Enclosure

Technical Evaluation Report

U.S. Nuclear Regulatory Commission Technical Evaluation of the New York State Energy Research and Development Authority's Radiological Survey and Dose Assessment Report For the Western New York Nuclear Service Center and Off-Site Areas In Follow Up to Aerial Gamma Radiation Survey Conducted in 2014

Final Report

U.S. Nuclear Regulatory Commission
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Contents

ACRONYMS AND INITIALISMS

ADAMS	Agencywide Documents Access and Management System
ANOVA	Analysis of Variance
ASER	Annual Site Environmental Report
cpm	Counts Per Minute
CFR	Code of Federal Regulations
DCGLs	Derived Concentration Guideline Levels
DQOs	Data Quality Objectives
DOE	U.S. Department of Energy
DP	Decommissioning Plan
GIS	Geographic Information System
GPS	Global Positioning System
NRC	U.S. Nuclear Regulatory Commission
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority, the Licensee
RESRAD	RESidual RADioactive (computer model)
ROI	Radionuclides of Interest
SNI	Seneca Nation of Indians
SOF	Sum of Fractions
TER	Technical Evaluation Report
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project

Technical Evaluation Report - Evaluation of the New York State Energy Research and Development Authority's Radiological Survey and Dose Assessment Report For the Western New York Nuclear Service Center and Off-Site Areas In Follow Up to Aerial Gamma Radiation Survey Conducted in 2014

Introduction

Purpose of the Staff's Evaluation

The purpose of this technical evaluation report (TER) is to document the U.S. Nuclear Regulatory Commission's (NRC's) review of the New York State Energy Research and Development Authority's (NYSERDA's or the licensee's) field survey and public dose assessment report, "Radiological Survey and Dose Assessment Report For the Western New York Nuclear Service Center and Off-Site Areas In Follow Up to Aerial Gamma Radiation Survey Conducted in 2014," Revision 1 (NYSERDA, 2016a and NYSERDA, 2016b) (or submittal).

NYSERDA's submittal assesses the associated risk from the radioactivity of five areas located off-site of the Western New York Nuclear Service Center (WNYNSC) that were shown to have above background radioactivity, as identified in the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b). NYSERDA designates these five areas, as Areas 1, 2, 3, 4 and 5, in its, "Field Sampling and Dose Assessment Plan for the WNYNSC in Follow Up to the Aerial Gamma Radiation Survey Conducted in 2014," dated October 2015 (NYSERDA, 2015). NYSERDA used various methods to estimate the dose and assessed risk to the public based on the results of its sampling and survey efforts. Included in NYSERDA's submittal are special request samples on the Seneca Nation of Indians (SNI) land at the Cattaraugus Reservation. NRC also reviewed this data even though the special request samples were not identified as potential areas of interest in the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b) and were not included in the scope of NYSERDA's sampling and dose assessment plan (NYSERDA, 2015).

Conclusions

NRC reviewed NYSERDA's submittal. In its submittal, NYSERDA concludes:

> "The assessed doses in Areas 1, 2, and 3, based upon multiple approaches and covering current and reasonably foreseeable future land use scenarios, were determined to be significantly less than the 25 mrem per year [/y]requirement identified in 10 C.F.R. § 20.1402, and there are no health and safety concerns identified for these locations."
>
> "For Areas 4 and 5, the assessed doses, based upon current land use scenarios and considering culturally specific SNI land use, were determined to be significantly less than the 25 mrem per year [/y]requirement identified in 10 C.F.R. § 20.1402, and there are no health and safety concerns identified for these locations."

NRC staff's conclusion is consistent with NYSERDA's conclusion that the expected risk from off-site residual radioactivity in the areas of interest is low. The resulting dose in each area of interest sampled is expected to be less than unrestricted use limits found in Title 10 of the Code of *Federal Regulations* (10 CFR) 20.1402. The staff's conclusion is based on the review of NYSERDA's submittal and the staff's own independent calculations and analysis.

Background

The U.S. Department of Energy (DOE) and NYSERDA conducted a series of five aerial radiological surveys in the vicinity of the WNYNSC between the years of 1968 and 1984. These surveys showed low levels of radioactivity along the Cattaraugus stream system downstream and off-site of the WNYNSC. More recently, an aerial radiological survey was conducted between the dates of September 22 through October 2, 2014. DOE and NYSERDA reported in the 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015b) levels of radioactivity "slightly" above background in multiple areas outside the WNYNSC, including three areas which were not previously identified in past aerial radiological surveys. Notably, two of the areas were on SNI land at the Cattaraugus Reservation, located approximately 20 miles west of the WNYNSC. The third area was located near the WNYNSC boundary along the trajectory of an air release of radioactivity from the reprocessing plant which occurred in 1968. Following the release, an area of soil was contaminated with cesium-137 (Cs-137) to the northwest of the reprocessing plant, which is referred to as the Cesium-Prong (NYSERDA, 2016a and NYSERDA 2016b).

After DOE and NYSERDA informed NRC about the elevated areas that were above background based on the draft 2014 aerial survey results, as part of NRC's regulatory oversight responsibilities, NRC reviewed the Draft 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015a) and performed a screening assessment to determine if immediate action was necessary to protect the public. The staff used conservative assumptions to account for uncertainties and also used historical information its screening assessment. NRC concluded that the offsite residual radioactivity above background identified in the areas of interest identified in the Draft 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015a) may be present, but the residual radioactivity is not anticipated to result in public doses that would exceed the dose limits of 10 CFR 20 for offsite releases. However, NRC informed NYSERDA (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15169A414) that characterization, through representative sampling of the areas of interest should be performed to identify what is there, its extent, and at what concentrations because the source term could only be inferred or postulated based on the results of the Draft 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015a) and historical information. If after characterization of the area, it was determined that the concentrations of the considered isotopes are significantly higher than estimated in the Draft 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015a) or if additional isotopes were determined to be present, then NRC would determine if additional actions are required.

Historical reports (Ecker, R.M., et al., 1982, Ecker, R.M., Y. Onishi, 1982, and NYSDEC, 1970), clearly identify increases in environmental activity associated with the fuel reprocessing operations at Nuclear Fuel Services, Inc. (the former operator and one of the former licensees of the reprocessing plant), for a variety of isotopes including but not limited to Cs-137, strontium-90 (Sr-90), cobolt-60 (Co-60), cerium-144 (Ce-144), antimony-125 (Sb-125), niobium-95 (Nb-95), americium-241 (Am-241), lead-210 (Pb-210), radium-226 (Ra-226), plutonium (Pu)-isotopes, thorium (Th)-isotopes, and uranium (U)-isotopes. NRC also conveyed to NYSERDA that a land use survey should be performed to inform which exposure pathways should be analyzed in the dose compliance demonstration to ensure all significant pathways of exposure to members of the public residing in the area are considered, all radionuclides of concern are appropriately considered, and to refine potential dose estimates. Also, NRC communicated to NYSERDA that it anticipated that NYSERDA will explain how uncertainty was considered in NYSERDA's conclusions regarding public health and safety risk (ADAMS Accession No. ML16293A131). NYSERDA voluntarily agreed to conduct the sampling and analysis and a follow-on dose assessment.

NYSERDA drafted a sampling and dose assessment plan based on evaluation of the 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015b) and other historical knowledge, which identified five areas outside of the WNYNSC for further study:

> "[t]o determine if areas identified in the 2014 Aerial Radiological Survey (Aerial Survey) of the Western New York Nuclear Service Center (WNYNSC) (Ref.1) as having elevated levels of radioactivity above background do in fact contain elevated radionuclide concentrations in the soil. If elevated soil concentrations were identified, a dose assessment (based on current and reasonably foreseeable future land use) was conducted to confirm that there were no health and safety concerns for the identified area. Because the areas sampled are offsite and the land use is unrestricted, the dose assessment results were compared to 10 C.F.R. § 20.1402, *Radiological Criteria for Unrestricted Use* (Ref.2)*"* (NYSERDA, 2016a).

NYSERDA also requested that NRC, along with other regulators, review NYSERDA's draft sampling and dose assessment plan. NRC provided comments (ADAMS Accession No. ML15281A416) on the draft plan, but stated:

> "Because the NRC is the regulator in the matter of potential offsite areas of elevated radioactivity, the NRC cannot provide input as a co-author or in consultation with NYSERDA. The objective of the U.S. Nuclear Regulatory Commission's (NRC's) review of NYSERDA's Plan is to provide comments regarding whether the NRC believes that NYSERDA's proposed strategy appears to be reasonable for 1) the characterization of the off-site areas of potential concern for use in its public dose compliance demonstration and 2) the associated public dose compliance demonstration to verify that there is not a public health and safety concern."

NRC met with the SNI Tribal Council in September 2015 and again in October 2016 and stated that, based on the NRC's screening assessment, NRC believes that there is no health and

safety concern due to the residual radioactivity in the five areas of interest, but indicated that sampling and assessment were needed to confirm the 2014 aerial survey results and whether NRC would require any further actions. NRC also delivered this same message at the DOE Quarterly Public meeting in September of 2015, during the question and answer period after the presentation on the 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015b) and NYSERDA's plans to conduct sampling in the five areas of interest.

NYSERDA conducted surveying and sampling and analysis of the five areas of interest in fall 2015 through MJW Technical Services, an NRC licensed service provider. The staff inspected this licensee when the surveying and sampling were conducted (ADAMS Accession No. ML15336A902). Later, the staff conducted an audit of NYSERDA's documentation (ADAMS Accession No. ML16133A270) related to NYSERDA's off-site assessment on June 8 and 9, 2016, and issued an audit report (ADAMS Accession No. ML16174A055) identifying information that the staff would need to begin its detailed technical review of NYSERDA's submittal.

NYSERDA describes the purpose of the off-site sampling in Section 4.0 of NYSERDA's submittal and states:

> "[t]he aerial radiation survey does not provide the data to confirm that all of the areas identified are below the public health and safety standards, for example the criteria in 10 CFR 20.1402, Radiological Criteria for Unrestricted Use."

Further, in the submittal, NYSERDA defines its goal for its sampling approach for the five areas of interest in its data quality objectives. The key goal is:

> "…to evaluate each of the five areas to determine if these areas do, in fact, contain elevated radionuclide concentrations in the soils, and for those with elevated concentrations, to complete a dose assessment that evaluates the current and reasonably foreseeable future land use scenarios to determine if there are any health and safety issues for the property."

It should be noted that NYSERDA did not perform sampling and analysis for the purpose of decommissioning, nor was NYSERDA required to use NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" guidance to characterize the five areas of interest. Rather, NRC's expectation, that it shared with NYSERDA, is that the sampling and analysis should be performed to characterize the five areas of interest in a technically defensible manner and that NYSERDA should assess the public health and safety risk due to the residual radioactivity using the characterization results that are shown to be elevated above background in the five areas of interest.

Regulations

NYSERDA holds NRC License No. CSF-1. Through license amendments, the technical specifications, safeguards requirements, and certain reporting requirements of this license were

placed in abeyance; and a license condition was added to allow the DOE to take control of approximately 200 acres of the center portion of the WNYNSC to conduct its responsibilities under the WVDP Act of 1980. New York State is an NRC Agreement State; however, because NRC License No. CSF-1 is a 10 CFR Part 50 license, NRC retains its regulatory authority for this license and over off-site residual radioactivity associated with the former reprocessing plant (ADAMS Accession No. ML022120257). Although parts of the current license, NRC License No. CSF-1, are in abeyance, the license is considered an operating license for a fuel cycle facility because the WVDP Act of 1980 prohibits NYSERDA from decommissioning until after DOE completes its WVDP Act mission.

The applicable Environmental Protection Agency environmental standards for reprocessing plants, presented in 40 CFR Part 190 (25 mrem/y whole body, 75 mrem/y to the thyroid, and 25 mrem/y to any other organ dose limits), apply to planned releases with regard to design, construction and normal operation of the reprocessing plant. While none of these situations are currently applicable, NRC informed NYSERDA that as a first step, that NRC would evaluate NYSERDA's evaluation of its offsite sampling and dose assessments against the 10 CFR 20.1402 unrestricted use dose limit of 25 mrem/y (0.25 mSv/y), as a benchmark. Depending on the dose results, NRC would determine if further action by NYSERDA would be required (ADAMS Accession No. ML15281A416) and whether a policy decision for clean-up criteria would be pursued.

The general requirements in 10 CFR Part 20, Subpart F, "Surveys and Monitoring", § 20.1501, apply to NRC License No. CSF-1. This requirement states:

> "(a) Each licensee shall make or cause to be made, surveys[1] of areas, including the subsurface, that
>
> (1) May be necessary for the licensee to comply with the regulations in this part; and
>
> (2) Are reasonable under the circumstances to evaluate --
>
> (i) The magnitude and extent of radiation levels; and
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> (ii) Concentrations or quantities of residual radioactivity; and
>
> (iii) The potential radiological hazards of the radiation levels and residual radioactivity detected."

[1] Per 10 CFR 20.1003, Definitions, survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material present.

Licensee's Sampling and Analysis Submittal

Purpose and Scope of Characterization

For the survey of the five areas of interest, NYSERDA generally followed its "Field Sampling and Dose Assessment Plan for the Western New York Nuclear Service Center In Follow Up to Aerial Gamma Radiation Survey Conducted in 2014" (NYSERDA, 2015). In its sampling and dose assessment plan (NYSERDA, 2015), NYSERDA explains that it considered the aerial radiological survey data collected during September 22 - October 4, 2015, to identify the five areas of interest, as noted in the Table 1, "Locations Selected for Additional Evaluation," below, in order to perform "ground truth measurements." Also, NYSERDA states in its plan that:

> "[t]he objectives of the survey, sampling and dose assessment project is to provide additional data for the five areas that were identified for further evaluation."

Field generated changes to NYSERDA's sampling and dose assessment plan (NYSERDA, 2015), as provided in Appendix A to NYSERDA's submittal, were also reviewed by NRC. The staff found that the field changes were reasonable for the justifications provided and that they were consistent with the stated purpose of the survey.

Table 1. Locations Selected for Additional Evaluation

Area No.	No. of Sub Areas	Location	Current Land Use	Global Positioning System (GPS) Coordinates (Location of Centroid)	
1	n/a	Cesium Prong	Residential properties, with cleared and tree covered areas.	42°27'46.97" N	78°40'13.53" W
2	2	Near Scoby Hill Dam (new location likely an extension of the Cesium Prong)	Varying in terrain and tree cover. These areas are not residential.	42°28'25.66" N	78°41'18.84" W
3	2	Near confluence of Buttermilk and Cattaraugus Creeks	Active agriculture area.	42°28'56.20" N	78°40'42.19" W
4	5	Cattaraugus Territory of the SNI	Wooded area that does not include residences.	42°32'23.84" N	79°02'13.07"W
5	6	Cattaraugus Territory of the SNI	Wooded area near residential property.	42°31'12.94" N	78°58'25.11" W

The five areas of interest in NYSERDA's sampling and dose assessment plan (NYSERDA, 2015) were established by NYSERDA to encompass grouped discrete smaller areas, identified as elevated in the 2014 Aerial Radiological Survey Report (DOE, NYSERDA. 2015b) and that

are referred to as “sub-areas” or, if a sub-area encompasses even smaller discrete elevated areas, such areas were referred to as “sub-regions,” throughout NYSERDA’s submittal. NYSERDA’s NRC licensed contractor surveyed the five areas of interest. In addition to these five areas of interest, “confirmatory” locations were also surveyed on the WNYNSC property to compare against the 2014 Aerial Radiological Survey Report results (DOE, NYSERDA, 2015b). Details of all areas that NYSERDA surveyed and sampled are shown in Figures 1 through 14 of NYSERDA’s submittal.

NYSERDA’s assessment of the sampling areas (five areas of interest or Areas 1-5) consisted of the following activities:

- evaluation of the entire area of the 2014 Aerial Radiological Survey (DOE, NYSERDA,2015b) to identify areas[2] where NYSERDA believed follow-up activities were warranted;
- follow-up GPS gamma walkover surveys and tissue equivalent surveys for each sampling sub-area to determine if any localized elevated radioactivity was present, to include taking dose rates at each sampling location;
- background sampling (or determination of background from existing background data) that NYSERDA deemed appropriate to use as background;
- biased and random soil sampling in the five sampling areas
    - If any elevated locations of radioactivity were identified, discernable relative to ambient radiation levels based on the GPS gamma walkover survey, biased soil samples were collected in those locations.
    - Random soil samples in each sampling sub-area were also collected, with the number of random samples dependent on the size of the sub-area.
    - All soil samples were collected from 0-100 centimeters (cm), with at least two at-depth samples collected from each of the five sampling areas; and
- analytical analysis of soil samples
    - All surface soil samples (either 0-5 cm or 0-15 cm) were sent for gross alpha, gross beta and gamma spectroscopy.
    - Next depth interval soil sample analysis were completed if the initial surface analysis were greater than the applicable mean background plus two standard deviations.
    - Detailed radionuclide analyses were completed for a minimum of 20 percent of the samples collected in each sub-area.

[2] NYSERDA indicated that it would assess the five areas that showed above background activity from the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b), and later (after NRC’s review of NYSERDA’s draft sampling and dose assessment plan) indicated that it would also evaluate additional areas that property owners specifically requested be sampled. As stated above, the special request samples that were included in the submittal [NYSERDA, 2016b] were evaluated by NRC.

Radionuclides of Interest

The radionuclides of interest (ROI) that NYSERDA identified for its assessment included those that were identified in Revision 2 of the WVDP Phase 1 DP (ADAMS Accession No ML100040378). As one of several methods to assess dose that NYSERDA provided in its submittal, NYSERDA used the weighted average soil concentrations obtained from its characterization activities and compared them to the surface soil decay-corrected Derived Concentration Guideline Levels $(DCGL)_w$ peak-of-the-mean (POM) values reported in Revision 2 of the WVDP Phase 1 DP (ADAMS Accession No. ML100040378). The POM values for the ROIs are the most conservative $DCGL_w$ values provided in Revision 2 of the WVDP Phase 1 DP (shown in Table 2, below) and are based upon a resident farmer scenario and an assumed 1 meter (m) thickness of residual radioactivity.

Table 2. Derived Concentration Guideline Level Values - Peak-of-the-Mean Values for 25 mrem/y (0.25 mSv/y) Total Effective Dose Equivalent (TEDE) for All Pathways (pCi/g)[3]

Nuclide	Surface Soil DCGLs (pCi/g)
Am-241	29
C-14	16
Cm-243	35
Cm-244	65
Cs-137	15
I-129	0.33
Np-237	0.26
Pu-238	40
Pu-239	25
Pu-240	26
Pu-241	1200
Sr-90	4.1
Tc-99	21
U-232	1.5
U-233	8.3
U-234	8.4
U-235	3.5
U-238	9.8

Note: The $DCGL_w$ is the DCGL applicable to the average concentration over the survey unit (for final status surveys).

