# Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report (FINAL)

**Brookhaven National Laboratory**
**Upton, New York**

**December 2010**

**Prepared for:**
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**Building No. 460**
**Upton, NY 11973**
**Prime Contract No. DE-AC02-98CH10886**

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# Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report

## A) PURPOSE:

The purpose of this addendum to the *Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (PWGC, April 2010) is to document the cleanup of a section of the proposed Long Island Solar Farm (LISF) Project area, located to the southeast of the former Hazardous Waste Management Facility (FHWMF) and adjacent to the previously remediated FHWMF Perimeter Area at Brookhaven National Laboratory (BNL). This area is designated Phase II. Remedial activities were performed in accordance with *Closeout Procedures at National Priority List Sites, OSWER Directive 9320.2-09A-P* (EPA, 2000a) and include:

- The excavation of contaminated soil above site cleanup goals;
- The completion of a final status survey (FSS) and sampling, including Oak Ridge Institute for Science and Education (ORISE) independent verification survey (IVS) and sampling ;
- The post closure dose assessment in accordance with the Residual Radioactivity Computer Code (RESRAD);
- The characterization, transportation and disposal of excavated soil at Energy Solutions Disposal Facility of Clive, Utah; and
- The implementation of institutional controls.

Remedial activities were performed by BNL's Environmental Protection Division (EPD), EPD seconded task order subcontractors and the BNL Radiological Control Division (RCD). Independent verification radiological surveys and sampling were performed by ORISE.

Work was performed in accordance with the Operable Unit (OU) I Record of Decision (ROD) and the *Final Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* (June, 2009). The FSS was performed in accordance with the *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, October 2010).

The U.S. Department of Energy (DOE) will maintain institutional controls for the subject area in accordance with Section 7.0 of this Completion Report. These institutional controls include the following:

- No soils may be removed from the area without release through BNL RCD.
- All disturbed soils will remain within the area from which they were disturbed.
- The area will be added to the BNL Land Use and Institutional Control Plan, as well as to the BNL website and BNL maps for tracking of the administrative controls.

## B) AREA DESCRIPTION AND BACKGROUND:

The section of the LISF Project area addressed by this addendum consists of an 11-acre, partially wooded parcel southeast of the FHWMF. As shown on Figure 1, approximately 9 acres are located south of Brookhaven Avenue and approximately 2 acres are located immediately north of Brookhaven Avenue. In total, the LISF Project will encompass approximately 200 acres of BNL land. The land will be used for the construction and operation of two large-scale commercial solar photovoltaic arrays totaling approximately 37 MW, and potentially a smaller research array of 1-2 MW with an associated support building.

Photograph 1 – LISF Project area, view to northeast.

The FHWMF Perimeter Area was partially characterized and remediated in 2009. Eleven discrete areas and an 18,750 $ft^2$ contiguous area of radiological soil contamination were remediated to meet OU I cleanup goals as specified by the *Final Record of Decision for Area of Concern 31 High Flux Beam Reactor* (BNL, February 2009) (HFBR ROD). This work, referred to as the FHWMF Perimeter Area Project,

was performed as a non-time-critical removal action authorized by the *Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* and is documented by the *Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (PWGC, April 2010). Additional discrete areas of elevated radioactivity that were considered to be outside of the scope of this effort, now known as Phase I, were detected in 2009. As described below, the additional discrete areas that were located within the 11-acre parcel of the LISF Project area were further characterized and remediated by the EPD in support of authorizing construction of the LISF Project. These discrete areas are collectively known as Phase II. Discrete areas of soil contamination that are outside of the LISF Project area will be addressed during future remedial efforts, referred to as Phase III.

## C) CHARACTERIZATION AND REMEDIAL ACTIVITIES

Between November 24th and December 8th, 2009, EPD directed BNL Radiological Controls Technicians (RCTs) to perform radiological surveys in the vicinity of the discrete areas of elevated radiological activity that were outside of the scope of the FHWMF Perimeter Area Project, southeast of the FHWMF. These walkover surveys were performed with an unshielded 2" by 2" NaI scintillation detector (Eberline Model SSPA 3) coupled to a count rate meter (Ludlum Model 2221). The initial boundary of this scoping survey was established based on process knowledge of the area and past investigation results, the direction of prevailing wind direction in relationship to the location of the FHWMF, and the location of existing roads. The primary purpose of this phase of characterization was to establish a boundary between the region southeast of the FHWMF where detectable radioactivity was at or below typical background levels (i.e. no further action required) and the region where a more comprehensive radiological walkover survey would be performed. Locations where radiological survey results were greater than 21,500 gross counts per minute (cpm), as per Appendix B of the *Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, August 2009), were identified with landscaping flags and surveyed with a global positioning system device (GPS).

As shown on Figure 1, the scoping survey was successful in establishing a boundary between regions with discrete areas having count rates above 21,500 CPM (orange shaded area) and regions further north, south and east where no elevated areas above background were identified (light blue shaded area). The 11-acre parcel proposed as part of the LISF Project is outside but adjacent to the high concentration of discrete areas (gray shaded area).

