracted. In each of these locations, the USDA contractor performed specific dose calculations to demonstrate that the annual dose rate from residual contamination in these survey units met the NRC criteria for unrestricted release. The NRC staff therefore considers USDA to have appropriately addressed these issues.

6. Conclusions

The USDA completed the decommissioning of its site in Beltsville, Maryland and submitted an FSSR to document the radiological conditions of the remediated areas. As documented in the NRC's SER for the DP, the NRC staff concluded that the DCGL values are ALARA. Based on observations during NRC inspections and the findings in this SER, decommissioning activities have been carried out in accordance with the DP, approved amendments to the DP, and MARSSIM guidance for sampling and evaluation of the site for residual radioactivity. The NRC staff has reviewed the FSS data and results for the USDA LLRBS using guidance in NUREG-1757 and guidance in MARSSIM (NUREG-1575). ORAU confirmatory survey results indicate that site satisfies the criteria for release from radiological controls.

For the reasons described above, the NRC staff has concluded that the FSS design and data collected were adequate to characterize the residual radioactivity. The NRC staff also concluded that the data analysis and dose assessments performed are appropriate and that the projected dose from residual radioactivity in these areas is less than 25 mrem/yr. For these reasons, the NRC staff has determined that the USDA has demonstrated that the LLRBS site meets the radiological criteria for license termination described in 10 CFR Part 20, Subpart E and the dose to the average member of the critical group is not likely to exceed the 25 mrem/yr dose criterion. As indicated previously, the USDA is not requesting license termination because they intend to continue conducting licensed activities at other locations in accordance with its NRC license. NRC staff will amend the USDA license to remove any specific license conditions that authorize activities related to the LLRBS.

The NRC staff initiated a Level 1 consultation for the USDA site in a March 22, 2012, letter to the USEPA. In the communication to the USEPA, NRC staff indicated that they will review the FSS data, and based on that review, will inform the USEPA if a Level 2 is required. The NRC staff reviewed the data in the FSSR and determined that none of the systematic soil samples exceeded the sum of the fractions trigger values for soil in Table 1 of the MOU. The NRC staff also evaluated the FSS results for radium-226 individually and determined that the FSS results did not exceed the Table 1 residential soil concentration trigger value of 5 pCi/g. Based on the above discussion, NRC staff concluded that a Level 2 consultation is not required for the USDA site and has prepared correspondence to be transmitted to the USEPA with its conclusion.

In addition to the analysis for the radionuclides of concern, samples obtained in accordance with the supplemental plan were also analyzed for a number of non-radiological parameters to support information requested by the USEPA. Because the NRC does not regulate these materials, the NRC has not considered the results of the non-radiological analyses in its determination that the LLRBS meets the NRC criteria for unrestricted release.

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Figure 1 – USDA Low Level Radiation Burial Site - Survey Units and Reference Area
(Excerpted from March 1, 2017 Final Status Survey Report)