[3] The staff found that the DCGLw table values for Cs-137 and Sr-90 being cited assumed a 30 y decay period. As such, DCGLw values for Cs-137 and Sr-90 should be approximately one-half of the values shown if applied to a current unrestricted situation in order to consistently coincide with a 25 mrem/y peak dose basis for all contaminants. The staff evaluated the adjusted DCGLw values for these radionuclides and found it did not alter the conclusion that the DCGLw criteria are met for all areas considered.

For the purposes of comparison of WVDP Phase 1 DP, Revision 2, DCGLs to NYSERDA's radiological characterization results and to estimate the potential dose to land users, NYSERDA made the following conservative assumptions:

- gross beta activity, in excess of background was compared to the WVDP Phase 1, Revision 2, Sr-90 $DCGL_{w,}$, assuming this activity was from Sr-90, and
- gross alpha activity, in excess of background, was compared to either the WVDP Phase I, Revision 2, Am-241 or Pu-239 $DCGL_w$, assuming that all this activity was either from Am-241 or Pu-239.

Data Quality

All radiological detection field equipment was calibrated within the last 12 months by a New York State Department of Health (NYSDOH) licensed calibration facility, using National Institute of Standards and Technology traceable Cs-137 calibration sources. In addition, field operability checks were performed typically three times per day.

For each sampling location, the number of samples to be collected and the increments of depth (e.g., 0-15 cm depth sample or a 15-30 cm depth sample) were predetermined in accordance with the NYSERDA sampling and dose assessment plan (NYSERDA, 2015). Excavation was performed and samples were collected using hand tools in order to carefully sample from the correct depths. Sampling equipment was thoroughly cleaned in between each depth to ensure against cross-contamination of samples. Field (split) duplicates were collected in accordance with the quality assurance project plan. Samples were placed in plastic sample bottles and labeled. Sample information was recorded on the sample bottles and on the field chain-of-custody forms for transfer to a secure sample storage area to await shipment to the analytical laboratory. Equipment blanks and a sample of the deionized water used for instrument cleaning were also sent to the laboratory for quality control analysis. Appendix F of NYSERDA's submittal provides a summary of all soil samples collected, including locations, depths, and type of laboratory analysis.

Most of the samples collected from each of the five areas of interest were submitted for radiochemical analysis, while others were archived, as specified in NYSERDA's sampling and dose assessment plan (NYSERDA, 2015). A total of 641 samples were collected in the field, and 532 were submitted for analysis to GEL Laboratories, a NYSDOH-Environmental Laboratory Program approved analytical laboratory.

All samples submitted for analysis were analyzed for gross alpha activity, gross beta activity, and by gamma spectroscopy. Also, some samples underwent additional isotopic analysis. Appendix C of the submittal provides further detail regarding the analyses including the isotopes, analytical method, and minimum detectable concentrations. Quality control samples, including field duplicates, equipment (rinsate) blanks, and deionized water were also collected and analyzed.

Analytical data were provided by the laboratory with two standard deviation precision. All analytical data underwent Level IV data validation in accordance with the Evaluation of Radiochemical Data Usability (DOE, 1997). NYSERDA determined that all data were usable. In Appendix G of the submittal, NYSERDA provides applicable laboratory certificates of analysis.

Global Positioning System Gamma Walkover Survey

For regions of interest which had not previously been sampled (Sub-Areas 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 4.3, 4.4, 4.5, 5.1, 5.2, 5.3, 5.4, 5.5, and 5.6), NYSERDA called for a GPS gamma walkover survey in its sampling and dose assessment plan (NYSERDA, 2015). This survey consisted of a course transect spacing (20 to 30 m spacing) using a 2” x 2” sodium iodide (NaI) detector suspended close to the ground. The detected count rate was to be data-logged along with the GPS coordinates and then plotted out in order to identify any trends or elevated radioactivity. If elevated radioactivity was discerned, samples would be collected at the elevated locations in addition to random sample locations.

In Area 2 (second area of interest), because both sub-areas were steeply sloped and with heavy tree cover, it was not possible to utilize the GPS data logging system. Instead, NYSERDA used a contingency method of laying out a grid and collecting data by hand. NYSERDA evaluated the readings in each sub-area and did not identify any zones that were elevated as compared to the rest of the readings in the area. The data are depicted in Figures 22 and 23 of the submittal.

In Area 3 (third area of interest), GPS gamma walkover surveys were conducted in both sub-areas using a nominal transect spacing of 20 m or less. Some portions of Sub-Area 3.1 were heavily wooded and overgrown. As a result, it was not possible for NYSERDA to completely survey the designated area although NYSERDA was able to survey the cultivated areas and immediately adjacent areas. The survey results indicated a pattern of elevated readings (See Figure 29 of the submittal) immediately to the southwest and down slope of Sub-Area 3.1. In Sub-Area 3.2, some sections were obstructed by trees, shrubs, and a debris pile and the survey team could not traverse these areas. The data for Sub-Area 3.2 are depicted in Figure 30 of the submittal; no elevated regions of this sub-area were identified.

In Areas 4 and 5 (fourth and fifth areas of interest, respectively), GPS gamma walkover surveys were conducted in all sub-areas as shown in Figures 35 - 39 (for Area 4) and Figures 45 - 50 (for Area 5) of the submittal. These areas were generally heavily wooded, although sufficient data was collected and analyzed. No elevated regions were identified in any of these sub-areas.

Soil Sampling and Direct Measurement Surveys

In addition to the GPS gamma walkover surveys, the sampling and dose assessment plan (NYSERDA, 2015) called for further radiation measurements and sampling. Specifically, NYSERDA called for tissue equivalent micro rem readings at ground level and at 100 cm elevations, static 2” x 2” NaI detector readings at contact and 100 cm elevations, collection of

soil and stream sediment samples (0-15 cm and 15-30 cm depths), and subsurface soil samples (30-100 cm depth). An exception was noted for the Cesium Prong area (Area 1) where the samples were collected in three depth intervals (0-5 cm, 5-15 cm, and 15-30 cm). All surface soil samples were sent to the laboratory for gross alpha, gross beta, and gamma spectroscopy analysis. Next, depth level samples were only analyzed if the initial surface analysis was greater than background plus two standard deviations.

The size of the various sub-areas and the total samples to be collected are detailed in Table 3 of the sampling and dose assessment plan (NYSERDA, 2015). The number of samples planned to be collected in each sub-area or sub-region[4] was based on the size of the area. For areas less than 2,000 m^2, the sampling and dose assessment plan (NYSERDA, 2015) called for a minimum of four locations to be sampled. For areas 2,001-10,000 m^2, a minimum of 15 locations were to be sampled. For areas greater than 10,000 m^2, a minimum of 24 locations were to be sampled. Each area where these surveys were performed is discussed separately in the following sections. As previously mentioned, changes to the survey and sampling plan were provided in Appendix A to the submittal. The staff were generally accepting of the justifications for the changes given the stated purpose of the surveys and sampling. The staff note that all soil sampling data were reported and summarized in Appendix H2 of the submittal and direct measurement data were provided in Appendix H32 for static 2 x 2 measurements and Appendix H1 of the submittal for exposure rate measurements.

Background Determinations

NYSERDA discusses the determination of background radiation and radionuclide concentrations in Section 6.1 of the submittal. NYSERDA called out two separate data sets for background. One set of background measurements was conducted for comparison to dose rates and soil concentrations from Areas 1, 2, and 3 and the confirmatory locations on the WNYNSC property. For that set of measurements, ten locations were surveyed and sampled from within the two reference background areas identified in the 2014 DOE Background Study (SEC, 2014). The two background locations selected by NYSERDA for Areas 1, 2, and 3 are shown in Figures 7, 8, and 9 of the submittal. The information in Table 4 of the submittal, which summarizes the background soil data for WNYNSC, is replicated in Appendix A, Table A-2 of this TER for ease of reference.

NYSERDA obtained a second set of background measurements to use for comparison to data from Areas 4 and 5. This data set was further segregated into two subsets, one collected from the floodplain of Cattaraugus Creek for application to Area 4 and one using data not collected from areas on the floodplain for application to Area 5. A total of ten locations were surveyed and sampled, five within the floodplain and five outside of the floodplain, as shown in Figures 12, 13, and 14 of the submittal. The information in Tables 7 and 8 of the submittal, which summarize the background soil data for SNI land, is replicated in Appendix A as Tables A-4 and A-6 of this TER for ease of reference.

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[4] NYSERDA defined a sub-region as an area within a sub-area that encompassed an area of an even smaller identified elevated radioactivity.

In the submittal, NYSERDA defines background data for WNYNSC as being an average exposure rate of 8.3 μR/h from the 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015b), including contribution from radon and cosmic radiation. Direct background radiation values measured during this survey effort for the WNYNSC and the SNI floodplain area and the SNI non-floodplain area are provided by NYSERDA in the text of Section 6 of the submittal and are replicated in table format as Tables A-1, A-3, and A-5, respectively, in Appendix A of this TER for ease of reference.

Summary of Area 1 Data

Area 1 encompasses an area outside the boundaries of the WNYNSC that has been previously characterized as the "Cesium Prong." It largely consists of residential properties to the north and west of the WNYNS boundary. Three locations were surveyed and sampled for comparison to data from a previous off-site investigation report (D&M, 1995). Sample Locations 1.1 and 1.2 are in a residential area and located within 350 ft of each other in a wooded lot behind a residence. Sample Location 1.3 was located on the edge of an open field along a tree line. The sample locations are shown in Figure 1 of the submittal. Direct radiation readings and soil samples were collected in the three locations. The planned fourth sample location was not attempted because it was on land that the survey team could not gain permission to sample.

The Area 1 tissue equivalent dose rate instrument gross readings at 100 cm elevation were 4, 5, and 6 μrem/h at sample locations 1.1, 1.2, and 1.3, respectively. Background was previously estimated at 3.69 μrem/h.

The Area 1 direct measurement readings using the 2"x2" NaI detector were averaged between two counts at each location and ranged from 7607 counts per minute (cpm) to 8361 cpm. The average across all locations was 7876 cpm. The comparable background count rate for Area 1 was 6333 cpm.

Six soil samples from the 0-5 and 5-15 cm depths were analyzed by gamma spectroscopy and for gross alpha and gross beta activity. Due to the proximity in geographic location, the soil concentration values for Locations 1.1 and 1.2 were averaged together for data comparison and dose assessment purposes. Weighted average soil concentrations for gross alpha, gross beta and Cs-137 results associated with the 0-15 cm depth are summarized in Table 10 of the submittal and replicated as Table A-7 in Appendix A of this TER for ease of reference. In the submittal, Area 1 samples were collected at depths of 0-5 cm and 5-15 cm, while the background samples were collected at 0-15 cm and 15-30 cm depths. Therefore, a weighted average for the 0-15 cm Area 1 depth was calculated by NYSERDA and used to compare the soil concentration to an equivalent background depth.

NYSERDA compared the Cs-137 concentrations in these samples to data in a previous off-site investigation report (D&M, 1995). NYSERDA determined that the samples showed slightly elevated Cs-137 concentrations when compared to the previous off-site investigation report's (D&M, 1995) decay-corrected data covering the general off-site geographical vicinity of the Cesium-Prong.

Summary of Area 2 Data

Area 2 consisted of two sub-areas. These sub-areas lie in a region nominally three miles to the northwest of the WVDP site that is transected by the Route 219 expressway. Sub-Area 2.1 is to the north and on the west side of this expressway, while Sub-Area 2.2 is to the south on the east side of this expressway (see Figure 2 of the submittal). These two sub-areas are both sloped, and tree covered.

NYSERDA, upon evaluation of the results of the GPS gamma walk over survey, did not identify any elevations or trends. As a result, NYSERDA used random sampling locations and survey locations. Figures 18 and 19 of the submittal show the sampling locations in Sub-Areas 2.1 and 2.2, respectively. NYSERDA identified four sampling locations in each sub-area.

Direct measurement results for Area 2 are summarized in the text of Section 7.2.3 of the submittal and replicated in Table A-8 of Appendix A of this TER for ease of reference.

Soil samples were collected in depth increments of 0-5 cm, 5-15 cm, and 15-100 cm. Samples were collected from the first two depth intervals at all locations. Samples were collected from the 15-100 cm depth at all locations in Sub-Area 2.2. Due to the difficult terrain and soil conditions, a 15-100 cm sample was only collected in one location in Sub-Area 2.1. Six soil samples were analyzed for Sub-Area 2.1 and nine soil samples were analyzed for Sub-Area 2.2. The weighted average soil concentrations for gross alpha, gross beta, and cesium results associated with each stratum depth are summarized in Tables 24 and 26 of the submittal and replicated in Table A-9 of Appendix A of this TER for ease of reference.

Summary of Area 3 Data

Area 3 is located at the confluence of Buttermilk and Cattaraugus Creeks (Figure 3 of the submittal, and considered two sub-areas designated 3.1 and 3.2. Both sub-areas are located on an active farm. Sub-Area 3.1 is a large, slightly sloped area, the majority of which is currently utilized to grow corn for livestock consumption. Sub-Area 3.2 is a smaller area located just north of Thomas Corners Road. This sub-area is sloped upward from the roadway towards the farm dwelling, and is transected by a gravel driveway.

In Sub-Area 3.1, a pattern of elevated readings was identified by NYSERDA upon evaluation of the GPS gamma walkover survey data (See Figure 29 of the submittal immediately to the southwest and down slope of the sub-area.) As a result, samples were collected from 7 elevated locations and NYSERDA used a random sampling collection pattern for 17 other locations for a total of 24 sample locations in Sub-Area 3.1. In Sub-Area 3.2, no elevated locations were identified by NYSERDA upon evaluation of the GPS gamma walkover data (See Figure 30 of the submittal). As a result, NYSERDA collected samples from four random locations. One planned sample location was relocated slightly west to avoid an existing driveway on the property. Figures 27 and 28 of the submittal depict the sampling locations in Sub-Areas 3.1 and 3.2, respectively.

Fifty-three soil samples were analyzed in Sub-Area 3.1 and six soil samples were analyzed in Sub-Area 3.2. The average soil concentrations for gross alpha, gross beta, and cesium results associated with each stratum depth sampled are summarized in Tables 37 and 39 of the submittal and replicated as Table A-11 of Appendix A of this TER for ease of reference.

Summary of Area 4 Data

Area 4 lies approximately 20 miles to the west of the WNYNSC on SNI land at the Cattaraugus Reservation and spans Cattaraugus Creek (See Figure 4 of the submittal). It includes five sub-areas, designated 4.1, 4.2, 4.3, 4.4, and 4.5, respectively. Each sub-area consists of multiple sub-regions, as shown in Figures 33 and 34 of the submittal. Area 4 is a wooded area with varying terrain that lies within the historic floodplain.

Direct measurements and samples were collected from each sub-region, as generally depicted in Figures 33 and 34 of the submittal. The number of sample locations in a sub-region varied between one and twenty locations depending on the size of the sub-region. Only random samples were collected because NYSERDA, upon evaluation of the GPS gamma walkover data, did not identify any elevated areas of radioactivity.

Direct measurements of exposure rates and 2” x 2” NaI count rates were obtained at each sampling location and summarized in text in Section 7.4.3 and in Table 51 of the submittal. This information is replicated in Table A-12 of Appendix A in this TER for ease of reference.

Soil samples were collected from each sub-region in Area 4. A total of twenty-four sampling locations were identified in each sub-areas in Area 4 with the exception of Sub-Area 4.4. Fifteen soil sampling locations were identified in Sub-Area 4.4. The weighted average soil concentrations for gross alpha, gross beta, and cesium results associated with each stratum depth that was sampled are summarized in Table 52 of the submittal and replicated in Table A-13 of Appendix A of this TER for ease of reference.

Summary of Area 5 Data

Area 5 lies approximately 17 miles to the west of the WNYNSC and 0.6 miles east of Cattaraugus Creek (Figure 5 of the submittal). It includes six sub-areas designated 5.1 through 5.6. Sub-Areas 5.1 and 5.2 contain 2 sub-regions while the remainder only contain one sub-region. The sub-areas and sub-regions can be seen in Figures 42, 43, and 44 of the submittal. Area 5 is relatively undisturbed old growth wooded area with varying terrain that lies outside the floodplain.

Direct measurements and samples were collected from each sub-region of Area 5 as generally depicted in Figures 42 through 44 of the submittal. The number of sample locations in a sub-region varied between two and eight locations depending on the size of the sub-region. Only random samples were collected because the GPS gamma walkover survey did not identify any elevated areas. Direct measurements are summarized in text in Section 7.5.3 and in Table 72

of the submittal. This information is replicated in Table A-14 of Appendix A of this TER for ease of reference.

Samples were collected from each sub-region in Area 5. Four sampling locations, each, were established in Sub-Areas 5.1, 5.3, 5.4, 5.5, and 5.6. Fifteen sampling locations were established in Sub-Area 5.2. The weighted average soil concentrations for gross alpha, gross beta, and cesium results associated with each stratum depth sampled in Area 5 are summarized in Table 73 of the submittal and replicated in Table A-15 of Appendix A of this TER for ease of reference.

Summary Data for Confirmatory Locations Located on the Western New York Nuclear Service Center Property

Direct radiation readings and soil samples were collected in the four locations as described in Table 4 of the sampling and dose assessment plan (NYSERDA, 2015). The objective for this area was to survey and sample at locations selected based on historical process knowledge (e.g., Cesium-Prong, effluent liquid discharge) along with two locations that may be attributed to direct radiation shine from the WVDP site. Figure 6 of the submittal depicts these locations.

The WNYNSC Confirmatory Area static readings using the 2”x2” NaI detector ranged from 7812 cpm to 16586 cpm. NYSERDA determined that the average across all locations in the WNYNSC Confirmatory Area was 11405 cpm. NYSERDA determined that the applicable background count rate for WNYNSC Confirmatory Area was 6333 cpm. These values are likely elevated, in part, due to the proximity of the sampling/measurement locations to the WVDP site. A tabulation of the static count rates is provided in Appendix H32 of the submittal.

The dose rates across the 4 locations at the WNYNSC ranged from 6 to 10 µrem/h with the average being 8.5 µrem/h. NYSERDA determined that the applicable background dose rate for the WNYNSC was 3.69 ± 0.12 µrem/h. Similar to the static 2” x 2” NaI count readings, these values are likely elevated, in part, due to proximity of the WVDP site.

Four soil samples from the 0-5 cm depth and one sample from the 30-100 cm depth were analyzed by gamma spectroscopy, gross alpha, and gross beta activity. The data, taken from Table 93 in the submittal, are provided below in Table 3 of this TER for ease of reference.