A total of nine discrete areas of elevated radiological activity (20, 21, 22, 26, 27, 30, 31, 32, and 37) were identified within the 11-acre parcel addressed by this addendum during the initial phase of characterization. Six of these discrete areas (20, 21, 22, 26, 27, and 30) were determined to be naturally occurring radioactive material (rocks). The remaining three discrete areas of elevated radiological activity (31, 32 and 37)

were remediated by removing small volumes of contaminated soil. The radiological walkover survey results for discrete areas of elevated radiological activity are summarized in Table 1.

A second phase of characterization, performed from March 19th to May 6th, 2010, included a more formal radiological walkover survey within the 11-acre parcel. The survey area was divided into 100' by 100' grids using a tape measure, spray paint and traffic cones. BNL's Facilities and Operations personnel cleared fallen trees and other low-lying brush with heavy equipment to facilitate a more thorough survey within each grid. As in the first phase of characterization, walkover radiological surveys were performed with an unshielded 2" by 2" NaI scintillation detector (Eberline Model SSPA 3) coupled to a count rate meter (Ludlum Model 2221).

A total of four additional discrete areas of elevated radiological activity (greater than 21,500 cpm) were identified within the 11-acre parcel during the second phase of characterization. All four discrete areas (40, 41, 42, and 43) were remediated by removing a small volume of contaminated soil. Location 43 was later determined to be outside of the LISF Project area and was therefore removed from the scope of this project. The remaining locations are shown on Figure 1 and the associated survey results are summarized in Table 1.

A third phase of characterization, as described in detail in Section D, was performed in accordance with the *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, October 2010) in September 2010. The purpose of the additional characterization was to confirm the results of the previous characterization and remedial efforts. An additional twelve discrete areas of elevated radiological activity (greater than 21,500 cpm) were identified within the 11-acre parcel. The majority of the additional twelve discrete areas (83-94) were either along the LISF Project area boundaries or within the 2 acres located immediately north of Brookhaven Avenue, where vegetation had not been sufficiently cleared during earlier characterization efforts. The twelve additional discrete areas of elevated radiological activity were remediated by removing a small volume of soil with either hand tools or a backhoe. These locations are shown on Figure 1 and the associated survey results are summarized in Table 1.

Photograph 2 – Remediation of discrete area of elevated radiological activity within the LISF area.

## D) FINAL STATUS SURVEY

After completion of remediation of small discrete areas of contamination, walkover surveys were performed and soil samples were collected and analyzed in accordance with Section D of the *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, October 2010), as specified below.

The primary radionuclides of concern, based on exposure potential, were Cs-137, Sr-90, and Ra-226. Although less likely to be present, certain other radionuclides were evaluated, including gamma emitters (e.g. Co-60, Eu-152, Eu-154), tritium, uranium isotopes, and plutonium isotopes. The chemical contaminants of concern were mercury and lead.

### Final Status Survey Design

As discussed in Section C, small discrete areas of contamination were remediated and surveyed in accordance with the *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, October 2010). In addition to radiological surveys following the removal of each discrete area of contamination, a set of grids was established, with each grid measuring approximately 100’ by 100’. The grid arrangement and locations of discrete areas of radiological contamination are shown on Figure 1.

For discrete areas of radiological contamination, a 100% gamma walkover scan was performed for the excavated area and for a radius of 10 feet beyond the edge of the excavated area. In addition, a one minute fixed point reading was taken near the center of

the excavated area. A sample was collected near the center of the excavated area and analyzed by gamma spectroscopy at GEL Laboratories of Charleston, South Carolina (GEL). Three composite samples were collected and analyzed for Sr-90, uranium isotopes, plutonium isotopes, tritium, and for chemical contaminants (mercury and lead). Samples from discrete areas 31, 32, 37, 40, 41, and 42 were composited into sample C1. Samples from discrete areas 83 - 90 were composited into sample C2. Samples from discrete areas 91 - 94 were composited into sample C3. Composite soil samples were submitted to GEL for analysis.

For the gridded areas, a gamma walkover scan (at least 50% coverage) was performed for each grid. One sample per grid was collected and analyzed by gamma spectroscopy at GEL. For every 5 grids, a sample from each grid was composited, and the composite samples were analyzed for Sr-90, uranium isotopes, plutonium isotopes, tritium, and for chemical contaminants (mercury and lead) at GEL.

The gamma scans were performed using a GPS-based gamma scintillation detector (2" by 2" Sodium Iodide) in conjunction with a Ludlum Model 2221 scaler/ratemeters and a with the PRO XR Satellite Receiver Trimble model TSCe Data Logger. Soil samples were collected in accordance with BNL EM standard operating procedures.

**Final Status Survey and Sampling Results**

The results of the final status radiological walkover survey for the discrete areas exhibit count rates below 21,500 cpm for all discrete areas, as shown in Figure 2. As specified in Appendix B of the *Field Sampling Plan for the Former HWMF Perimeter Area* (BNL, August 2009), the 21,500 cpm count rate was determined to approximate a Cs-137 concentration of 15 pCi/g in soil when using the unshielded NaI gamma scintillation detector.