Table 3. Western New York Nuclear Service Center Average Soil Gross Concentrations

Sub-Area	Depth (cm)	Gross Alpha[a] (pCi/g)	Gross Beta[a] (pCi/g)	Cesium-137[a] (pCi/g)
C.1	0-5	9.4E+00 ± 3.2E+00	2.9E+01 ± 2.82E+00	1.2E+00 ± 1.4E-01
C.2	0-5	8.1E+00 ± 3.1E+00	2.0E+01 ± 3.40E+00	8.7E+00 ± 2.4E-01
	30-100	1.3E+01 ± 3.9E+00	4.7E+01 ± 4.09E+00	3.0E+01 ± 5.7E-01
C.3	0-5	1.0E+01 ± 3.4E+00	8.7E+00 ± 2.27E+00	9.4E-01 ± 2.1E-01
C.4	0-5	2.2E+01 ± 5.1E+00	4.0E+01 ± 4.42E+00	1.4E+00 ± 1.7E-01

a: uncertainty is reported ± 1 sigma

The individual sample numbers, depths, concentrations, uncertainties, and method detection limits are provided in Appendix H2 of the submittal.

Staff's Evaluation of Licensee's Sampling and Analysis Submittal

Survey Approach

The staff consider the survey conducted by NYSERDA to be a non-routine survey to assess former operational impacts in an area that is outside of the owner controlled area. NYSERDA states in its submittal that the objective of the sampling and dose assessment plan (NYSERDA, 2015) is to determine whether the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b) indicated impacted areas and to "evaluate the radiological impact of any contamination identified." This is consistent with NRC regulations in 10 CFR 20.1501 in that the surveys that were conducted were reasonable.

With regard to the targeted areas for radiological surveys, the staff independently verified the Remote Sensing Laboratories (RSL)[5] identification of areas for follow-up investigation based on elevation of anthropogenic and Cs-137 count rates above background. However, the staff needed to make certain assumptions for the verification because insufficient detail was provided regarding the four criteria used to identify the areas of interest (see page 4 of NYSERDA, 2016b). For example, the submittal did not provide the parameters used to interpolate the count rate point data into the raster data provided to NRC during the June 2016 NRC audit of NYSERDA survey information or the method used to generate the contour data from the raster data. RSL's algorithm for applying criterion 3, determining co-location of elevated anthropogenic and Cs-137 extraction data, was also unclear (e.g., intersection of buffer zones created around elevated areas or some other approach). An additional criterion (Criterion 4 listed on page 4 of the submittal) was used by RSL to eliminate a number of small areas of radioactivity that were likely in the noise or represented "false positives" and to allow investigators to focus on areas that were more likely to be statistically above background. However, the qualitative nature of the final criteria also made it difficult for the staff to reproduce the maps showing five areas of interest.

The staff determined that the areas identified for follow-up investigation appear to closely match the areas where the interpolated Cs-137 data meet Criterion 1 and are within 300 ft of areas where the interpolated anthropogenic data meet Criterion 2. However, they do not also include areas where the interpolated anthropogenic data meet Criterion 2 and are within 300 ft of the areas of the interpolated Cs-137 data meeting Criterion 1.

NRC confirmed with NYSERDA (ADAMS Accession No. ML18053A254 [Pkg.]) that the Cs-137 extractions were in fact used to identify the areas for follow-up investigation and the anthropogenic extractions were only used as a check to identify areas most likely to be impacted. In some cases, areas where Cs-137 was above background, but not co-located with anthropogenic counts above background (areas that did not meet RSL's Criterion 3 listed on

[5] Organization that DOE and NYSERDA hired to conduct the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b).

page 4 of the submittal), NYSERDA conservatively expanded the area for follow-up investigation to include these areas. Because the anthropogenic extractions are prone to false positives and would unnecessarily increase the area for follow-up investigation, for this survey the use of Cs-137 extraction data, alone, to determine areas for follow-up investigation appears to be reasonable. Additionally, based on the staff's review of the sampling data, Cs-137 appears to be the best indicator of areas potentially impacted by West Valley operations, and it is reasonable to assume that if other ROIs were present they would be co-located with Cs-137. The staff found no indication from its review of the expanded analytical data that other ROIs were detected in the off-site sampled areas. The staff notes that the level of detail provided in the submittal on the criteria and steps used to identify areas for follow-up investigation and any limitations of the approach used to determine elevated areas could have been expanded. Nonetheless, the staff generally finds the methods used by RSL and NYSERDA to be reasonable.

The staff determined that gross alpha and gross beta above background are more likely reflective of natural variations in radioactivity, particularly potassium-40 (K-40), naturally occurring uranium, or impacts from Cs-137 which was detected, rather than reflective of what was conservatively considered by NYSERDA to be the limiting alpha and beta emitters of concern, Pu-239/Am-241 (alpha) and Sr-90 (beta), respectively. In fact, Pu-239/Am-241 and Sr-90 were generally not detected in expanded analyses that NYSERDA obtained.

For the staff's independent analysis, unlike NYSERDA, the staff did not consider weighted averages based on measurement uncertainty. The staff simply determined the arithmetic mean (average) of each pertinent sampling sub-set (e.g., each sub-area and, if applicable, each depth interval), as well as the arithmetic average background for each depth interval sampled. If data were replicated, indicating repeated analysis of a sample, the staff simply selected the most conservative of the data to use in the evaluation. The staff then calculated the net exposure rates at 1 m and net sampling/depth interval soil concentrations. The 1 m net exposure rate data was compared to 5.5 µrem/h, a bounding rate corresponding to ~25 mrem/y (~0.25 mSv/y) for a resident farmer scenario evaluated by NYSERDA and discussed in more detail in the dose modeling section in this TER.

Finally, the staff did not consider the static count measurements, as there is no criteria applicable to that data and the GPS gamma walkover survey performed the primary function of scanning for elevations based on gross count rate. While the static count data could potentially be used to develop a correlation to soil sampling results, this was not considered necessary because sampling data was obtained at each measurement location.

Background Determinations

While NYSERDA's submittal established means weighted by the measurement uncertainty for comparisons, the staff performed a simplified data evaluation for comparisons by simply determining the arithmetic mean (average) and not combining measurement or sampling data in a manner that would reduce the overall number of data points being considered or generate a bias in the result. Generally, with regards to background, this resulted in a slightly less conservative background determination (i.e., a higher background concentration).

With a limited number of data points (at most 5 sampling locations in any area designated for background), the staff determined it would be most appropriate to consider the total data set (10 sampling locations) from background areas designated for WVNYSC (Areas 1, 2, and 3) for this study as the differences between the background areas were relatively minor. Similarly, the background data sets for the SNI Floodplain (applicable to Area 4) and Non-Floodplain (applicable to Area 5) were determined as arithmetic means for each depth interval. Any discrepancy between NRC and NYSERDA calculated background concentrations is due to the statistical methods utilized (arithmetic mean versus weighted average) and the staff's conservative selection (the staff selected datum of least magnitude for background data sets) from replicate datum present in the raw data. The staff's summary data tables for background are provided in Appendix B of this TER in Tables B-1 through B-4. The end result is that a generally less conservative (i.e., slightly higher) background was usually, but not in all cases, calculated by the staff. However, this relative bias is also present when evaluating the survey data for the impacted areas so it is not considered to be significant.

The WVNYSC background data were obtained at locations previously used for site background determinations and are considered by the staff to be appropriate for the purpose of consistency. SNI background sample data were reviewed to ensure there were no obvious impacts from licensed activities. This included review of transuranic data, fission product data, and naturally occurring radionuclide data that were reported by NYSERDA in the expanded analysis for these data sets. The staff determined that there were no significant transuranic, fission product, or activation data that would indicate SNI background areas associated with Areas 4 and 5 had been impacted by West Valley licensed activities. The staff found that the results for most of these radionuclides were less than the respective detection limits. There was an anomalous result for Curium-245/246 (Cm-245/246) in one instance that was only slightly greater than the detection limit (i.e., less than twice the detection limit) and had relatively significant reported uncertainty (greater than 80% of the result). The staff considered the result to be insignificant as no other transuranic exceeded the detection limit and, given the very low level that was reported, it is likely to be an anomalous outlier. Cesium-137 was routinely reported greater than the detection limit but the staff believes that this is expected because of historical atmospheric fallout and relatively long half-life of this radionuclide. The staff did note that the concentrations in the floodplain and the non-floodplain were not significantly different as indicated both by the overlapping uncertainties in the data sets and an Analysis of Variance (ANOVA) analysis of the data sets. Also, the staff found that the Cs-137 concentrations are not inconsistent with the expected background levels for New York found in literature (Wallo, et al., 1994) when corrected for radiological decay. The concentration of naturally occurring radioisotope chains all exhibited approximate secular equilibrium leading to the conclusion that no artificial addition of these radionuclides was present (i.e., neither enriched uranium nor chemically separated uranium were demonstrated in the data set).

Global Positioning Survey Gamma Walkover Survey

The staff reviewed the evaluation of the scanning surveys as shown in Figures 22, 23, 29, 30, 35, 36, 37, 38, 39, 45, 46, 47, 48, 49, and 50 in the submittal. The staff found that the

conclusions reached by NYSERDA were reasonable in that only the lower portion of Sub-Area 3.1 showed any apparent trend possibly indicative of an elevation. This is based on review of the color coded plotted data as per the legend in the figures in the submittal.

Exposure Rate Measurements

The staff calculated the average of the exposure rate measurements at 1 m height in Area 1 and in all sub-areas in Areas 2, 3, 4, and 5. The results are shown in Table B-4 of Appendix B of this TER.

These values are comparable to those determined by NYSERDA with the differences attributable to how the average for these areas was calculated. NRC finds the general approach taken by NYSERDA of weighted averaging to be a non-standard method for evaluating such data even though the results are comparable with relatively minor differences. In all cases, the average net exposure rates were less than 5.5 µrem/hr which is the exposure rate that is estimated by NYSERDA to result in the 10 CFR 20.1402 unrestricted use limit of 25 mrem/y (0.25 mSv/y) TEDE all pathway dose for a resident farmer scenario discussed in more detail in the dose modeling section below.

Sampling Results

Similar to the exposure rate measurements, the staff determined the average soil concentrations, by depth interval, for Area 1 and Sub-Areas 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 4.3, 4.4, 4.5, 5.1, 5.2, 5.3, 5.4, 5.5, and 5.6. Area 1 had only three sample locations and NYSERDA "averaged" two of those locations. The staff elected to consider each sample result as a single data point (i.e., the staff did not average together data points to reduce a data set) and determined averages for each area/sub-area and depth interval, where applicable. Also, NYSERDA calculated weighted averages of the samples in Areas 1 and 2 to obtain a "comparable" data set (meant to equate to the 0-15 cm depth interval taken for background). Staff did not replicate that effort but instead considered each sampling depth interval individually. Tables B-5 through B-9 in Appendix B of this TER provide the results of the staff's determinations. The staff then calculated a net concentration as shown in Table B-10 of this TER.

As previously mentioned, NYSERDA determined that all sub-areas met the WVDP Phase 1 DP, Revision 2 criteria. The staff considered each depth interval of each sub-area to determine individual soil intervals which were above the WVDP Phase 1 DP, Revision 2, DCGLs. This approach is conservative for ROIs such as Sr-90 and Am-241/Pu-239 which are considered to have a significant plant ingestion pathway dose. This is because the DCGLs assume 1 m of contamination and the dose is highly correlated to thickness of contamination. Nonetheless, for the purposes of a screening evaluation to focus NRC's review of the data, the staff identified potentially problematic intervals: the 15-30 cm depth interval in Sub-Areas 3.1, 4.2, and 4.5 and the 30-60 cm depth interval in Sub-Area 5.6.

The staff further investigated these areas and noted that Sub-Area 3.1 is the only area in which the GPS gamma walkover survey indicated an increasing trend and which was additionally sampled in the area of identified elevation. NRC looked for elevations in the provided data in the submittal and noted that only in a couple of instances did any analytical results exceed two standard deviations of the applicable data set. However, the data were effectively at the upper range for the allowable deviations and, for that reason, the staff considered the entire data set, because it did not indicate a significant variation from the overall population. Biased sampling in Sub-Area 3.1 likely resulted in an expected bias in the data set sufficient to increase the sum of fractions (SOF) to slightly above unity at "1.02."

The staff further reviewed the expanded analyses for samples in Sub-Areas 3.1, 4.2, 4.5 and 5.6 and determined that applying the Pu-239 and Sr-90 criteria to the gross alpha and gross beta results seems extremely conservative because neither of these two radionuclides were detected above the detection limit in the sub-areas. The staff's review of the entirety of sub-area's expanded analyses found that trace levels of Cm-245/246 appear to be reported intermittently, leading the staff to believe there may be cross contamination of these radionuclides at the laboratory as no other transuranic or fission product radionuclides (other than Cs-137) were detected. Primarily, the naturally occurring radionuclides and Cs-137 were present at concentrations greater than the detection limit and the naturally occurring radionuclide concentrations appeared consistent with background levels. The staff concluded that the screening method being used (gross alpha and gross beta) introduced too much variability into the comparison relative to the criteria being applied to these measurements, particularly for the gross beta measurement. The variance in naturally occurring alpha and beta emitters, compounded by biased sampling, resulted in exceeding the DCGLs in some circumstances such as in Sub-Area 3.1. Also, for Area 4, the staff used a background data set that included a conservative outlier that wasn't used in the NYSERDA evaluations for the two sub-areas (when replicate data points were present, the staff elected to utilize the most conservative data). The staff noted that, if considering the entirety of the sub-areas (i.e., all depth intervals), the average concentration, when weighted by the depth intervals represented, would be lower than the WVDP Phase 1 DP, Revision 2, DCGLs in all sub-areas except for sub-area 5.6.

The staff further considered the sample that comprised the entirety of data for the 30-60 cm depth interval in Sub-Area 5.6. The staff concludes that the elevated gross alpha and gross beta results in this sample are likely due to analytical error because these two results are almost double what is otherwise reported in the sub-area and the analysis was performed at a different time than the other samples in the sub-area causing the results to be flagged for excessive holding time. Except for one apparent anomaly (a Cm-245/246 result that only marginally exceeded the detection limit), only naturally occurring radionuclides and Cs-137 were detected at concentrations greater than the detection limit in the expanded analyses for this sub-area and the naturally occurring radionuclide concentrations appeared consistent with the other areas. Finally, the staff note that NYSERDA considered the gross alpha/beta sample results of the 30-60 cm sample inconsistent with expected levels of alpha and beta activity based on the expanded analysis of the sample and NYSERDA omitted that sample data in its evaluations.

For these reasons, the staff consider omitting this data point to be appropriate in this case. When this data point is omitted, then this sub-area also meets the DCGL screening criteria.

The staff concludes that, because the weighted average of all depth interval concentrations in each area/sub-area can be shown to meet the WVDP Phase 1 DP, Revision 2, criteria when using conservative screening measurements (i.e., selecting only conservative data from replicate measurements and applying Pu-239 and Sr-90 WVDP Phase 1 DP, Revision 2, DCGLs to gross alpha and gross beta measurements, respectively), this verifies NYSERDA's determination that all areas are lower than the WVDP Phase 1 DP, Revision 2, DCGLs. The staff note that this was also the case when staff adjusted the Sr-90 and Cs-137 criteria to approximately one-half the values presented in Table 2 in order to assure the dose basis for these radionuclides equated to 25 mrem/y maximum. Comparison of average soil concentrations to the WVDP Phase 1, Revision 2, DCGLs is only one of several methods NYSERDA used to conclude that the risk from radioactivity in off-site areas (all areas of interests or Areas 1, 2, 3, 4 and 5) is low. The staff's evaluation of other methods is presented in the dose modeling section of this TER, below.

Staff's Conclusions on Characterization

NYSERDA's efforts to characterize the areas of interest were based on the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b). While there may be other areas of elevated residual radioactivity, the staff believes that the areas identified by the 2014 Aerial Radiological Survey are likely bounding. It is well documented that there is Cs-137 fallout present in the State of New York. Fallout is not associated with licensed operations and not regulated by NRC. Regardless, these identified areas of interest, which are expected to be the most likely locations of elevated contamination based on the 2014 Aerial Radiological Survey results, did not exceed applicable WVDP Phase I, DP, Revision 2, DCGL criteria. Therefore, NRC does not anticipate that any unidentified elevated areas would be of concern.

The staff concludes that the GPS gamma walkover surveys demonstrated that random sampling for these areas is an acceptable method of sample location determinations. NYSERDA focused the sampling in the one area where a general elevation was determined (Sub-Area 3.1) which likely introduced a conservative bias into that data set, but did not find evidence of significant heterogenic deposition that would exceed the unrestricted use standards in 10 CFR 20.1402.

Because the expanded analysis shows no detections of Sr-90 at concentrations greater than the detection limit, the staff believe that the use of the Sr-90 DCGL as a screening limit for comparison against the net beta soil concentrations provides a significantly conservative estimate of the risk from beta emitters. Similarly, applying the Pu-239 criteria to the gross alpha measurements introduced significant conservatism because Pu-239 was not detected above the detection limit in the expanded analyses. However, the Pu-239 DCGL is significantly greater than the expected natural variation of gross alpha activity in the sample data set so comparisons of results based on this surrogate relationship against clean-up levels for Pu-239 would likely not result in an exceedance of the Pu-239 DCGL. Regardless of the conservatism

generated, it is understandable that the DCGLs of Sr-90 and Pu-239 were utilized in this manner because it presumes conservative alpha and beta emitting radionuclides that were dominant in emissions from the WVDP, as well as being relatively long-lived, and can be considered to bound the contribution from other radionuclides that may be present. Although Cs-137 was present, the concentrations were 1 to 2 orders of magnitude less than the WVDP Phase 1 DP, Revision 2, DCGL.

Net exposure rate measurements in each area/sub-area were found to be less than NRC's unrestricted use limit 25 mrem/y (0.25 mSv/y) in 10 CFR 20.1402. Note that the unrestricted use limit is also substantially lower than NRC's general public dose limit of 100 mrem/y (1mSv/y).

NRC finds that the licensee's practice of weighted averaging data based on measurement uncertainty may underestimate concentrations and, consequently, dose. With regards to weighting based on measurement uncertainty, this practice will generally give more weight to smaller measurements because the uncertainty is typically lower for smaller measurements rather than larger measurements. Also, there is considerable heterogeneity in the sample collection/analysis which introduces greater uncertainty than is reported in the measurement uncertainty alone. While the staff does consider NYSERDA's treatment of data using weighted averages to be a non-standard method, the staff was able to verify the conclusions reached by NYSERDA, as explained in the staff's evaluation of the dose modeling under the "Source Inventory/Concentrations" section of this TER.

In at least two instances, NYSERDA did not utilize data which appeared inconsistent with other analytical data in the sample or with surrounding samples. The staff agrees with NYSERDA that such reported results appear to be outliers and not representative of the general contamination levels in the area. However, these outliers were included in the staff's selection of conservative analytical results when replicate data were observed, and contributed to the discrepancies in the evaluations that staff performed compared to what NYSERDA determined. Regardless, both the NYSERDA weighted averages over the one-meter surface soil interval and NRC derived weighted averages (based on sampling depth intervals) over the same interval were found to meet the WVDP Phase 1, Revision 2, DCGLs which were considered as screening criteria. The staff note that it was necessary to omit the one 30-60 cm outlier data point in sub-area 5.6 to state this conclusively; the staff determined, as described previously, that this omission is appropriate.