In addition, individual 1-minute fixed-count measurements were taken with the NaI probe at each of the fixed sample points. The results ranged from 11,000 to 17,000 cpm. A total of 18 soil samples and 3 composite samples were collected for the discrete areas and all results were below site cleanup criteria. FSS soil sample results are provided in Appendix A.

For the gridded areas, the final status radiological walkover survey gamma walkover survey also exhibited count rates below 21,500 cpm at all locations, as shown on Figure 3. A total of 48 soil samples and 10 composite samples were collected from the gridded areas and all results were below site cleanup criteria. FSS soil sample results are provided in Appendix A.

In order to determine an average value for use in post remediation dose assessment, all the soil sample data were averaged, with results shown in Table 2.

Chemical results for soil samples analyzed for mercury and lead indicated that residual

soil concentrations for these contaminants are within their respective cleanup goals. Chemical results are provided in Appendix A and the soil sample results for chemical contaminants are summarized in Table 3.

**Post Remediation Dose Assessment**

A dose assessment was conducted to evaluate radiological dose impacts from the remaining residual radioactive materials using RESRAD, Version 6.5 (ANL, 2001). The average concentration for each radionuclide was used as input to the model in order to determine the projected dose.

As anticipated, Ra-226 was not detected above cleanup goals during these characterization efforts; however, it is included in the dose assessment as it is specified as a radionuclide of concern in the OU I ROD. The cleanup value of 5 pCi/g was selected for Ra-226 based on DOE Order 5400.5, Radiation Protection of the Environment and the Public. The average Ra-226 background concentration on BNL property had previously been established at approximately 0.56 pCi/g (CDM, 1996). Therefore, the average Ra-226 value of 0.69 pCi/g from the FHWMF Perimeter Area is consistent with typical background levels. When performing the post-remediation dose assessment using RESRAD, the background subtracted Ra-226 value of 0.13 pCi/g is used (0.69-0.56). In addition, the value of 0.69 pCi/g Ra-226 was also calculated as a conservative comparison.

The RESRAD model was run with "no background subtract" (Ra-226 = 0.69 pCi/g) and with "full background subtract" (Ra-226 = 0.13 pCi/g). Cs-137 was detected at an average concentration of 2.44 pCi/g, and U-238 was detected in one composite sample at a concentration of 1.2 pCi/g. No other radionuclides of BNL origin were detected.

One radiological dose scenario was evaluated, considering the radiation dose to a current industrial worker (no decay), because the site will be for industrial use. The parameters and pathways used in this dose assessment for the subject parcel of the LISF Project area are shown in the RESRAD summary reports (Appendix B).

The results of the dose assessment indicate that the maximum projected dose to an industrial worker in Year 0 is 1.9 mrem/yr, which is below the dose objective of 15 mrem/year. The results also indicate that the NYSDEC TAGM 4003 guideline of 10 mrem/yr would be met under the scenarios described above. If background was not subtracted for Ra-226 (use 0.0.69 pCi/g without background subtract), then the industrial dose would be 3.1 mrem/yr.

**Final Status Survey Conclusions**

As indicated above, results of the FSS following the completion of spot remediation within the subject parcel of the LISF Project area demonstrates conformance to the site cleanup goals established for the project.

**Final Status Survey Independent Verification**

The IVS of the subject parcel of the LISF Project area was performed by an ORISE survey team from September 25th through October 1st, 2010. ORISE collected soil samples and had them analyzed for Cs-137, Ra-226, and Sr-90. The average results, along with a comparison to BNL's average results, are presented in Table 4.

ORISE reported that the a majority of the scan results for the survey area were not distinguishable from background; and the elevated areas detected during the IVS were investigated and determined to meet the established release criteria. The results from soil sample analysis were less than 25% of respective cleanup goals for the radionuclides of concern. Verification survey activities validated BNL's classifications, radiological status and satisfaction of the guidelines.

The results of the IVS are documented in the *Independent Verification Survey Report for the Long Island Solar Farm, Brookhaven National Laboratory, Upton, New York* (5119-SR-01-0, ORISE, November 2010), provided in Appendix C.


Photograph 3 – ORISE initiating independent verification survey activities.

## E) WASTE MANAGEMENT

The waste management strategy, waste characterization, packaging, handling, and storage were performed in accordance with BNL Subject Base Management System (SBMS) waste management procedures. A total of approximately 12.5 cubic yards of excavated

soil contaminated above cleanup goals, classified as low-level radioactive waste (LLRW), were placed in either B-12 or B-25 shipping containers.

Photograph 4 – B-25 shipping container containing waste soil prior to shipment to Energy Solutions of Utah.