NYSERDA included in its submittal select SNI special request samples that it collected and analyzed that were outside the scope of the areas of interest identified from the 2014 Aerial Radiological Report (DOE, NYSERDA, 2015b) and NYSERDA's sampling and dose assessment plan (NYSERDA, 2015). These samples were taken on the property of three homeowners and in two areas of land near Lake Erie, referred to as land "reaches." The staff also evaluated those data sets. The evaluation is found in Appendix C of this TER.

Dose Assessment

Licensee's Dose Assessment Approach

NYSERDA used various methods of estimating potential doses to members of the public for each of the areas under investigation, including the following:

- Results from the 2014 Aerial Radiological Survey Report in excess of background exposure rates interpolated from the 2014 Aerial Radiological Survey data (DOE, NYSERDA, 2015b).
- Tissue equivalent dose rate survey meter data collected during the 2015 sampling campaign reported in its submittal.
- RESidual RADioactive (RESRAD)-OFFSITE 3.1 modeling using current land use scenarios informed by surveys; and measured concentrations of gross alpha (represented by Am-241, or Pu-239), gross beta (represented by Sr-90), and Cs-137 soil concentrations in excess of background.
- Comparison against Revision 2 of the WVDP Phase 1 DP, DCGLs for surface soils and the resident farmer scenario.
- Internal ingestion dose conversion factors published in International Commission on Radiological Protection No. 68 (ICRP 68) considering average concentrations of Sr-90 and Cs-137 in excess of background and in edible portions of fish extracted from data reported in DOE's 2012 Annual Site Environmental Report (ASER) (independent assessment of fish consumption pathway).

For Areas 1, 2, and 3 only, the following method was also used to assess dose.

- RESRAD 7.0 modeling using reasonably foreseeable future land use and measured concentration of gross alpha, gross beta, and Cs-137 in excess of background[6].

Conceptual Models and Exposure Scenarios

Based on current land use surveys of property owners (Appendix D of the submittal), NYSERDA selected the resident homemaker scenario for Area 1, the recreational hiker (with hunting) scenario for Area 2, the resident farmer scenario for Area 3. NYSERDA also consulted with SNI to develop culturally specific collector and hunter scenarios for Areas 4 and 5. The dose from current land use exposure scenarios was evaluated using the RESRAD OFFSITE 3.1 computer code. In response to the staff's recommendation during the June 2016 audit (NRC, 2016), NYSERDA also evaluated reasonably foreseeable future land use. The resident farmer was evaluated for Areas 1 and 3, and Sub-Area 2.2; and the same recreational hiker (with hunting) scenarios was retained for Sub-Area 2.1. Only culturally specific exposure scenarios were evaluated for Areas 4 and 5, because NYSERDA concluded that the current scenarios were

[6] For Areas 4 and 5, the current land use scenarios were assumed to be reasonably foreseeable and therefore, no additional scenarios were evaluated.

expected to adequately assess reasonably foreseeable future land use. The RESRAD 7.0 computer code was used to evaluate reasonably foreseeable land use scenarios for Areas 1, 2 and 3 (excluding Sub-Area 2.1).

Source Inventory/Concentrations

To develop the inventory for use in dose modeling evaluations, NYSERDA collected a predetermined number of soil samples from each area, as identified in the previous section of this TER, and calculated a weighted mean and standard deviation (weights based on uncertainty in measurements). Gross alpha, gross beta, and Cs-137 measurements were taken from each sample location. Gross alpha measurements were attributed to Pu-239 or Am-214; gross beta results were attributed to Sr-90. Expanded analyses were also conducted in each area. Expanded analysis provided information on hard-to-detect radionuclides such as Technetium (Tc)-99, Iodine (I)-129, Carbon (C)-14. Background samples were obtained from ten locations (grouped into two areas) near the WNYNSC and ten locations on the Cattaraugus Territory of the SNI (grouped into floodplain and non-floodplain locations). Background measurements were subtracted from the soil sample results to assess the risk from radioactivity above background from each of the areas investigated.

Parameter Selection

Hydrology data for the contaminated, unsaturated, and saturated zones were based on information in the WVDP Phase 1 DP, Revision 2 (DOE, 2009). Appendix H3-7 of the submittal listed parameters that differed from default values. In cases where area specific scenarios were not consistent with assumptions used in the DOE WVDP Phase 1 DP, Revision 2 (DOE, 2009), modifications were made to pathways and parameters (e.g., exposure pathways, irrigation rates, consumption rates, erosion rates, and occupancy times). For parameters where there was no site-specific data available or there was no corresponding WVDP Phase 1 DP, Revision 2, value, the RESRAD-OFFSITE default parameters were used.

The Area 1 dose assessment was based on a resident homemaker. The resident is assumed to spend eight hours sleeping and another eight hours working inside the dwelling. Of the remaining eight hours, 50 percent is assumed to be spent inside the dwelling (bringing total time in the dwelling to 20 hours) and 50 percent is assumed to be spent outside in the elevated area (bringing the total time spent outside the dwelling to four hours). It is assumed that this resident homemaker also hunts deer and consumes the deer meat. No plant, fish, or dairy cattle milk is consumed from this area. The resident homemaker's dwelling is located on-site and within the elevated area.

The Area 2 dose assessment was based on a recreational hiker who is assumed to spend 100 h/y in the elevated area. It is assumed that this recreational hiker also hunts and consumes deer. No plant, fish, or dairy cattle milk is consumed from this area. The recreational hiker's dwelling is not located within the elevated area assessed. No irrigation was assumed for any part of Areas 1 and 2. The evapotranspiration coefficient provided in the WVDP Phase 1 DP, Revision 2 (DOE, 2009), was recalculated to maintain the same infiltration rate of

0.26 m/y. The soil erodibility factor, which is used to calculate the erosion rate, was set to the maximum value of the default range (0 to 0.5) in the User Manual for RESRAD-OFFSITE 3.1 (NRC, 2015). Selection of a high soil erodibility factor facilitates transport of radioactivity from the elevated areas to the surface water and thereby increases the uptake of radioactivity by deer consumed by the resident homemaker.

The Area 3 dose assessment was based on a resident farmer who is assumed to spend 1000 h/y tending feed crops in Sub-Area 3.1 and 1000 h/y tending livestock in a pasture located just north of the dwelling, which is not located in the elevated area. It is assumed that this resident farmer consumes cattle that consume grain grown in the elevated area but that graze in the pasture where no elevated radioactivity is present. No plant, milk, or fish is consumed from this area. The resident farmer's dwelling is located outside of the elevated area, but within the general area and therefore is included in the assessment. It is further assumed that 100 h is spent traversing Sub-Area 3.2. Irrigation was only assumed for crop fields in Area 3. The evapotranspiration coefficient listed in the Revision 2 of the WVDP Phase 1 DP (DOE, 2009) was recalculated to maintain the same infiltration rate of 0.26 m/y.

For Areas 4 and 5 the collector and hunter/fisher scenarios are evaluated using culturally specific land use information provided by SNI (see Appendix D of the submittal). Occupancy factors are provided in Table 1, below for ease of reference. As discussed in more detail in the dose assessment evaluation section of this TER, NYSERDA assumes a larger model domain encompasses Sub-Areas 4.1, 4.2, and 4.3; and a separate model domain encompasses Sub-Areas 4.4 and 4.5 (see Figure 1 of this TER), below. In the case of Area 5, all sub-areas in Area 5 (Sub-Areas 5.1 through 5.6) are included in the same model domain. Although the sub-areas are grouped together into three model domains, each of the sub-areas located in Areas 4 and 5 are run individually and the dose results reported for each sub-area only include the single sub-area being reported, although there are multiple sources located in each of the modeled areas. Potential cumulative impacts of multiple source areas are discussed in the dose assessment evaluation section of this TER. Table 2, below, provides a summary of the modeled versus actual contaminated area fractions for each of the sub-area simulations. The collector and hunter are assumed to consume wild vegetation, wild game, and fish (fish only in Area 4). Well and surface water are used for irrigation in Areas 4.1 through 4.3. Water is not assumed to be used for drinking water. There are no dwellings assumed to be located in Areas 4 and 5.

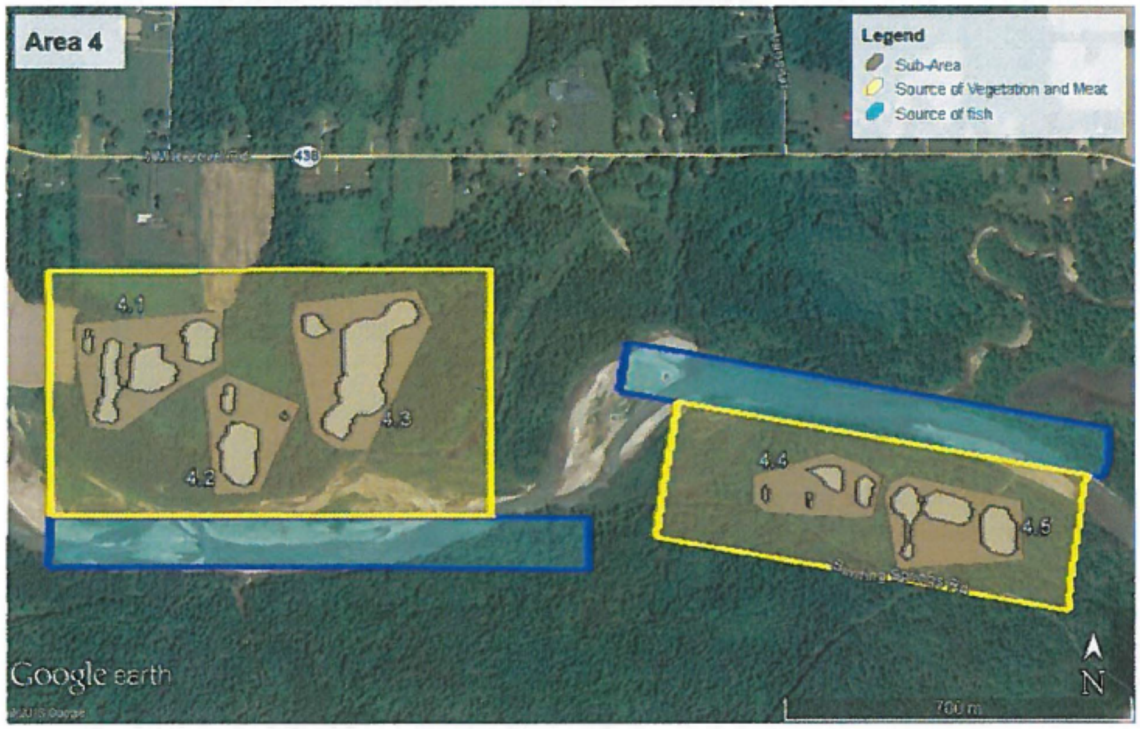
Table 1. Occupancy Factors (Factor of Total Time Spent in Each Area) Used in RESRAD OFFSITE for Areas 4 and 5

	Contaminated Zone	Fruit and Non-Leafy Vegetable	Leafy Vegetable	Total Fraction in Areas	Total Hours in Areas
Sub-Areas 4.1, 4.2, and 4.3					
Collector	0.1358	0.1045	0.0833	0.3236	2834
Hunter	0.3436	0.0417	0.0628	0.4481	3925
Sub-Areas 4.4 and 4.5					
Collector	0.1256	0.1045	0.0628	0.2929	2566
Hunter	0.3333	0.0417	0.0628	0.4378	3835
Area 5					
Collector	0.1256	0.0942	0.0942	0.2826	2476
Hunter	0.2917	0.0417	0.0417	0.3751	3286*

*The land use survey for the hunter in Area 5 summarized in a table in Appendix D of the submittal lists the total hours spent in Area 5 as 3470 hours, although the sum of the number of hours spent participating in recreational activities or collecting fruit, non-leafy, and leafy vegetables listed in the same table adds up to only 3286 hours. A review of the RESRAD OFFSITE file also reveals that the hunter spends a total of 3286 hours in Area 5.

Table 2. Areas of Each Sub-Area and Each Model Domain

Sub-Area Label	Area of Contaminated Sub-Area m^2	Area of Total Model Domain m^2	Modeled Contaminated Fraction of Total Modeled Area	Actual Combined Source Fraction
4.1	18,513	450,000	0.04	0.12
4.2	10,080	450,000	0.02	
4.3	25,650	450,000	0.06	
4.4	4,746	233,750	0.02	0.09
4.5	15,708	233,750	0.07	
5.1	1334	1,080,000	0.001	0.01
5.2	6600	1,080,000	0.006	
5.3	575	1,080,000	0.0005	
5.4	1786	1,080,000	0.002	
5.5	320	1,080,000	0.0003	
5.6	891	1,080,000	0.0008	



(a)

(b)

Figure 1. Seneca Nation of Indians Sub-Areas and Larger Model Domain (a) Area 4 and (b) Area 5

In addition to the current land use scenarios and based on the staff's recommendation (NRC, 2016), NYSERDA evaluated a resident farmer scenario for Areas 1 and 3; and Sub-Area 2.2. It

is assumed that the farmer's dwelling, crop fields, and pasture lands reside in the elevated area. In addition, the crop that is grown is consumed by the farmer. The farmer also maintains and consumes both dairy and meat from the cattle.

Based on the staff's recommendation (NRC, 2016), NYSERDA also calculates dose from fish consumption. NYSERDA obtained radiological concentrations of strontium and cesium in the edible portion of the fish in Cattaraugus Creek from DOE's 2012 ASER (DOE, 2013). Hog-nosed Sucker and White Sucker are sampled from above the Springville Dam and Steelhead Trout are sampled from below the Springville Dam. Brown Trout, White Sucker, Bullhead, and Hog-nosed Sucker were also sampled at a background location. This data is provided in Appendix H41 of NYSERDA's submittal. The average radiological concentrations of strontium and cesium in the edible portion of the fish for the two areas around Springville Dam and the background area are also provided in the dose assessment report. ICRP 68 ingestion dose coefficients and an assumed consumption rate of 9 kg/y are used to calculate dose from fish ingestion for Areas 1, 2, and 3; and 16 or 49 kg/y for the collector and hunter, respectively, for Area 4. For Area 5, NYSERDA used 0 kg/y as the fish ingestion dose coefficient based on land use survey data. Although 9 kg/y of fish are assumed to be consumed by residents and recreationalists in Areas 1, 2, and 3, land use survey data suggests that fishing is not a current land use practice in Areas 1, 2, and 3. For Area 4, NYSERDA indicates that a factor of 29 was used to increase the dose associated with consumption of fish bones for SNI (see Appendix H77 for more information). The doses associated with fish ingestion are found to be less than 0.1 mrem/y (0.001 mSv/y) for Areas 1, 2, and 3; and less than 1 mrem/y (0.01 mSv/y) for Area 4 (NYSERDA, 2016b).

Staff's Evaluation of the Licensee's Dose Assessment Submittal

Conceptual Models and Exposure Scenarios

The staff reviewed NYSERDA's dose assessment methodology and found it to be generally acceptable with exceptions noted below. NYSERDA performed dose modeling using RESRAD OFFSITE 3.1 and current land use scenarios informed by land use surveys and review of Geographic Information System (GIS) data. RESRAD OFFSITE is used to assess radiation exposures of a human receptor located on top of or at some distance from soils contaminated with radioactive materials. Details of the dose modeling are found in the dose modeling report (NYSERDA, 2016). It should be noted that NRC licensees typically perform site-specific decommissioning dose modeling using the RESRAD (onsite) code (e.g., onsite analyses are typically bounding and consistent with reasonably foreseeable future land use for unrestricted use). There is no detailed NRC guidance and a limited knowledge base specifically for complex codes like RESRAD OFFSITE from which an NRC licensee could draw from. Because of the relatively large number of site-specific parameters in the RESRAD OFFSITE code compared to the RESRAD (onsite) code, a significantly greater amount of resources are needed to support justification of RESRAD OFFSITE model parameters.

NYSERDA described and illustrated the RESRAD OFFSITE model domains for each of the exposure areas in its dose assessment report (e.g., see Figure 2 below from the submittal).

However, in some cases, the location of groundwater wells and groundwater flow direction appeared to be based on default specifications. In cases where the flow direction was based on default specifications, the distance from the downgradient edge of the contaminated zone to surface water did not appear to be correctly specified. Nonetheless, the impact of use of default parameter values and distance specifications did not have a significant impact on the results due to a general lack of importance of water dependent pathways (in many cases the external dose or direct plant ingestion pathways dominated the risk from the evaluated areas). Although land use surveys provided in Appendix D of NYSERDA's submittal alluded to the presence of groundwater wells in Areas 1 and 4, the wells in Area 1 appeared to be located up-gradient of the elevated areas (west, south, or southwest of the elevated areas) and would therefore, not impact the dose assessment. The wells in Area 4 were stated to be located "adjacent" to the sampled area and were used for field irrigation only. The groundwater well in the RESRAD OFFSITE model domain was placed between the contaminated zone and surface water with a groundwater flow direction from the contaminated zone to surface water. However, the default distances from the contaminated zone to the well and surface water were used rather than allowing RESRAD OFFSITE to calculate the distances. Based on land use surveys, no wells appear to be located in Areas 2, 3, Subareas 4.4 and 4.5; and Area 5. In Areas 2 and 3; and Subarea 4.4 and 4.5, however, a well was conservatively placed in the RESRAD OFFSITE model with the default specifications. Additionally, as recommended by the staff in the June 2016 audit (NRC, 2016), NYSERDA evaluated reasonably foreseeable future land use using the RESRAD (onsite) code for Areas 1, 2, and 3. The built-in conceptual model in RESRAD assumes that the groundwater well is located on-site and the surface water is downgradient of the contaminated zone, leading to potentially higher estimates of dose through groundwater-dependent pathways, should such doses have been potentially underestimated in the RESRAD OFFSITE calculations. Therefore, the impact of conceptual model inaccuracies was mitigated through use of a more conservative hydrological model in supplementary RESRAD calculations.

Figure 2. Example RESRAD OFFSITE Conceptual Model for Area 1

As part of its independent analysis, the staff also used GIS tools to map the areas of interest and determine current land use and other important attributes such as topography, grade, land cover, proximity to surface water/flood plains, location of residences, and other important features (see Figure 3 of this TER). The staff reviewed NYSERDA's selection of current land use scenarios and determined that the scenarios selected were reasonable. In one case (for Sub-Area 2.1), NYSERDA eliminated consideration of a resident scenario due to the steep topography. The staff confirmed that the slope of the land would not be conducive to residential construction. Although residences were located in nearby areas that had a more flat terrain, due to the steep terrain, NYSERDA's elimination of the resident scenario is reasonable.