Waste verification sampling for disposal was performed in accordance with the *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, October 2010). Samples were analyzed by GEL for comparison to Energy Solution's waste acceptance criteria (WAC). Waste verification samples were analyzed for Strontium-90, Uranium-235/238, Plutonium-238/239/240/241, Tritium, Polychlorinated Biphenyls, Pesticides/Herbicides, Full Recoverable Metals, Volatile Organic Compounds, Semi-Volatile Organic Compounds, Gamma Spectroscopy and Full TCLP. According to waste characterization results, the waste shipped met the WAC of Energy Solutions of Clive, Utah. Waste verification results were submitted to BNL's Waste Management Division.

One B-12 shipping container and one B-25 shipping container were shipped on September 28, 2010 via truck to Energy Solutions Disposal Facility of Clive, Utah for final disposal. Waste shipment services were provided by Hittman Transport Services. An additional two B-25 shipping containers holding project generated LLRW soil were staged at BNL's Waste Management Facility for shipment.

Waste minimization and pollution prevention methods employed during characterization and remedial activities included excavation in as small a lift as possible to minimize excavation of soil below cleanup goals and judicious use of consumables (e.g., PPE).

## F) SUMMARY OF PROJECT COSTS

The characterization and remediation of soils within the subject section of the LISF Project area cost approximately $240,000 to complete. The clean-up costs included the following details:

| | |
|---|---|
| Engineering and planning | $ 10,000 |
| Characterization and Remediation | $ 180,000 |
| Waste Transportation & Disposal | $ 25,000 |
| ORISE IVS | $ 25,000 |
| Total Cost | $ 240,000 |

## G) LESSONS LEARNED

The following is a summary of the lessons learned from this project and the corrective actions for future projects:

- The hydraulic fluid filter housing on the excavator used during remedial activities was damaged by an upturned tree root. A skid plate was installed on the bottom of the excavator to prevent future damage.
- Workers were required to take BNL Tick Training, and the presence of ticks and the associated hazards were discussed during daily tailgate safety meetings. As a result, workers were well prepared for the high potential of encountering ticks during characterization and remedial activities and associated incidences were avoided.

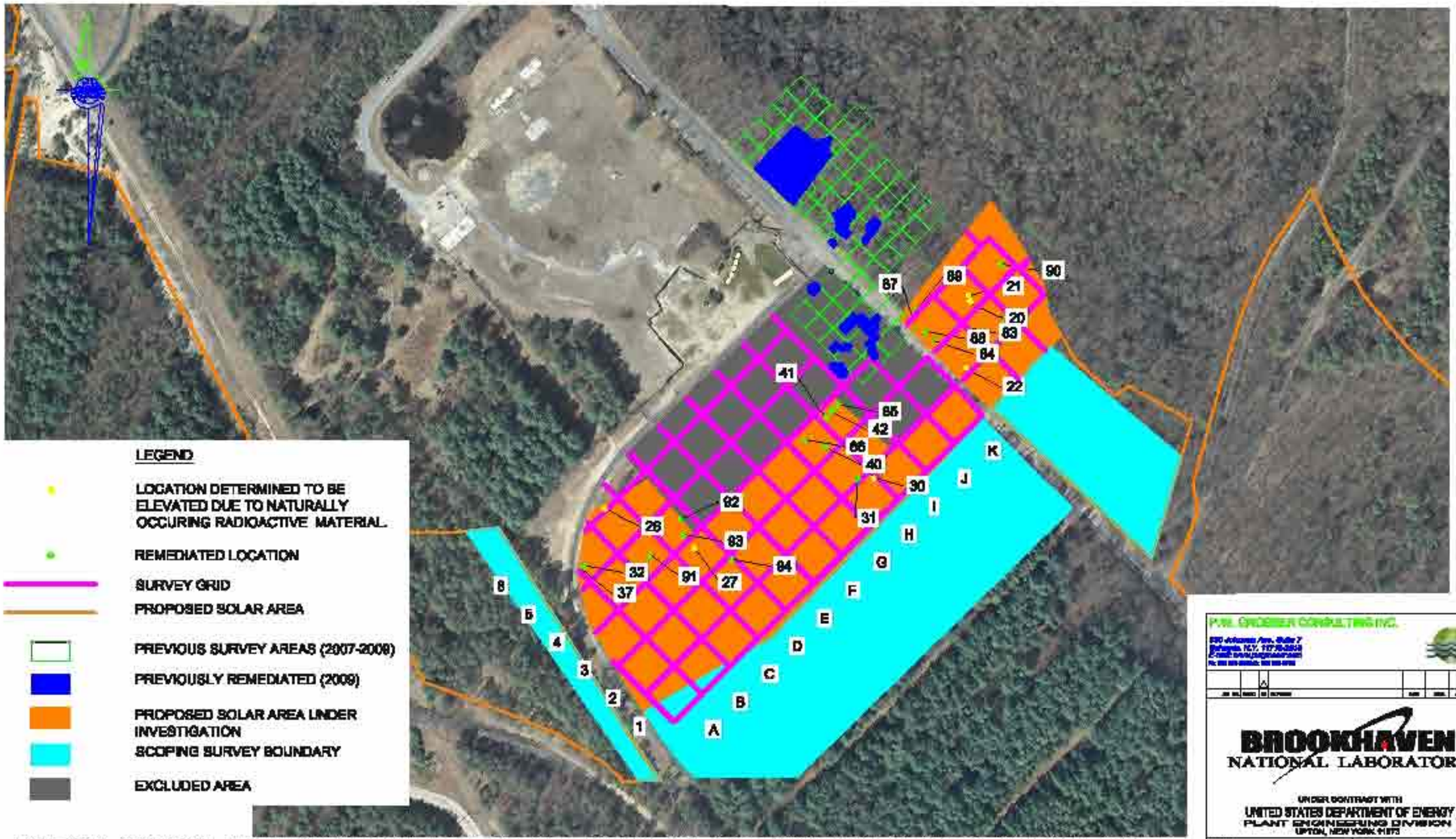
## H) REFERENCES

BNL, 2009. *Field Sampling Plan for the Former HWMF Perimeter Area*, August 2009.

BNL, 2010. *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan*, October 2010.

ORISE, 2010. *Independent Verification Survey Report for the Long Island Solar Farm, Brookhaven National Laboratory, Upton, New York* (5119-SR-01-0,), November 2010.

# FIGURES




# RADIOLOGICAL WALKOVER SURVEY FOR LONG ISLAND SOLAR FARM PROJECT AREA

(11/24/09 - 5/6/10)

SCALE: 1" = 250'

0 250 500

SCALE: 1" = 250'

P.W. GROSSER CONSULTING INC.

BROOKHAVEN NATIONAL LABORATORY

UNDER CONTRACT WITH
UNITED STATES DEPARTMENT OF ENERGY
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

PROPOSED AREAS FOR LONG ISLAND SOLAR FARM PROJECT AREA (1,230/20 - 5/6/10)