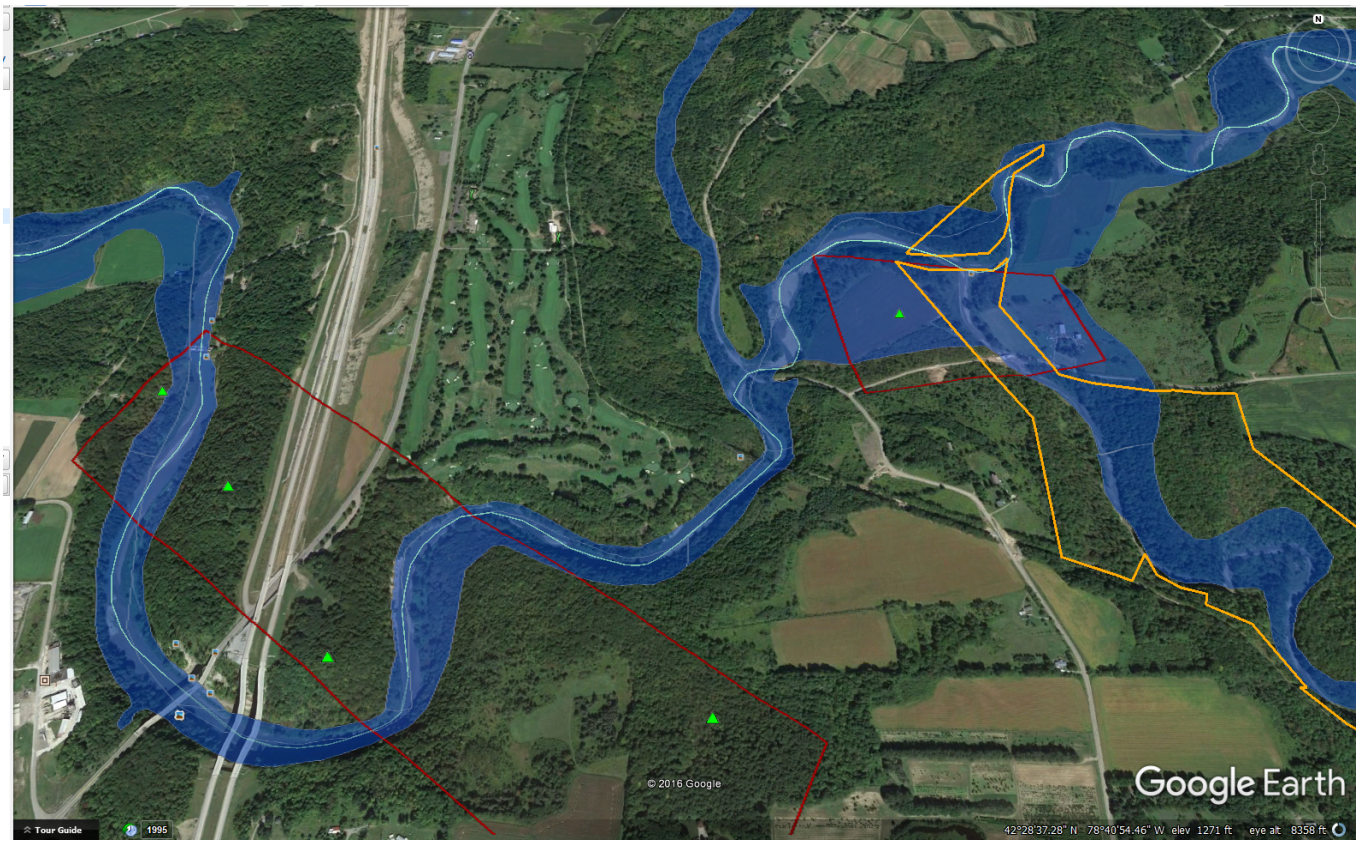


Figure 3. Example Use of Google Earth to Identify Attributes of Areas of Interest

During the June, 2016, audit (NRC, 2016), the staff recommended that NYSERDA also evaluate reasonably foreseeable exposure scenarios (in addition to exposure scenarios based on current land use) consistent with decommissioning guidance provided in NUREG-1757, Volume 2, Revision 1 (NRC, 2002). Based on the staff's recommendation, NYSERDA included evaluation of what was described as "conservative" reasonably foreseeable land use evaluation for Areas 1, 2, and 3. Areas 1 and 3, and Sub-Area 2.2 were assessed using a "Resident Farmer" scenario with livestock and crop cultivation for consumption. A hiker scenario (with hunting) was retained for Sub-Area 2.1, where the deeply sloped terrain and extremely small size were used as arguments to dismiss consideration of a resident farmer land use scenario. Based on review of the topography in Sub-Area 2.1, the staff concurs with NYSERDA's use of a "recreational hiker" exposure scenario for this area. For all scenarios and for all areas the estimated dose were less than the unrestricted use limit of 0.25 mSv/y (25 mrem/y).

For Areas 4 and 5 the collector and hunter/fisher scenarios alone are evaluated using culturally specific land use information provided by SNI[7]. Therefore, only the RESRAD OFFSITE results

[7] The staff noted that while Appendix H tables (Appendices H6 and H7) indicated that the Appendix D ingestion rates obtained from the SNI land use survey were used in the RESRAD OFFSITE simulations, closer inspection of the RESRAD OFFSITE input files revealed that for Areas 4.1-4.5 and Areas 5.1-5.6, the vegetable consumption rates appeared to be reduced by one half possibly assuming a contaminated fraction of 0.5. The staff independently evaluated NYSERDA's dose assessment using the consumption rates specified in Appendix D of the submittal (NYSERDA, 2016b) and concluded that the doses were well below the unrestricted release limit. Therefore, the reduced consumption rates do not alter the staff's conclusions.

based on the hunter/fisher scenarios is used to assess dose. In the submittal, NYSERDA indicates that SNI expects no change in the current land use for the foreseeable future. While the approach used by NYSERDA appears reasonable, for additional support NRC staff performed independent scoping calculations using RESRAD (onsite). In these calculations, the staff used the highest depth weighted average concentration for Am-241/Pu-239 and the maximum average soil interval for Cs-137 for any of the Sub-Areas 4.1 to 5.6 , the largest combined contaminated area for Sub-Areas 4.1-4.5, and the highest occupancy factors and ingestion rates from land use survey data in Appendix D of the submittal for Areas 4 and 5. All other parameters were taken from the Sub-Area 3.1 RESRAD (onsite) analysis. The estimated dose was still well below the unrestricted release limit. The staff also considered the relatively high occupancy factors and ingestion rates provided for homeowner's areas listed in Appendix D of NYSERDA's submittal and the dose was still below the unrestricted release limit. Given the conservatism of the calculation, the staff has confidence that the doses are well within the unrestricted use limits.

NYSERDA groups Sub-Areas 4.1 through 4.3 together in the same model domain (see Figure 1 of this TER); Sub-Areas 4.4 and 4.5 together; and Sub-Areas 5.1 through 5.5. However, NYSERDA does not include multiple sources in the same model domain but rather assumes that each individual source is located in the larger model domain which is absent any other sources. The staff evaluated a bounding scenario in which the sources in each of the model domains were assumed to be co-located and combined into a single, larger source using the maximum Cs-137 concentration from any soil interval within a group; and maximum, average gross alpha, and gross beta for any of the sub-areas within a group (i.e., Sub-Areas 4.1 through 4.3; Sub-Areas 4.4 and 4.5; and Sub-Areas 5.1 through 5.6 are grouped together). The total source area was assumed to overlap the model domain to efficiently evaluate (but significantly overestimate) the impact of this assumption on the results. Although the doses could be significantly higher, the doses were all significantly less than the unrestricted release limit. Therefore, the staff has confidence that any non-conservatisms in the conceptual model will not impact the conclusion regarding the low risk of the areas of offsite radioactivity.

Source Inventory/Concentrations

NYSERDA obtained random samples from each of the five areas of interest, as described in the previous section of this TER. If elevated measurements were identified during GPS gamma walkover surveys, samples were taken in the elevated areas. GPS gamma walk over surveys identified only one elevated region immediately to the southwest and down slope of Sub-Area 3.1. As a result, samples were collected from seven elevated locations, and random locations were used for 17 other locations in Area 3.1. For all other subareas, the number of random samples was based on the size of the elevated area (see information provided on page ES-1 of the submittal [NYSERDA, 2016b]). Gross alpha, gross beta, and Cs-137 measurements and Bicron tissue equivalent dose rate measurements at 1 and 100 cm were taken at each sampling location for use in dose modeling. If surface samples were two standard deviation above background, the next deeper depth increment samples were analyzed. The assessment of the gross alpha and beta dose impacts was based on what NYSERDA considered to be the most conservative isotopes (Am-241, or Pu-239 [alpha]; and Sr-90 [beta]) and was expected to

account for all of the anthropogenic nuclides of concern except C-14, I-129, and Tc-99. For these radionuclides, NYSERDA performed what was described as a qualitative analysis. In all cases for these three radionuclides, either the soil concentration was below the detection limit or the soil concentration detected was significantly less than the Revision 2 of the WVDP Phase 1 DP DCGLs (C-14, I-129, and Tc-99 DCGLs are 16, 0.33, and 21 pCi/g, respectively). Additionally, an analysis of the isotopic data indicated that the radionuclides that account for most of the gross alpha and beta soil concentrations are radionuclides that are considered naturally occurring radioactive material (e.g., natural uranium decay chain, natural thorium decay chain, and potassium-40).

NYSERDA calculates a gross alpha, gross beta, and Cs-137 weighted mean concentration for each sub-area and each soil interval (e.g., 0-15, 15-30, 30-60, and 60-100 cm). The weights are based on measurement uncertainty. In general, the weighted approach leads to lower concentrations compared to an approach where measurement uncertainty is not considered in the averaging process. NYSERDA also calculates a weighted mean concentration for the three background areas (WNYNSC, SNI floodplain, and SNI non-floodplain), which generally leads to lower background concentrations compared to an unweighted approach, although in some cases higher background concentrations are calculated. The net concentrations are calculated by subtracting the appropriate average background measurement from each average sub-area measurements for each soil interval. After the net sub-area concentrations are calculated by soil interval, a weighted mean concentration for the entire soil column is calculated using the soil interval thickness to determine the weights. The staff notes that for certain radionuclides it is more appropriate to consider individual soil intervals (e.g., top soil interval(s) for Cs-137), while in other cases averaging over the entire soil column may be acceptable if consistent with the dose modeling assumptions. Additional discussion about the thickness weighted averaging approach is provided below.

Bicron dose rate readings were also averaged using the uncertainty in the instrument to calculate the weights (NYSERDA, 2016a and NYSERDA, 2016b). Average Bicron exposure rate measurements using the weighted mean are generally lower compared to use of an unweighted mean. This is because the uncertainty in the Bicron measurements is estimated at 10 percent of the measurement, and higher exposure rate measurements, therefore, have higher measurement uncertainty and are weighted lower. The average Bicron dose rate measurements in excess of background were used to estimate dose from the external exposure pathway.

The measurement uncertainty weighted concentrations and exposure rates are generally lower than concentrations and exposure rates calculated using an unweighted approach, use of a weighted mean to calculate background concentrations or exposure rates also generally tends to err on the side of lower background concentrations and exposure rates. Thus, underestimates of the background concentrations and exposure rates help offset the underestimates in the sub-area concentrations and exposure rates when calculating the net concentration and exposure rates. Additionally, NYSERDA does not consider negative concentrations resulting from subtraction of background from the sub-area concentrations resulting in higher concentrations compared to an approach where negative concentrations are

considered in the averaging approach. In most cases, gross alpha and gross beta net concentrations are both positive and negative surrounding a value of 0 pCi/g, suggesting the gross alpha and beta concentrations may be indistinguishable from background. Parametric and non-parametric statistical t- and ANOVA tests reveal that the either there is no statistically significant difference between background and potentially impacted areas or that the background concentrations are higher for gross alpha and gross beta, while typically statistically significant differences were noted with respect to background and potentially impacted areas for Cs-137. Review of the expanded analyses also supports NYSERDA's conclusion that gross alpha and beta measurements are generally reflective of background radioactivity. The end result is that if one considers the thickness-weighted average gross alpha and beta concentrations for the entire soil column considering negative net measurements for individual soil intervals, negative concentrations for the entire soil column are typically calculated.

In the case of Cs-137, it may not be appropriate to calculate average concentrations over the entire soil column. NYSERDA collected and analyzed background samples from the top 15 cm of soil, and deeper soil intervals for most of the sub-areas. However, in Areas 1 and 2, NYSERDA divided the top 15 cm into two intervals (measurements were taken from both a 0 to 5 cm and a 5 to 15 cm increment). Therefore, NYSERDA calculated a weighted average concentration (weights based on thickness of soil interval) for the samples collected from the 0 to 5 and 5 to 15 cm intervals to match the background soil sample taken from 0 to 15 cm interval to facilitate background subtraction. For Cs-137 whose dose is dominated by the external dose pathway, the concentration at the top of the soil column is more risk significant than the concentration at depth due to attenuation of radioactivity at depth in the soil column. The approach of using a weighted average concentration leads to a lower estimate of the Cs-137 concentration in the top 0 to 5 cm interval for Sub-Areas 1.1 and 2.2. Likewise, NYSERDA calculated a thickness-weighted, average Cs-137 concentration using data for the 0-15, 15-30, 30-60, and 60-100 cm soil intervals in Areas 3, 4, and 5 leading to a lower estimate of the Cs-137 concentration in the top (0 to 15 cm) interval for Sub-Areas 3.2, 4.3, 4.5, 5.1, 5.2, 5.3, 5.4, 5.5, and 5.6. However, the potential impact of underestimation of Cs-137 concentrations at the surface was evaluated and would not cause the doses to be in excess of the unrestricted use standard found in 10 CFR 20.1402. In fact, the maximum (average) Cs-137 concentration for any soil interval and any sub-area (around 2 pCi/g) is significantly less than the DCGLs derived in Revision 2 of the WVDP Phase 1 DP of 15 pCi/g, and is also significantly less than the screening value in NUREG-1757, Volume 2, Appendix H of 11 pCi/g. In the vast majority of cases, average Cs-137 concentrations are more than an order of magnitude less than the screening level leading to doses less than 10 percent of the standard, which is considered insignificant (see NUREG-1757, Volume 2, Section 3.3 on "Insignificant Radionuclides and Exposure Pathways").

In contrast to Cs-137, dose from radionuclides such as Sr-90 and Pu-239 are dominated by plant ingestion pathways (and in the case of Pu-239 soil ingestion is also important). For these radionuclides, the average concentration in the larger sampled soil column is more appropriate to compare to the DCGLs. For example, Sr-90 dose is dominated by the plant ingestion pathway and consequently, Sr-90 dose is strongly correlated to thickness of contamination within the root zone as a greater thickness of contamination in contact with vegetation will

theoretically lead to greater root uptake, all else being equal. Because Sr-90 has a very low WVDP Phase 1 DP, Revision 2, DCGL of 4.1 pCi/g, which is a small fraction of the gross beta concentration in background, and because variability in gross beta measurements is relatively high, comparison between gross beta concentrations and the clean-up levels is problematic. Nonetheless, if the entire 1 m soil interval is averaged and compared to the DCGLs derived for the WVDP Phase 1 DP, Revision 2, a SOF less than 1 is calculated in all cases. Because there is no evidence from expanded analyses that Sr-90 (nor Am-241/Pu-239) are present in off-site areas above background (gross alpha and beta likely represent natural background radioactivity), the approach used to evaluate potential risk from the WNYNSC is expected to be overly conservative, but acceptable.

Parameter Selection

NYSERDA performed dose assessments using the RESRAD-OFFSITE 3.1 computer code. Hydrology data for the contaminated, unsaturated, and saturated zones were based on the WVDP Phase 1 DP, Revision 2 (DOE, 2009). Appendix H of the submittal (NYSERDA, 2016b) provides a listing of parameter inputs that differed from the RESRAD defaults. In cases where area specific scenarios were not deemed to be consistent with assumptions used in WVDP Phase 1 DP, Revision 2 modifications were made and described in the text and in Appendix H. These inconsistencies include exposure pathways, irrigation rates, consumption rates, erosion rates, and occupancy times. If no site-specific data or the WVDP Phase 1 DP, Revision 2 parameter input was available, the RESRAD-OFFSITE default parameters were used in the assessment.

In general, NYSERDA's selection of parameter values attempted to err on the side of higher doses and are considered conservative. In the case of meat transfer factors, NYSERDA did not use meat transfer factors specifically for deer and wild game. NYSERDA used the default transfer factors in the RESRAD (onsite) and RESRAD-OFFSITE codes which are for beef. If other types of meat are considered, such as deer and wild game, the default meat transfer factors in RESRAD could be adjusted or the uncertainty in transfer factors considered if no data are available in the literature. However, given the low risk significance of the meat ingestion pathway to the dose results, the uncertainty in the meat transfer factors is not expected to have a significant impact on the results. In the case of fish consumption, NYSERDA did consider ingestion of bones that concentrate Sr-90 for the hunter/fisher scenario evaluated for Areas 4 and 5 resulting in a dose 29 times higher than the dose if consumption of only what is considered the "edible" portions of fish is assumed (see Appendix H77 [NYSERDA, 2016b] for more information). The staff notes that NYSERDA may have adjusted the "dry" concentration of Sr-90 and Cs-137 in fish reported in DOE's 2012 ASER (DOE, 2013) to a "wet" concentration. The RESRAD-OFFSITE model uses "dry" concentration rather than "wet" concentrations (erring on the side of a higher "wet" concentration) for the purposes of calculating the fish ingestion dose. This is expected to over-predict the fish ingestion dose based on sampling data. While NYSERDA's conversion to "wet" concentration may have overestimated the concentrations, NYSERDA also used a weighted average based on uncertainty, which may tend to underestimate the concentration as discussed above. Considering both the use of the wet concentration and the potential underestimation based on the weighted average approach, NYSERDA's calculated fish concentrations is expected to be overestimated due to the

conversion to wet weight. With respect to the pedigree of the data, DOE collects fish samples every 5 years. The next sampling year is 2017 with the data being reported sometime in 2018. Because NYSERDA used the most recent fish sampling data available in 2012, NYSERDA's approach is reasonable.

In some cases, no data was readily available to support parameter selection and default parameters were used. In these cases, the parameter selections may lead to over- or under-estimates in dose. However, NYSERDA's use of reasonably foreseeable future land use using the conceptual model in RESRAD helped to mitigate parameter uncertainty with conservative dose modeling assumptions (e.g., consideration of onsite well, consideration of plant and animal ingestion pathways, etc.) for Areas 1, 2, and 3. In the case of Areas 4 and 5, it is unclear if SNI's survey input intended to bound reasonably foreseeable future land use. While the collector/hunter scenarios may not bound reasonably foreseeable future land use, it is not expected that other uses of the land would lead to significantly higher doses above the unrestricted use standard based on the relatively low levels of radioactivity found on SNI land, due to the significant safety margin in the current analysis, and based on the relatively high occupancy factors and ingestion rates considered in the staff's independent scoping calculations.

Evaluation of Results

Table 3 shows that for all dose assessment methods, NYSERDA calculates doses that are significantly below the unrestricted release standard. In some very limited cases, the staff calculated a higher soil concentration (e.g., top 0 to 5 or 0 to 15 cm, Cs-137 soil interval and a handful of measurements for gross alpha and gross beta), which could impact the dose modeling results. The impact of potentially underestimating concentrations for use in the dose modeling was evaluated by the staff and did not significantly impact the conclusions of the analysis. The staff's evaluation of conceptual model and exposure scenario uncertainty discussed above (and using the staff's calculated concentrations) also provides confidence that the areas can meet unrestricted release criteria.

Table 3. NYSERDA Maximum Sub-Area Dose Results for Areas 1, 2, 3, 4 and 5 (mrem/y)

Method	**Aerial[8]**	**Bicron**	**OFFSITE**	**ONSITE**	**FISH**
Method Type	External Dose Measurement	External Dose Measurement	Dose Modeling	Dose Modeling	Biota Sampling
Area 1	0.0	8.0	1.0	1.7	<0.1
Area 2	0.1	0.4	5E-03	0.13	<0.1
Area 3	1.8	3.9	0.8	7.3	<0.1
Area 4	3.7	1.9 (11.9*)	0.57	NA	0.6
Area 5	1.3	4.6 (8.5*)	0.1	NA	NA

*Uses maximum soil sample concentration and assumes receptor spends all of his time (e.g., performs all activities) in that single "hot spot" location.

[8] 2014 Aerial Radiological Survey Report (DOE, NYSERDA, 2015b)

Evaluation of potential dose based on exposure rates extracted from the 2014 Aerial Radiological Survey (DOE, NYSERDA, 2015b) results and tissue equivalent dose rate survey meter data provides additional confirmation that the doses will be below unrestricted release standards (see Table 3). Evaluation of this data also helps assess uncertainty in the source inventory calculations that are based on a limited number of measurements. Considering NYSERDA's assumptions regarding occupancy factors for applicable scenarios in each of the areas, a measured net exposure rate of (i) 7.2 µrem/h for a resident homemaker scenario for Area 1[9], (ii) 250 µrem/h for a light recreational scenario for Area 2[10], (iii) 5.5 µrem/h for a resident farmer scenario for Area 3[11], and (iv) 6.4 µrem/h for a hunter for Sub-Areas 4.1 through 4.3[12] would equate to the unrestricted release limit of 25 mrem/y (0.25 mSv/y) from external radiation exposure. NYSERDA's assumptions regarding the exposure scenarios and associated occupancy factors appeared to be reasonable to the staff. In all cases, the exposure rates measured in Areas 1, 2, 3, 4 and 5 are less than the specified exposure rates, and the calculated dose from the external radiation exposure pathway is significantly less than 25 mrem/y (0.25 mSv/y).

It is important to note that in most cases the predicted doses are less than 10 percent of the unrestricted use dose limit or 2.5 mrem/y (0.025 mSv/y). For example, based on several different dose estimation methods, the dose from Area 2 was less than 10 percent of the unrestricted release limit in all cases. NYSERDA's RESRAD OFFSITE dose modeling results revealed doses less than 2.5 mrem/y (0.025 mSv/y) for all areas. The staff considers pathways and radionuclides that contribute less than 10 percent of the release standard to be insignificant. Detailed modeling is typically unnecessary for insignificant radionuclides and exposure pathways (see Section 3.3 in NUREG-1757, Volume 2, Revision 1).

Finally, NUREG-1757, Volume 2, Revision 1 (NRC, 2006) provides a list of screening values in Appendix H (see Table D2). It is important to note that the Cs-137 screening value of 11 pCi/g was never exceeded in Areas 1, 2, 3, 4 and 5 for any single measurement. Although the screening values assume only surficial residual radioactivity (approximately top 0 to 15 cm), for Cs-137, deeper soil radioactivity is attenuated and a greater thickness of residual radioactivity (greater than 15 cm) will have negligible effect on the screening value.

As discussed above gross alpha and gross beta appear to be reflective of background rather than residual radioactivity, and use of the Pu-239 and Am-241 screening values to represent gross alpha above background, and the Sr-90 screening value to represent gross beta above background is expected to be overly conservative, because these radionuclides were not actually detected in expanded analysis. Additionally, the use of the Sr-90 screening value in Area 2 (Sr-90 dominates the sum of fractions) is expected to be very conservative, because the

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[9] NYSERDA assumed that 83 percent of the homemaker's time was spent indoors with a gamma shielding factor of 0.273, and 17 percent of the homemaker's time was spent outdoors with a shielding factor of 1.
[10] NYSERDA assumed the recreational user spent effectively 100 h/y in the area.
[11] NYSERDA assumed the resident farmer spent 66% of their time indoors with a gamma shielding factor of 0.273 applied, and 34% of their time outdoors with a shielding factor of 1.
[12] NYSERDA assumed the hunter/fisher spent 3925 h outdoors in Sub-Areas 4.1 to 4.3 (less than was spent outdoors in other Sub-Areas in Areas 4 and 5.

recreational hiker exposure scenario was selected given the small area and steep terrain. If the plant ingestion pathway associated with the resident farmer scenario were eliminated for Sr-90, the screening value for Sr-90 would be substantially higher.

In summary, the staff's conclusion is consistent with NYSERDA's conclusion that the expected risk from off-site residual radioactivity in Areas 1 through 5 is low, and the dose assessment provides further support that there is no public health and safety concern in the areas evaluated. The resulting dose in each area of interest sampled is expected to be less than unrestricted use limits found in 10 CFR 20.1402. The staff's conclusion is based on review of NYSERDA's submittal and the staff's own independent calculations and analysis.

Uncertainty Analysis

A formal uncertainty analysis was not performed and is not required given the low risk significance of the elevated areas of residual radioactivity. Screening values could be used with limited justification to release the areas with no restrictions consistent with NRC's regulations in 10 CFR 20.1402. In cases where screening values are used, no formal uncertainty analysis is needed. Additionally, NYSERDA's exhaustive evaluation of potential dose to members of the public based on multiple methods provides confidence that uncertainty in dose predictions has been adequately managed.

Special Request Samples

NYSERDA included in its submittal SNI special request samples that it collected and analyzed that were outside the scope the areas of interest identified from the 2014 Aerial Radiological Report (DOE, NYSERDA 2015b) and NYSERDA's sampling and dose assessment plan (NYSERDA, 2015). These samples were taken on the property of 3 homeowners and in two areas of land, referred to as reaches, near Lake Erie. The staff also evaluated the data. The evaluation is found in Appendix C of this TER.

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Appendix A, Licensee's Reported Survey Results

Background Summary Data As Reported by Licensee

Table A-1. Western New York Nuclear Service Center Background Direct Radiation Measurements

Survey Method	Background Determination (Range)	Screening Criteria (Background (Bkg) + 2 sigma)
Bicron µrem/h measurements	3.69 ± 0.12 µrem/h at 1 m elevation	3.93 µrem/h
2" x 2" NaI Static Count Measurements	6333 cpm on average at 1m elevation (6146 to 6781 cpm)	n/a

Table A-2. Western New York Nuclear Service Center Background Soil Concentrations

Depth (cm)	Alpha* (pCi/g)	Beta* (pCi/g)	Cesium-137* (pCi/g)
0-15	1.2E+01 ± 5.6E-01	2.3E+01 ± 4.9E-01	2.9E-01 ± 1.3E-02
15-30	1.1E+01 ± 5.3E-01	2.0E+01 ± 4.5E-01	1.1E-01 ± 1.0E-02
30-60	1.4E+01 ± 1.2E+00	2.4E+01 ± 1.0E+00	0.0E-00 ± 1.7E-02
60-100	1.4E+01 ± 1.2E+00	2.8E+01 ± 1.1E+00	1.1E-01 ± 1.9E-02

*Uncertainty is reported ± 1 sigma

Table A-3. SNI Floodplain Background Direct Radiation Measurements

Survey Method	Background Determination (Range)	Screening Criteria (Bkg + 2 sigma)
Bicron µrem/h measurements	4.96 ± 0.22 µrem/h at 1 m elevation	5.41 µrem/h
2" x 2" NaI Static Count Measurements	7943 cpm on average at 1 m elevation (6512 to 8864 cpm)	n/a

Table A-4. SNI Floodplain Background Soil Concentrations

Depth (cm)	Alpha* (pCi/g)	Beta* (pCi/g)	Cesium-137* (pCi/g)
0-15	1.5E+01 ± 8.9E-01	2.2E+01 ± 7.3E-01	7.8E-02 ± 1.2E-02
15-30	1.4E+01 ± 7.0E-01	2.5E+01 ± 6.2E-01	7.5E-02 ± 1.4E-02
30-60	1.5E+01 ± 8.7E-01	2.4E+01 ± 7.5E-01	3.5E-02 ± 1.3E-02
60-100	1.5E+01 ± 2.0E+00	2.2E+01 ± 1.5E+00	-3.0E-03 ± 2.0E-02

*Uncertainty is reported ± 1 sigma

Table A-5. SNI Non-Floodplain Background Direct Radiation Measurements

Survey Method	Background Determination (Range)	Screening Criteria (Bkg + 2 sigma)
Bicron µrem/h measurements	4.40 ± 0.21 µrem/h at 1 m elevation	4.81 µrem/h
2" x 2" NaI Static Count Measurements	8745 cpm on average at 1 m elevation (7022 to 12,270 cpm)	n/a

Table A-6. SNI Non-Floodplain Background Soil Concentrations

Depth (cm)	Alpha* (pCi/g)	Beta* (pCi/g)	Cesium-137* (pCi/g)
0-15	1.3E+01 ± 7.8E-01	2.0E+01 ± 6.2E-01	1.6E-01 ± 1.9E-02
15-30	1.4E+01 ± 7.7E-01	2.6E+01 ± 6.9E-01	9.4E-02 ± 1.3E-02
30-60	1.3E+01 ± 7.7E-01	2.6E+01 ± 7.1E-01	1.3E-02 ± 1.5E-02
60-100	2.2E+00 ± 1.8E+00	3.7E+01 ± 1.5E+00	1.0E-03 ± 1.3E-02

*Uncertainty is reported ± 1 sigma

Survey Area Summary Data as Reported by Licensee

Table A-7. Area 1 Weighted Average Soil Gross Concentrations

Location	Depth (cm)	Gross Alpha[a] (pCi/g)	Gross Beta[a] (pCi/g)	Cesium-137[a] (pCi/g)
1.1/1.2(L12[b])	0-15	8.6E+00 ± 7.9E-01	1.9E+01 ± 7.7E-01	1.1E+00 ± 4.1E-02
1.3(L23[c])	0-15	1.0E+01 ± 1.3E+00	2.3E+01 ± 1.2E+00	4.6E-01 ± 5.6E-02

a. Uncertainty is reported ± 1 sigma.
b. Locations 1.1 and 1.2 were combined and compared to the sample collected at the location associated with the L12 described in the D&M, 1995. "Western New York Nuclear Service Center Off-site Radiation Investigation, Volume 1: Summary Report," Dames and Moore (D&M), December 1, 1995.
c. Location 1.3 was compared to the sample collected at the location associated with the L23 described in the 1995 Report.

Table A-8. Area 2 Direct Measurement Summary Results

Sub-Area	Survey Method	Gross Results – Average (Avg) (Range)	Applicable Bkg
2.1	**Bicron µrem/h measurements**	7.8 µrem/h (7 to 9 µRem/h)	3.69 µrem/h
	2" x 2" NaI Static Count Measurements	9736 cpm (9426 to 10,117 cpm)	6333 cpm
2.2	**Bicron µrem/h measurements**	4 µrem/h (3 to 5 µRem/h)	3.69 µrem/h
	2" x 2" NaI Static Count Measurements	5917 cpm (5690 to 6052 cpm)	6333 cpm

Table A-9. Area 2 Weighted Average Soil Gross Concentrations

Sub-Area	Depth (cm)	Gross Alpha[a] (pCi/g)	Gross Beta[a] (pCi/g)	Cesium-137[a] (pCi/g)
2.1	**0-15**	1.0E+01 ± 9.4E-01	2.4E+01 ± 7.1E-01	4.8E-01 ± 3.2E-02
2.2	**0-15**	9.8E+00 ± 1.2E+00	1.8E+01 ± 1.1E-00	7.3E-01 ± 4.4E-02
	15-100	1.3E+01 ± 1.0E+00	1.8E+01 ± 6.7E-01	0.0E-00 ± 2.2E-02

a. Uncertainty is reported ± 1 sigma.

Table A-10. Area 3 Direct Measurement Summary Results

Sub-Area	Survey Method	Gross Results – Avg (Range)	Applicable Bkg
3.1	**Bicron µrem/h measurements**	7.55 ± 0.16 µrem/h	3.69 µrem/h
	2" x 2" NaI Static Count Measurements	9939 cpm (8360 to 10980 cpm)	6333 cpm
3.2	**Bicron µrem/h measurements**	4.11 ± 0.21 µrem/h	3.69 µrem/h
	2" x 2" NaI Static Count Measurements	7760 cpm (7074 to 7760 cpm)	6333 cpm

Table A-11. Area 3 Average Soil Gross Concentrations

Sub-Area	Depth (cm)	Gross Alpha[a] (pCi/g)	Gross Beta[a] (pCi/g)	Cesium-137[a] (pCi/g)
3.1	0-15	1.3E+01 ± 2.9E-01	2.2E+01 ± 2.5E-01	1.1E+00 ± 1.3E-02
	15-30	1.4E+01 ± 3.5E-01	2.4E+01 ± 2.8E-01	1.4E+00 ± 1.5E-02
	30-60	1.6E+01 ± 1.1E+00	2.3E+01 ± 7.7E-01	2.2E+00 ± 8.7E-02
	60-100	1.4E+01 ± 5.3E-01	2.3E+01 ± 4.5E-01	2.5E-01 ± 2.1E-02
3.2	0-15	1.3E+01 ± 9.9E-01	1.9E+01 ± 8.2E-01	5.5E-01 ± 2.4E-02
	15-30*			
	30-60	1.2E+01 ± 1.8E+00	1.9E+01 ± 1.6E+00	1.3E-01 ± 4.2E-02
	60-100	7.8E+00 ± 1.6E+00	2.2E+01 ± 1.6E+00	8.1E-02 ± 2.6E-02

a. Uncertainty is reported ± 1 sigma.
* No samples analyzed for this depth interval

Table A-12. Area 4 Direct Measurement Summary Results

Sub-Area	Survey Method	Gross Results – Avg (Range)	Applicable Bkg
4.1	**Bicron µrem/h measurements**	5.6 ± 0.1 µrem/h	4.96 µrem/h
	2” x 2” NaI Static Count Measurements	9030 cpm (7871 to 10299 cpm)	7943 cpm
4.2	**Bicron µrem/h measurements**	4.9 ± 0.1 µrem/h	4.96 µrem/h
	2” x 2” NaI Static Count Measurements	8740 cpm (7723 to 10383 cpm)	7943 cpm
4.3	**Bicron µrem/h measurements**	4.4 ± 0.1 µrem/h	4.96 µrem/h
	2” x 2” NaI Static Count Measurements	7966 cpm (7225 to 9804 cpm)	7943 cpm
4.4	**Bicron µRem/h measurements**	4.5 ± 0.1 µrem/h	4.96 µrem/h
	2” x 2” NaI Static Count Measurements	7799 cpm (7130 to 9210 cpm)	7943 cpm
4.5	**Bicron µrem/h measurements**	4.5 ± 0.1 µrem/h	4.96 µrem/h
	2” x 2” NaI Static Count Measurements	8205 cpm (7263 to 9367 cpm)	7943 cpm

Table A-13. Area 4 Weighted Average Soil Gross Concentrations

Sub-Area	Depth (cm)	Gross Alpha[a] (pCi/g)	Gross Beta[a] (pCi/g)	Cesium-137[a] (pCi/g)
4.1	0-15	1.5E+01 ± 4.2E-01	2.0E+01 ± 3.2E-01	7.8E-01 ± 1.2E-02
	15-30	1.5E+01 ± 4.0E-01	2.4E+01 ± 3.1E-01	8.3E-01 ± 1.2E-02
	30-60	1.5E+01 ± 7.1E-01	2.1E+01 ± 5.0E-01	2.7E-01 ± 1.7E-02
	60-100	1.3E+01 ± 7.4E-01	2.3E+01 ± 5.5E-01	7.3E-02 ± 1.2E-02
4.2	0-15	1.5E+01 ± 4.1E-01	2.4E+01 ± 3.2E-01	1.1E+00 ± 1.2E-02
	15-30	1.5E+01 ± 4.1E-01	2.4E+01 ± 3.1E-01	1.6E+00 ± 1.6E-02
	30-60	1.2E+01 ± 7.3E-01	1.9E+01 ± 5.3E-01	2.3E-01 ± 1.4E-02
	60-100	1.4E+01 ± 7.8E-01	2.0E+01 ± 5.5E-01	3.9E-02 ± 1.1E-02
4.3	0-15	1.5E+01 ± 4.0E-01	2.3E+01 ± 3.1E-01	9.0E-01 ± 1.3E-02
	15-30	1.3E+01 ± 3.7E-01	2.2E+01 ± 3.1E-01	6.3E-01 ± 1.0E-02
	30-60	1.4E+01 ± 6.5E-01	1.7E+01 ± 4.2E-01	1.7E-01 ± 1.5E-02
	60-100	1.2E+01 ± 7.9E-01	1.9E+01 ± 6.0E-01	6.9E-02 ± 1.1E-02
4.4	0-15	1.3E+01 ± 4.9E-01	2.1E+01 ± 3.9E-01	5.2E-01 ± 1.2E-02
	15-30	1.4E+01 ± 5.1E-01	2.1E+01 ± 3.9E-01	6.7E-01 ± 1.4E-02
	30-60	1.2E+01 ± 8.9E-01	1.7E+01 ± 6.4E-01	1.4E-01 ± 1.8E-02
	60-100	1.1E+01 ± 9.5E-01	1.8E+01 ± 6.8E-01	1.4E-01 ± 1.0E-02
4.5	0-15	1.4E+01 ± 3.6E-01	2.3E+01 ± 3.0E-01	6.9E-01 ± 1.0E-02
	15-30	1.5E+01 ± 3.9E-01	2.5E+01 ± 3.2E-01	4.7E-01 ± 1.0E-02
	30-60	1.7E+01 ± 8.5E-01	2.2E+01 ± 5.7E-01	1.1E-01 ± 1.2E-02
	60-100	1.7E+01 ± 8.1E-01	2.0E+01 ± 5.5E-01	3.0E-02 ± 9.0E-03

a. Uncertainty is reported ± 1 sigma.