1

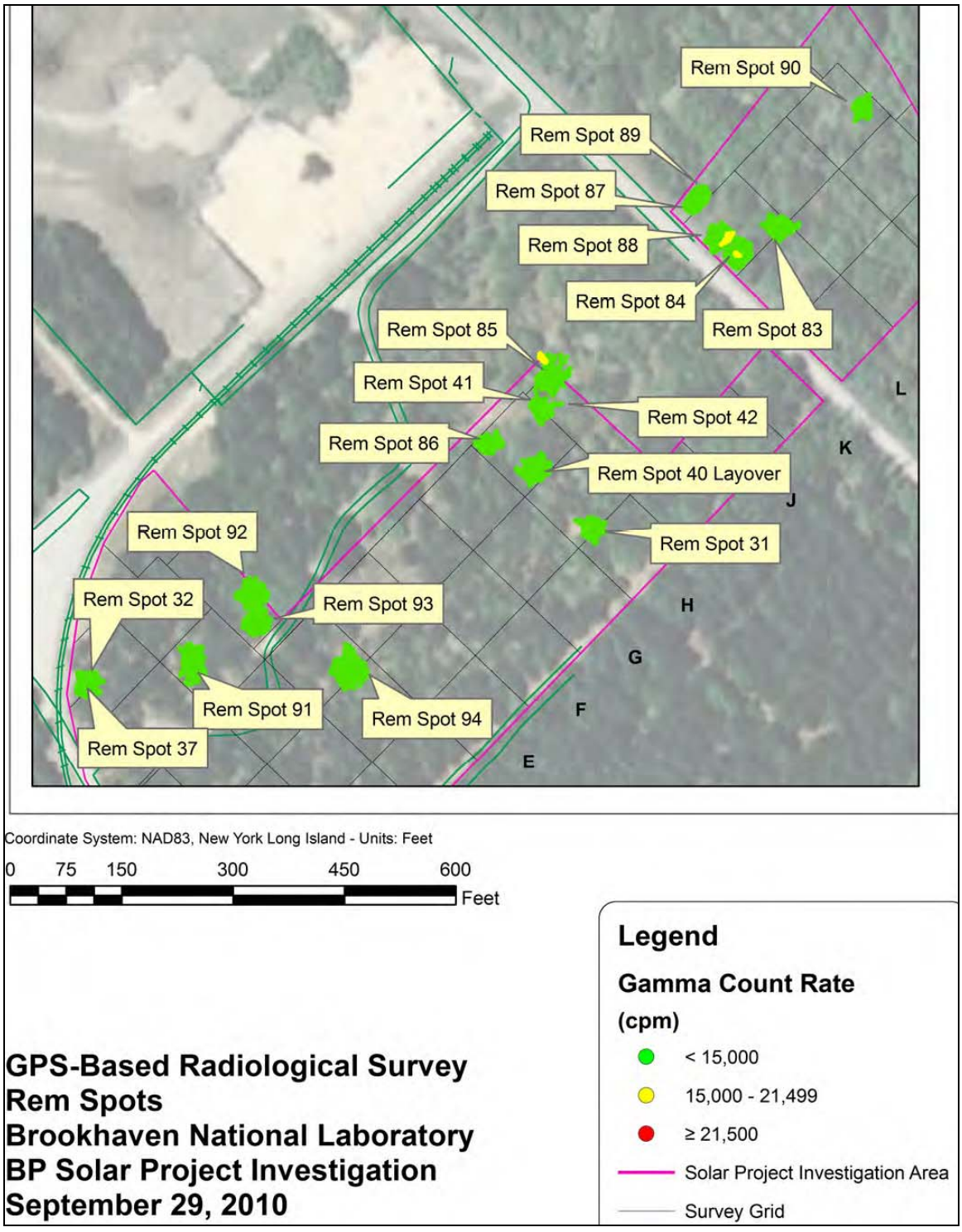



Figure 2 - Gamma Walkover Survey for Discrete Areas

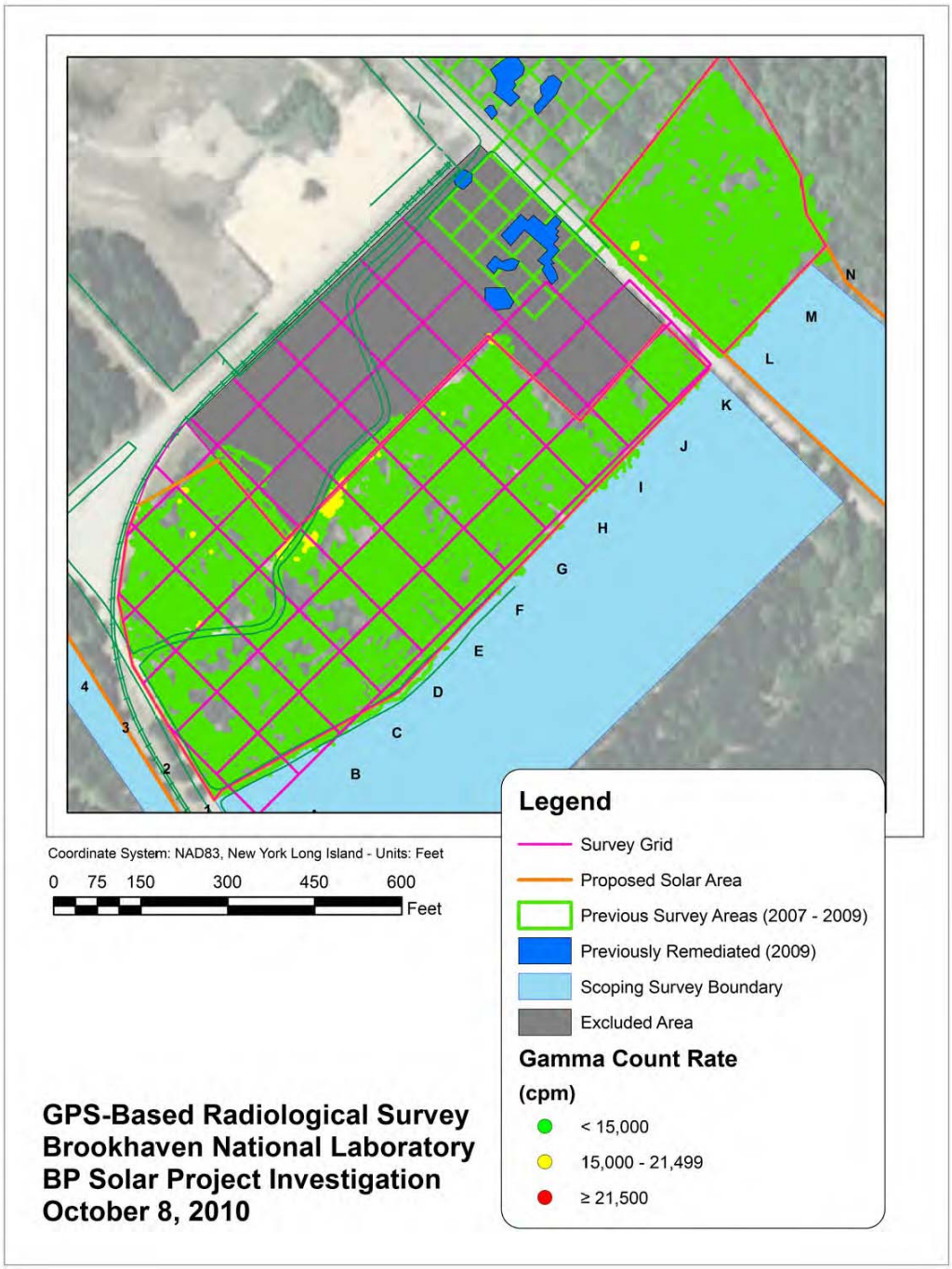



Figure 3 - Gamma Walkover Survey for LISF

# TABLES

# Table 1
## Characterization Results

| Date | Survey Point | GPS Grid Number | Background (kcpm) @ Ground Level | No shielding (kcpm) gross @ Ground Level 1-minute Static Count | No shielding (kcpm) net @ Ground Level | Remediation Date | Remediated Level (kcpm) gross @ Ground Level 1-minute Static Count | Comments |
|---|---|---|---|---|---|---|---|---|
| 11/24/2009 | 20 | NA | 10 | 27 | 17 | 12/7/2009 | 11 | NORM (Rock) |
| 11/24/2009 | 21 | NA | 10 | 24 | 14 | 12/7/2009 | 11 | Rock |
| 11/24/2009 | 22 | NA | 10 | 26 | 16 | 9/14/2010 | 13 | NORM (Rock) |
| 11/25/2009 | 26 | C6 | 4 | 23 | 19 | 12/8/2009 | 10 | NORM (Rock) |
| 11/25/2009 | 27 | D3 | 7 | 40 | 33 | 8/26/2010 | 10 | NORM (Rock) |
| 12/2/2009 | 30 | H1 | 10 | 30 | 20 | 12/8/2009 | 11 | NORM (Rock) |
| 12/2/2009 | 31 | H2 | 10 | 45 | 35 | 12/8/2009 | 11 | |
| 12/2/2009 | 32 | B5 | 14 | 24 | 10 | 12/8/2009 | 14 | |
| 12/8/2009 | 37 | B5 | 13 | 25 | 12 | 12/8/2009 | 13 | |
| 4/13/2010 | 40 | H3 | 10 | 33 | 23 | 4/20/2010 | 12 | |
| 4/16/2010 | 41 | I3 | 9 | 100 | 91 | 8/26/2010 | 10 | Cluster |
| 4/16/2010 | 42 | I3 | 9 | 42 | 33 | 4/20/2010 | 9 | |
| 9/7/2010 | 83 | L3 | 11 | 60 | 49 | 9/9/2010 | 17 | |
| 9/8/2010 | 84 | L3 | 11 | 40 | 29 | 9/9/2010 | 15 | |
| 9/13/2010 | 85 | I3 | 11 | 30 | 19 | 9/14/2010 | 12 | |
| 9/13/2010 | 86 | H3 | 10 | 29 | 19 | 9/16/2010 | 15 | |
| 9/15/2010 | 87 | L3 | 13 | 25 | 12 | 9/15/2010 | 17 | |
| 9/15/2010 | 88 | L3 | 13 | 35 | 22 | 9/16/2010 | 15 | |
| 9/17/2010 | 89 | L3 | 11 | 25 | 14 | 9/17/2010 | 15 | |