Table A-14. Area 5 Direct Measurement Summary of Results

Sub-Area	Survey Method	Gross Results – Avg (Range)	Applicable Bkg
5.1	**Bicron µrem/h measurements**	6.2 ± 0.3 µrem/h	4.40 µrem/h
	2” x 2” NaI Static Count Measurements	6295 cpm (6108 to 6464 cpm)	8745 cpm
5.2	**Bicron µrem/h measurements**	4.6 ± 0.1 µrem/h	4.40 µrem/h
	2” x 2” NaI Static Count Measurements	7266 cpm (6348 to 8984 cpm)	8745 cpm
5.3	**Bicron µrem/h measurements**	4.7 ± 0.2 µrem/h	4.40 µrem/h
	2” x 2” NaI Static Count Measurements	7499 cpm (6839 to 8614 cpm)	8745 cpm
5.4	**Bicron µrem/h measurements**	5.0 ± 0.3 µRem/h	4.40 µRem/h
	2” x 2” NaI Static Count Measurements	5992 cpm (5878 to 6126 cpm)	8745 cpm
5.5	**Bicron µrem/h measurements**	5.5 ± 0.3 µrem/h	4.40 µrem/h
	2” x 2” NaI Static Count Measurements	6288 cpm (5933 to 7211 cpm)	8745 cpm
5.6	**Bicron µrem/h measurements**	4.5 ± 0.2 µrem/h	4.40 µrem/h
	2” x 2” NaI Static Count Measurements	6408 cpm (5724 to 7525 cpm)	8745 cpm

Table A-15. Area 5 Weighted Average Soil Gross Concentrations

Sub-Area	Depth (cm)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Cesium-137 (pCi/g)
5.1	0-15	9.3E+00 ± 6.8E-01	1.7E+01 ± 6.5E-01	4.0E-01 ± 2.3E-02
	15-30	1.5E+01 ± 1.0E+00	2.2E+01 ± 8.2E-01	4.0E-02 ± 1.0E-02
	30-60	1.7E+01 ± 1.8E+00	2.3E+01 ± 1.3E+00	9.4E-02 ± 2.2E-02
	60-100	7.0E+00 ± 8.0E-01	1.6E+01 ± 7.4E-01	-3.0E-02 ± 1.7E-02
5.2	0-15	9.1E+00 ± 3.9E-01	1.4E+01 ± 3.4E-01	4.4E-01 ± 1.2E-02
	15-30	1.2E+01 ± 4.4E-01	2.2E+01 ± 3.7E-01	6.0E-02 ± 7.0E-03
	30-60	1.1E+01 ± 6.2E-01	2.0E+01 ± 5.4E-01	5.2E-02 ± 1.1E-02
	60-100	2.0E+01 ± 1.2E+00	2.5E+01 ± 8.0E-01	5.0E-03 ± 8.0E-03
5.3	0-15	9.0E+00 ± 7.0E-01	2.1E+01 ± 6.9E-01	6.2E-01 ± 2.6E-02
	15-30	1.2E+01 ± 8.0E-01	1.7E+01 ± 6.5E-01	5.7E-01 ± 1.1E-02
	30-60	1.5E+01 ± 1.9E+00	1.9E+01 ± 1.2E+00	4.0E-03 ± 1.6E-02
	60-100	1.0E+01 ± 9.9E-01	1.9E+01 ± 9.3E-01	-1.6E-02 ± 1.6E-02
5.4	0-15	9.9E+00 ± 8.4E-01	1.8E+01 ± 7.2E-01	4.5E-01 ± 2.5E-02
	15-30	1.1E+01 ± 8.2E-01	1.5E+01 ± 6.5E-01	1.0E-02 ± 1.2E-02
	30-60	9.5E+00 ± 2.1E+00	1.8E+01 ± 1.9E+00	3.0E-03 ± 1.3E-02
	60-100	1.3E+01 ± 2.0E+00	1.7E+01 ± 1.5E+00	0.0E+00 ± 1.5E-02
5.5	0-15	1.0E+01 ± 8.6E-01	1.6E+01 ± 8.0E-01	5.1E-01 ± 2.1E-02
	15-30	7.9E+00 ± 7.4E-01	1.4E+01 ± 6.8E-01	1.3E-02 ± 9.0E-03
	30-60	1.7E+01 ± 2.9E+00	1.7E+01 ± 1.8E+00	-9.0E-03 ± 1.4E-02
	60-100	9.1E+00 ± 1.8E+00	1.8E+01 ± 1.6E+00	1.0E-03 ± 1.8E-02
5.6	0-15	6.8E+00 ± 7.4E-01	1.6E+01 ± 7.2E-01	6.6E-01 ± 2.3E-02
	15-30	8.2E+00 ± 7.5E-01	1.6E+01 ± 7.0E-01	7.4E-02 ± 1.6E-02
	30-60*			
	60-100	4.8E+00 ± 1.4E+00	1.4E+01 ± 1.5E-01	5.0E-03 ± 1.9E-02

*No samples analyzed for this depth interval.
Uncertainty is reported as ±1 sigma.

Appendix B, Summary of Data Calculated and Evaluated by U.S. Nuclear Regulatory Commission Based on the Submittal

Table B-1. Western New York Nuclear Service Center Average Soil Background Concentrations

Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137 (pCi/g)
0-15	14 ± 5	23 ± 4	0.3 ± 0.1
15-30	12 ± 4	20 ± 3	0.1 ± 0.1
30-60	14 ± 3	25 ± 5	0.01 ± 0.01
60-100	15 ± 6	29 ± 9	0.1 ± 0.1

Table B-2. Floodplain (Area 4 Applicable) Average Soil Background Concentrations

Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137 (pCi/g)
0-15	13 ± 3	22 ± 3	0.07 ± 0.05
15-30	13 ± 3	21 ± 10	0.09 ± 0.20
30-60	16 ± 4	24 ± 5	0.03 ± 0.08
60-100*	15	22	0.00

Table B-3. Non-Floodplain (Area 5 Applicable) Average Soil Background Concentrations

Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137 (pCi/g)
0-15	13 ± 3	18 ± 8	0.23 ± 0.16
15-30	14 ± 4	25 ± 5	0.10 ± 0.07
30-60	16 ± 7	28 ± 9	0.01 ± 0.01
60-100*	22	37	0.00

Table B-4. Staff's Summary of Exposure Rates

Area/Sub-Area	Average Gross Bkg Exposure Rate (µrem/h)**	Average Gross Exposure Rate (µrem/h)	Net Avg Exposure Rate* (µrem/h)
1 (includes all sub areas)	3.8 ± 0.4	5.0 ± 1.0	1.2
2.1		7.8 ± 1.0	4
2.2		4.0 ± 0.8	0.2
3.1		8.3 ± 1.7	4.5
3.2		4.8 ± 1.3	1
4.1	5.2 ± 0.8	5.9 ± 0.9	0.7
4.2		5.2 ± 1.0	0
4.3		5.1 ± 1.3	0
4.4		4.9 ± 1.0	0
4.5		4.9 ± 1.0	0
5.1	6.0 ± 3.9	6.5 ± 0.9	0.5
5.2		4.8 ± 0.7	0
5.3		4.8 ± 0.4	0
5.4		5.3 ± 0.8	0
5.5		5.8 ± 0.8	0
5.6		4.8 ± 0.8	0

*Negative net exposure rates were reported as zero.
**The background count rate calculated for Areas 1, 2, and 3 by NYSERDA is 3.7 µrem/h. For Areas 4 and 5, the background calculated by NYSERDA was 4.96 and 4.40 µrem/h, respectively. The discrepancy is due to the weighted averaging method used by NYSERDA in determining the average background.

Table B-5. Area 1 (all Sub-Areas) Average Gross Soil Concentrations of Radionuclides

Depth (cm)	**Alpha (pCi/g)**	**Beta (pCi/g)**	**Cesium-137* (pCi/g)**
0-5	9 ± 3	25 ± 1	2.2 ± 1.6
5-15	9 ± 2	18 ± 3	0.3 ± 0.2

Table B-6. Area 2 Average Gross Soil Concentrations of Radionuclides

Sub-Area	Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137 (pCi/g)
2.1	**0-5**	11 ± 2	25 ± 7	0.5 ± 0.3
	5-15	12 ± 5	25 ± 3	0.6 ± 0.4
2.2	**0-5**	12 ± 4	25 ± 6	1.7 ± 0.4
	5-15	9 ± 2	14 ± 4	0.3 ± 0.1
	15-100	13	18	0.0

Note: Only one sample was analyzed from the 15-100 cm depth interval and reported values are not an average.

Table B-7. Area 3 Average Gross Soil Concentrations of Radionuclides

Sub-Area	Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137* (pCi/g)
3.1	**0-15**	13 ± 3	22 ± 4	1.1 ± 0.3
	15-30	14 ± 4	24 ± 4	1.6 ± 0.6
	30-60	16	23	2.2
	60-100	14 ± 1	24 ± 3	0.4 ± 0.3
3.2	**0-15**	13 ± 2	19 ± 3	0.5 ± 0.1
	15-30			
	30-60	12	19	0.1
	60-100	8	22	0.1

Note: No analysis of samples for depth interval 15-30 cm in Sub-Area 3.2 occurred and only one sample was analyzed from depth interval 30-60 cm in Sub-Area 3.1 and in the lower two depth intervals of Sub-Area 3.2 reported values are not averages.

Table B-8. Area 4 Average Gross Soil Concentrations of Radionuclides

Sub-Area	Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137* (pCi/g)
4.1	**0-15**	15 ± 4	24 ± 9	1.0 ± 0.6
	15-30	15 ± 4	24 ± 3	1.2 ± 1.1
	30-60	18 ± 8	21 ± 4	0.5 ± 0.6
	60-100	13 ± 2	22 ± 2	0.2 ± 0.2
4.2	**0-15**	15 ± 3	24 ± 4	1.3 ± 0.7
	15-30	16 ± 3	25 ± 9	2.3 ± 1.4
	30-60	13 ± 4	19 ± 4	0.5 ± 0.4
	60-100	14 ± 3	21 ± 3	0.1 ± 0.1
4.3	**0-15**	15 ± 4	24 ± 4	1.1 ± 0.6
	15-30	13 ± 3	23 ± 4	1.0 ± 0.9
	30-60	13 ± 5	23 ± 12	0.5 ± 0.9
	60-100	14 ± 4	20 ± 4	0.2 ± 0.3
4.4	**0-15**	13 ± 3	22 ± 3	0.6 ± 0.4
	15-30	18 ± 19	22 ± 3	0.9 ± 0.6
	30-60	12 ± 4	18 ± 4	0.1 ± 0.1
	60-100	12 ± 4	19 ± 2	0.02 ± 0.03
4.5	**0-15**	14 ± 3	24 ± 4	0.8 ± 0.4
	15-30	15 ± 4	25 ± 4	0.7 ± 0.5
	30-60	19 ± 5	22 ± 1	0.2 ± 0.2
	60-100	17 ± 2	20 ± 3	0.1 ± 0.1

Table B-9. Area 5 Average Gross Soil Concentrations of Radionuclides

Sub-Area	Depth (cm)	Alpha (pCi/g)	Beta (pCi/g)	Cesium-137* (pCi/g)
5.1	**0-15**	11 ± 2	18 ± 3	0.4 ± 0.1
	15-30	18 ± 8	25 ± 10	0.05 ± 0.02
	30-60*	17	23	0.09
	60-100*	7	16	-0.03
5.2	**0-15**	9 ± 2	16 ± 6	0.5 ± 0.2
	15-30	14 ± 6	23 ± 7	0.1 ± 0.1
	30-60	18 ± 13	23 ± 11	0.06 ± 0.04
	60-100	21 ± 4	26 ± 5	0.00 ± 0.01
5.3	**0-15**	9 ± 2	22 ± 2	0.62 ± 0.04
	15-30	12 ± 4	17 ± 2	0.1 ± 0.1
	30-60*	15	19	0.00
	60-100*	10	19	-0.02
5.4	**0-15**	10 ± 2	18 ± 1	0.5 ± 0.1
	15-30	11 ± 3	15 ± 1	0.02 ± 0.04
	30-60*	9	18	0.00
	60-100*	13	17	0.00
5.5	**0-15**	10 ± 2	16 ± 1	0.5 ± 0.1
	15-30	8 ± 2	14 ± 2	0.01 ± 0.01
	30-60*	17	17	-0.01
	60-100*	9	18	0.00
5.6	**0-15**	7 ± 2	20 ± 15	0.8 ± 0.3
	15-30	9 ± 4	16 ± 3	0.1 ± 0.1
	30-60*	31	35	0.01
	60-100*	5	14	0.00

* Only one sample analyzed at this depth interval. Reported values are not averages.

Table B-10. Staff's Determinations of Net Soil Concentrations Compared to NYSERDA's Net Soil Concentrations

Net Average Soil Concentrations (Average Minus Average Background) +									
		average Net (top, pCi/g)*		average Net (near top, pCi/g)*		average Net (near bottom, pCi/g)*		average Net (bottom, pCi/g)*	
Area/Sub-Area		NRC	NYSERDA	NRC	NYSERDA	NRC	NYSERDA	NRC	NYSERDA
1 0-5cm, 5-15cm	alpha	-4.1	-3.4	-4.5	-3.3				
	beta	1.9	2.5	-5.8	-5.3				
	Cs-137	1.9	1.8	0.0	0.0				
2.1 0-5cm, 5-15cm	alpha	-2.5	-1.6	-1.9	-2.4				
	beta	1.8	1.1	1.8	1.4				
	Cs-137	0.2	0.2	0.3	0.2				
2.2 0-5cm, 5-15cm, 15-100cm	Alpha	-1.8	-2.0	-5.0	-4.0	0.2	1.1		
	Beta	1.3	0.7	-9.5	-9.4	-2.0	-1.8		
	Cs-137	1.4	1.4	0.0	0.0	-0.1	0.0		
3.1 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-0.7	0.2	**1.4**	**2.3**	2.1	2.4	-1.3	-0.7
	Beta	-1.5	-0.6	**3.6**	**3.8**	-2.0	-1.1	-5.3	-4.9
	Cs-137	0.8	0.8	**1.4**	**1.3**	2.2	2.2	0.3	0.1
3.2 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-0.3	0.5			-2.8	-2.4	-7.4	-6.6
	Beta	-4.4	-3.7			-5.8	-4.9	-6.8	-6.1
	Cs-137	0.2	0.3			0.1	0.1	0.0	0.0
4.1 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	2.2	0.1	2.8	1.1	2.4	-0.1	-1.4	-1.4
	Beta	1.8	-2.0	2.8	-0.9	-2.8	-3.8	0.5	0.7
	Cs-137	0.9	0.7	1.1	0.8	0.5	0.2	0.2	0.1
4.2 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	2.1	0.4	**3.2**	1.8	-2.5	-3.4	-0.4	-1.0
	Beta	2.2	1.5	**4.2**	-0.9	-4.7	-5.7	-1.5	-1.8
	Cs-137	1.3	1.0	**2.2**	1.5	0.4	0.2	0.1	0.0
4.3 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	2.2	0.3	0.8	-1.0	-3.0	-1.4	-1.1	-2.3
	Beta	1.8	1.0	1.4	-2.6	-0.6	-7.4	-2.1	-2.7
	Cs-137	1.0	0.8	0.9	0.6	0.5	0.1	0.2	0.1
4.4 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	0.4	-1.2	5.3	0.5	-3.6	-3.8	-2.7	-3.5
	Beta	-0.1	-0.8	0.5	-3.4	-6.1	-7.2	-3.5	-3.7
	Cs-137	0.6	0.4	0.8	0.6	0.1	0.1	0.0	0.0
4.5 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	0.9	-0.1	**2.8**	1.0	2.9	2.0	2.4	2.0
	Beta	1.5	1.1	**3.7**	0.0	-1.8	-2.4	-1.8	-1.8
	Cs-137	0.7	0.6	**0.6**	0.4	0.1	0.1	0.1	0.0
5.1	alpha	-1.7	-3.5	3.8	0.9	1.6	4.8	-14.9	-14.9

0-15cm, 15-30cm, 30-60cm, 60-100cm	Beta	-0.6	-3.2	-0.2	-3.5	-5.5	-3.5	-21.2	-21.2
	Cs-137	0.2	0.2	-0.1	-0.1	0.1	0.1	0.0	0.0
5.2 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-3.3	-3.7	-0.4	-1.9	1.9	-1.3	-1.0	-2.3
	Beta	-2.0	-5.6	-2.4	-3.6	-5.3	-6.5	-10.5	-11.9
	Cs-137	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
5.3 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-3.6	-3.8	-2.2	-2.6	-0.7	2.5	-11.9	-11.9
	Beta	3.3	1.5	-7.7	-8.5	-9.4	-7.4	-18.2	-18.2
	Cs-137	0.4	0.5	0.0	0.0	0.0	0.0	0.0	-0.02
5.4 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-2.5	-2.9	-3.2	-3.0	-6.3	-3.1	-8.6	-8.6
	Beta	-0.3	-2.1	-9.7	-10.5	-10.0	-8.0	-20.1	-20.1
	Cs-137	0.3	0.3	-0.1	-0.1	0.0	0.0	0.0	0.0
5.5 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-2.4	-2.6	-6.4	-6.3	1.5	4.7	-12.9	-12.9
	Beta	-1.8	-3.5	-11.1	-11.8	-11.1	-9.1	-18.3	-18.3
	Cs-137	0.3	0.4	-0.1	-0.1	0.0	0.0	0.0	0.0
5.6 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-5.7	-6.0	-5.2	-5.9	**15.0**		-17.1	-17.1
	beta	1.7	-3.9	-9.1	-9.5	**7.1**		-23.1	-23.1
	Cs-137	0.5	0.5	-0.1	0.0	**0.0**		0.0	0

Note: Net values in **bold** result in a sum of fraction above one.
+ West Valley Demonstration Project, Phase 1 DP, Revision 2, criteria established for alpha = Pu-239 (25 pCi/g), beta = Sr-90 (4.1 pCi/g), and Cs-137 (15 pCi/g).
* For areas 1 and 2, the “top,” “near top,” and “near bottom” depth intervals coincide with 0-5cm, 5-15cm, and 15-100cm, respectively. For Areas 3, 4, and 5, the “top,” “near top,” “near bottom,” and “bottom” depth intervals coincide with 0-15cm, 15-30cm, 30-60cm, and 60-100cm, respectively.
Negative net concentrations did not contribute to the SOF determinations.
NRC staff derived net average depth interval concentrations for NYSERDA from concentrations reported in Appendix H2 of the submittal.