| 9/17/2010 | 90 | L4 | 9 | 26 | 17 | 9/17/2010 | 15 | |
| 9/24/2010 | 91 | B4 | 11 | 28 | 17 | 9/29/2010 | 14 | |
| 9/27/2010 | 92 | C4 | 10 | 23 | 13 | 9/29/2010 | 11 | |
| 9/27/2010 | 93 | C4 | 10 | 22 | 12 | 9/29/2010 | 11 | |
| 9/28/2010 | 94 | D2 | 10 | 40 | 30 | 9/29/2010 | 13 | |

Notes:
NA – Not Applicable
NORM – Naturally Occurring Radioactive Material

## Table 2
## Summary of Surface Soil Results for Radionuclides

| | Cs-137 (pCi/g) | Sr-90 (pCi/g) | Ra-226 (pCi/g) | U-238 (pCi/g) |
|---|---|---|---|---|
| Cleanup Goal | 23 | 15 | 5 | 9 |
| Average | 2.44 | No samples indicated detectable values | 0.69 | 1.2* |
| Maximum | 16.7 | No samples indicated detectable values | .88 | 1.2 |

* One sample of 13 composite samples indicated detectable U-238. In order to assure a conservative calculation, this value of 1.2 pCi/g U-238 was used as the average for the entire site.
Tritium (H-3), Cobalt-60, Plutonium-238, Plutonium 239/240, and Uranium-235 were also analyzed, and no samples indicated detectable values of these radionuclides.

## Table 3
## Summary of Soil Sample Results for Chemical Contaminants

| | Lead (mg/kg) | Mercury (mg/kg) | Copper (mg/kg) | Nickel (mg/kg) | Zinc (mg/kg) |
|---|---|---|---|---|---|
| Cleanup Goal | 400 | 1.84 | 270 | 140 | 2,200 |
| Average | 26 | 0.024 | 9 | 3.8 | 33 |
| Maximum | 201 | 0.040 | 26 | 7 | 132 |

## Table 4
## Summary of BNL FSS and ORISE IVS Results

| Radionuclide | Average ORISE Soil Sample Results (pCi/g) | Average BNL Grid Area Soil Sample Results (pCi/g) | Average BNL Discrete Area Soil Sample Results (pCi/g) |
|---|---|---|---|
| Cs-137 | 0.82 | 0.51 | 4.3 |
| Ra-226 | 0.70 | 0.68 | 0.70 |
| Sr-90 | Results not available in draft report | Not detected | Not detected |