Net Average Soil Concentrations (Average Minus Average Background) +									
		average Net (top, pCi/g)*		average Net (near top, pCi/g)*		average Net (near bottom, pCi/g)*		average Net (bottom, pCi/g)*	
Area/Sub-Area		NRC	NYSERDA	NRC	NYSERDA	NRC	NYSERDA	NRC	NYSERDA
1 0-5cm, 5-15cm	alpha	-4.1	-3.4	-4.5	-3.3				
	beta	1.9	2.5	-5.8	-5.3				
	Cs-137	1.9	1.8	0.0	0.0				
2.1	alpha	-2.5	-1.6	-1.9	-2.4				

0-5cm, 5-15cm	beta	1.8	1.1	1.8	1.4				
	Cs-137	0.2	0.2	0.3	0.2				
2.2	Alpha	-1.8	-2.0	-5.0	-4.0	0.2	1.1		
0-5cm, 5-15cm, 15-100cm	Beta	1.3	0.7	-9.5	-9.4	-2.0	-1.8		
	Cs-137	1.4	1.4	0.0	0.0	-0.1	0.0		
3.1	alpha	-0.7	0.2	**1.4**	**2.3**	2.1	2.4	-1.3	-0.7
0-15cm, 15-30cm,	Beta	-1.5	-0.6	**3.6**	**3.8**	-2.0	-1.1	-5.3	-4.9
30-60cm, 60-100cm	Cs-137	0.8	0.8	**1.4**	**1.3**	2.2	2.2	0.3	0.1
3.2	alpha	-0.3	0.5			-2.8	-2.4	-7.4	-6.6
0-15cm, 15-30cm,	Beta	-4.4	-3.7			-5.8	-4.9	-6.8	-6.1
30-60cm, 60-100cm	Cs-137	0.2	0.3			0.1	0.1	0.0	0.0
4.1	alpha	2.2	0.1	2.8	1.1	2.4	-0.1	-1.4	-1.4
0-15cm, 15-30cm,	Beta	1.8	-2.0	2.8	-0.9	-2.8	-3.8	0.5	0.7
30-60cm, 60-100cm	Cs-137	0.9	0.7	1.1	0.8	0.5	0.2	0.2	0.1
4.2	alpha	2.1	0.4	**3.2**	1.8	-2.5	-3.4	-0.4	-1.0
0-15cm, 15-30cm,	Beta	2.2	1.5	**4.2**	-0.9	-4.7	-5.7	-1.5	-1.8
30-60cm, 60-100cm	Cs-137	1.3	1.0	**2.2**	1.5	0.4	0.2	0.1	0.0
4.3	alpha	2.2	0.3	0.8	-1.0	-3.0	-1.4	-1.1	-2.3
0-15cm, 15-30cm,	Beta	1.8	1.0	1.4	-2.6	-0.6	-7.4	-2.1	-2.7
30-60cm, 60-100cm	Cs-137	1.0	0.8	0.9	0.6	0.5	0.1	0.2	0.1
4.4	alpha	0.4	-1.2	5.3	0.5	-3.6	-3.8	-2.7	-3.5
0-15cm, 15-30cm,	Beta	-0.1	-0.8	0.5	-3.4	-6.1	-7.2	-3.5	-3.7
30-60cm, 60-100cm	Cs-137	0.6	0.4	0.8	0.6	0.1	0.1	0.0	0.0
4.5	alpha	0.9	-0.1	**2.8**	1.0	2.9	2.0	2.4	2.0
0-15cm, 15-30cm,	Beta	1.5	1.1	**3.7**	0.0	-1.8	-2.4	-1.8	-1.8
30-60cm, 60-100cm	Cs-137	0.7	0.6	**0.6**	0.4	0.1	0.1	0.1	0.0
5.1	alpha	-1.7	-3.5	3.8	0.9	1.6	4.8	-14.9	-14.9
0-15cm, 15-30cm,	Beta	-0.6	-3.2	-0.2	-3.5	-5.5	-3.5	-21.2	-21.2
30-60cm, 60-100cm	Cs-137	0.2	0.2	-0.1	-0.1	0.1	0.1	0.0	0.0
5.2	alpha	-3.3	-3.7	-0.4	-1.9	1.9	-1.3	-1.0	-2.3
0-15cm, 15-30cm,	Beta	-2.0	-5.6	-2.4	-3.6	-5.3	-6.5	-10.5	-11.9
30-60cm, 60-100cm	Cs-137	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
5.3	alpha	-3.6	-3.8	-2.2	-2.6	-0.7	2.5	-11.9	-11.9
0-15cm, 15-30cm,	Beta	3.3	1.5	-7.7	-8.5	-9.4	-7.4	-18.2	-18.2
30-60cm, 60-100cm	Cs-137	0.4	0.5	0.0	0.0	0.0	0.0	0.0	-0.02
	alpha	-2.5	-2.9	-3.2	-3.0	-6.3	-3.1	-8.6	-8.6
5.4	Beta	-0.3	-2.1	-9.7	-10.5	-10.0	-8.0	-20.1	-20.1

0-15cm, 15-30cm, 30-60cm, 60-100cm	Cs-137	0.3	0.3	-0.1	-0.1	0.0	0.0	0.0	0.0
5.5 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-2.4	-2.6	-6.4	-6.3	1.5	4.7	-12.9	-12.9
	Beta	-1.8	-3.5	-11.1	-11.8	-11.1	-9.1	-18.3	-18.3
	Cs-137	0.3	0.4	-0.1	-0.1	0.0	0.0	0.0	0.0
5.6 0-15cm, 15-30cm, 30-60cm, 60-100cm	alpha	-5.7	-6.0	-5.2	-5.9	**15.0**		-17.1	-17.1
	beta	1.7	-3.9	-9.1	-9.5	**7.1**		-23.1	-23.1
	Cs-137	0.5	0.5	-0.1	0.0	**0.0**		0.0	0

Note: Net values in **bold** result in a sum of fraction above one.
+ West Valley Demonstration Project, Phase 1 DP, Revision 2, criteria established for alpha = Pu-239 (25 pCi/g), beta = Sr-90 (4.1 pCi/g), and Cs-137 (15 pCi/g).
* For areas 1 and 2, the “top,” “near top,” and “near bottom” depth intervals coincide with 0-5cm, 5-15cm, and 15-100cm, respectively. For Areas 3, 4, and 5, the “top,” “near top,” “near bottom,” and “bottom” depth intervals coincide with 0-15cm, 15-30cm, 30-60cm, and 60-100cm, respectively.
Negative net concentrations did not contribute to the SOF determinations.
NRC staff derived net average depth interval concentrations for NYSERDA from concentrations reported in Appendix H2 of the submittal.

Appendix C, Special Request Samples Taken by the Licensee

Home Owner and Reach Data Review

The staff also reviewed the data for Homeowners 3, 4, and 5 as well as Reaches 7 and 21 (areas of land near Lake Erie) available in Appendix H2 of the submittal (NYSERDA, 2016b). Because of the limited data obtained for each of these areas, the staff visually compared each data set to the background data sets for SNI flood plain and non-flood plain as well as the background data set for WNYNSC (see box and whisker charts in Figures C-1 through C-3 of this TER). Based on this visual comparison of the data sets, the staff was able to conclude that the Homeowner and Reach gross alpha and gross beta data do not demonstrate a significant exceedance of background. In all cases the upper ranges are bounded by the background data sets and the medians of the background data sets are either higher or very similar to the medians of the Homeowner and Reach data sets. Some of the Homeowner and Reach Cs-137 data do appear slightly elevated relative to background, especially the data collected for Homeowner 5. However, even though the Cs-137 concentration is elevated, the concentration remain significantly below the soil screening levels established for a 25 mrem/y (0.25 mSv/y) exposure and therefore do not constitute a safety hazard to the public.

As an additional check, the staff also performed statistical analysis (ANOVA and t-test) comparing SNI background data to the compiled set of data for Homeowners 3, 4, and 5; and Reaches 7 and 21 (insufficient data was available to perform statistical analyses for individual locations as there were only a few data points for each location). For this test, the non-flood plain and flood plain background data were also combined, because data for only 5 sample locations each were available for the non-flood plain and flood plain background locations. Use of both background data sets was deemed reasonable because ANOVA tests comparing the non-flood plain and flood plain background data showed that the two SNI background areas are not statistically different. The results of the statistical analyses comparing SNI background to potentially impacted areas showed that Cs-137 is statistically above background (using a significance level of 0.05) in the potentially impacted homeowner and reach locations. On the other hand, gross alpha in background and potentially impacted areas are not statistically different. While gross beta in background and potentially impacted areas are statistically different, the mean background concentration is actually higher than the mean potentially impacted area concentration. Therefore, only Cs-137 is statistically higher in potentially impacted areas compared to background. Because Cs-137 concentrations in potentially impacted areas are an order of magnitude below the screening value of 11 pCi/g for a resident farmer scenario published in NUREG-1757, Volume 2, Appendix H, the risk associated with Cs-137 above background in Homeowners 3, 4, and 5 locations; and Reaches 7 and 21 are expected to be low.

This is somewhat supported by the tissue equivalent dose rate readings provided in Appendix H64 of the submittal (NYSERDA, 2016b). With the exception of Reach 21, the gross readings reported for each area were less than the applicable background readings. The net Reach 21 reading (2.6 µrem/h) was significantly below 6.5 µrem/h, which would equate to 25 mrem/y

(0.25 mSv/y) based on the assumed occupancy rate of 3835[13] h/y outdoors (see Appendix H64) for Reach 21.

Although the assumed occupancy rates are significantly higher for the Homeowners 3, 4, 5 than they are for the hunter/fisher scenario evaluated for Areas 4 and 5 (Appendix D of the submittal [NYSERDA, 2016b]) values of 6665 h/y for Homeowners (page 18) and 3925h/y for Area 4 hunter/fisher (page 17), respectively, the Bicron tissue equivalent survey meter readings for homeowner locations are below background. Therefore, an external dose above background of zero is calculated for the Homeowners 3, 4, and 5 based on the Bicron survey meter results.

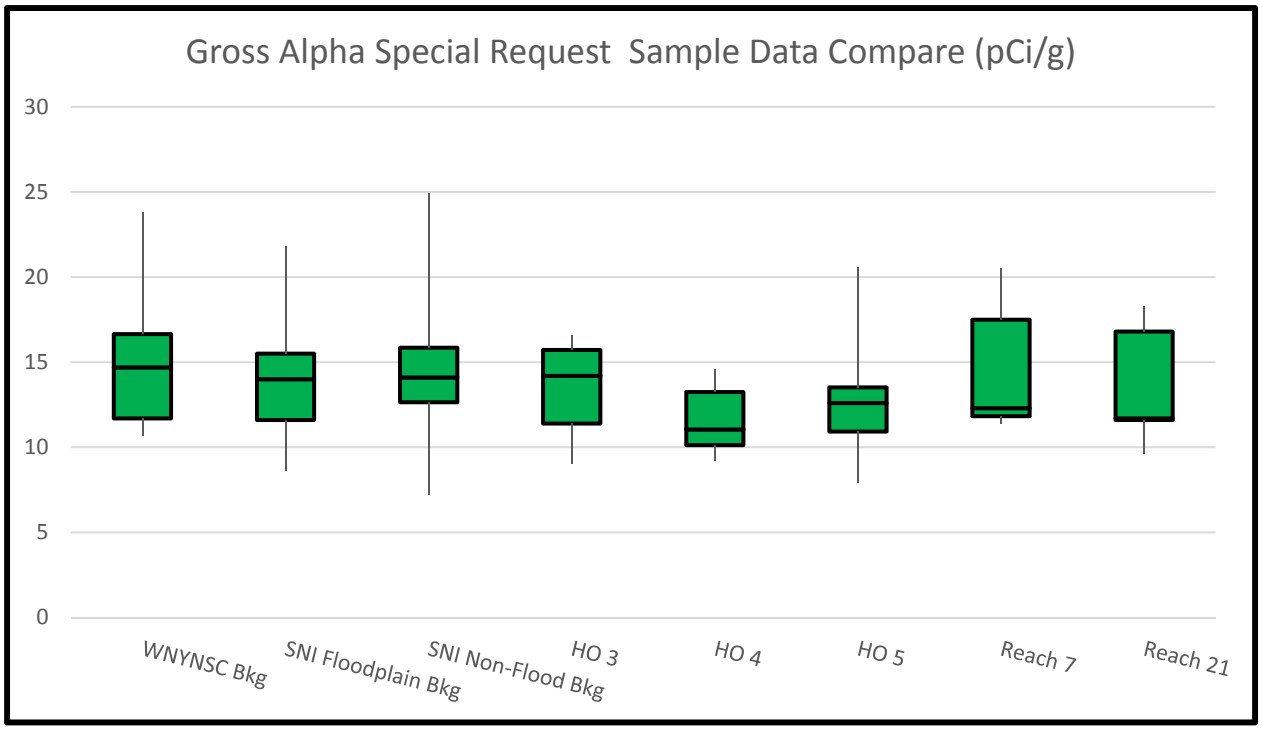

Figure C-1, Box and Whisker Plots Special Request Sample Comparisons (Gross Alpha)

[13] Note that NYSERDA adjusted the occupancy rate down to 3073 h/y for the hunter/fisher as explained in a footnote to Table 14 of Appendix H64. For conservatism, the staff calculated the exposure rate leading to an external dose of 0.25 mSv/y based on an assumed occupancy of 3835 h/y, the higher occupancy rate found in Appendix D (page 18) of the submittal (NYSERDA, 2016b).

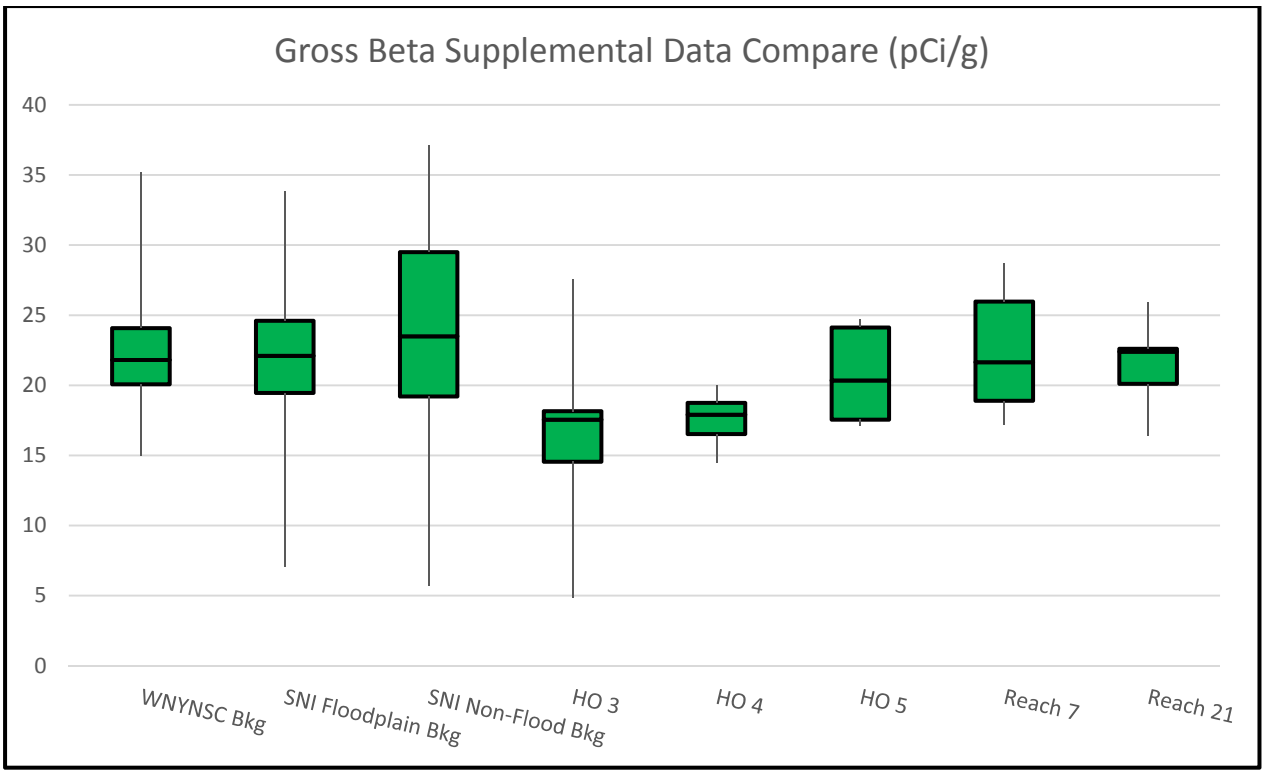

Figure C-2, Box and Whisker Plots Special Request Sample Comparisons (Gross Beta)

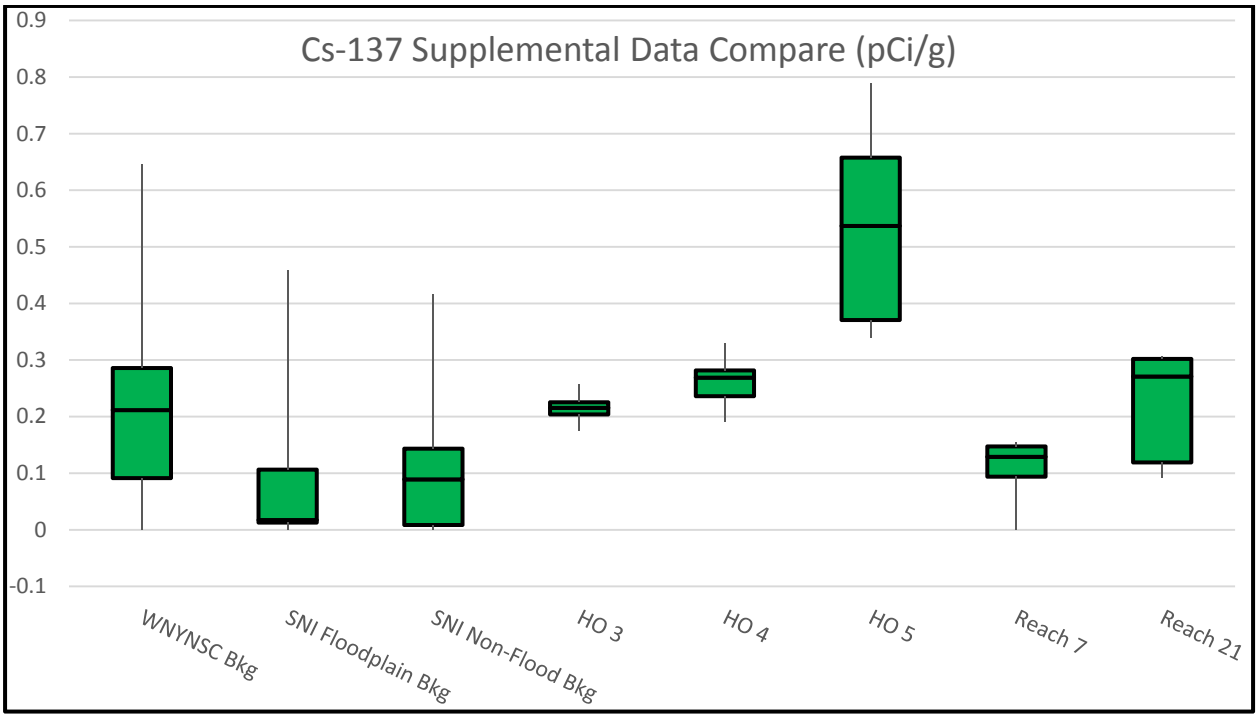

Figure C-3, Box and Whisker Plots Special Request Sample Comparisons (Cs-137)

Note: For Figures C-1 through C-3, the whiskers (vertical lines) indicate the range of data. The box indicates the 25th to 75th percentile range of the data, and the median (or 50th percentile) of the data is indicated by the line within the box. The data sets for the home owners and reaches consist of only six data points or less.