# Appendix A
# Final Status Survey Results

**FHWMF Perimeter Area**
**Final Status Survey**
**Discrete Area Offsite Analytical Results**

| Parameter | Residential Cleanup Value | 31 (pCi/g) | | 32 (pCi/g) | | 37 (pCi/g) | | 40 (pCi/g) | | 41 (pCi/g) | | 42 (pCi/g) | | 83 (pCi/g) | | 84 (pCi/g) | | 85 (pCi/g) | | 86 (pCi/g) | | 87 (pCi/g) | | 88 (pCi/g) | | 89 (pCi/g) | | 90 (pCi/g) | | 91 (pCi/g) | | 92 (pCi/g) | | 93 (pCi/g) | | 94 (pCi/g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rad Gamma Spec Analysis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Americium-241 | 39 | 0.0535 | U | -0.000829 | U | 0.138 | U | 0.0306 | U | 0.0307 | U | 0.0352 | U | 0.0153 | U | 0.0237 | U | 0.0991 | U | 0.0563 | U | -0.0292 | U | 0.0438 | U | 0.0152 | U | -0.00632 | U | -0.0121 | U | 0.0318 | U | 0.0825 | U | -0.0351 | U |
| Beryllium-7 | NA | 0.0557 | U | -0.0931 | U | -0.177 | DL | -0.00904 | U | -0.124 | U | -0.0219 | U | -0.392 | U | -0.247 | U | -0.0393 | U | 0.315 | U | -0.216 | U | 0.168 | U | -0.173 | U | -0.258 | U | 0.209 | U | 0.181 | U | 0.0186 | U | 0.0508 | U |
| Cesium-134 | NA | 0.0272 | DL | 0.0657 | UI | 0.0856 | UI | 0.074 | UI | 0.0662 | UI | 0.0613 | UI | 0.0665 | U | 0.0479 | U | 0.0566 | U | 0.0676 | U | 0.0623 | U | 0.0737 | UI | 0.0972 | UI | 0.0457 | U | 0.0772 | U | 0.0548 | U | 0.0522 | U | 0.0426 | U |
| Cesium-137 | 23 | 0.695 | J | 1.63 | J | 1.86 | J | 1.13 | J | 1.36 | J | 3.76 | | 16.7 | | 5.78 | | 2.06 | | 3.75 | | 3.21 | | 2.59 | | 1.96 | | 12.2 | | 6.78 | | 2.67 | | 1.16 | | 7.2 | |
| Cobalt-57 | NA | 0.00159 | DL | 0.000526 | DL | 0.00177 | DL | -0.0000216 | U | 0.00288 | U | -0.0035 | U | -0.00283 | U | 0.0112 | U | -0.00854 | U | 0.00686 | U | 0.013 | DL | -0.00632 | U | 0.0016 | U | -0.00982 | U | -0.00553 | U | -0.00941 | U | -0.00129 | U | -0.0051 | U |
| Cobalt-60 | 1260 | 0.00284 | U | -0.00258 | U | -0.00144 | U | 0.00536 | U | -0.0137 | U | 0.00317 | U | 0.00289 | U | -0.0217 | U | 0.0198 | U | 0.0176 | U | 0.0289 | DL | 0.00991 | U | 0.00567 | U | -0.0014 | U | -0.00633 | U | -0.0185 | U | -0.0135 | U | -0.0114 | U |
| Europium-152 | NA | -0.00434 | U | 0.00665 | U | -0.00596 | U | 0.0138 | U | -0.0305 | U | 0.0327 | U | -0.149 | U | -0.00694 | U | -0.00742 | U | -0.0248 | U | 0.00151 | U | -0.00858 | U | -0.0331 | U | -0.0649 | U | -0.06 | U | 0.0538 | U | 0.0614 | U | 0.00487 | U |
| Europium-154 | NA | -0.0327 | U | -0.00765 | U | -0.0193 | U | -0.00713 | U | -0.024 | U | -0.029 | U | -0.0566 | U | 0.0448 | U | -0.00548 | U | 0.0512 | U | 0.0284 | U | -0.00799 | U | 0.0691 | U | -0.0102 | U | -0.0329 | U | -0.0307 | U | -0.00937 | U | -0.0107 | U |
| Europium-155 | NA | 0.00699 | U | 0.0689 | U | 0.0229 | U | 0.0915 | J-UI | 0.0763 | U | 0.0528 | U | 0.0275 | U | 0.0466 | U | 0.128 | U | 0.0171 | U | 0.0928 | U | 0.0433 | U | 0.015 | U | 0.114 | U | -0.00222 | U | 0.0969 | U | 0.0501 | U | 0.0815 | U |
| Manganese-54 | NA | 0.00454 | U | -0.00381 | U | -0.000284 | U | 0.00625 | U | 0.0309 | J-UI | 0.0108 | U | -0.018 | U | -0.0021 | U | -0.0115 | U | 0.0116 | U | -0.0122 | U | 0.0126 | U | 0.0185 | U | -0.0223 | U | 0.000822 | U | 0.0273 | U | 0.0116 | U | 0.00682 | U |
| Potassium-40 | NA | NR | | NR | | NR | | NR | | NR | | NR | | 8.23 | | 7.78 | | 8.39 | | 8.83 | | 7.8 | | 7.35 | | 9.97 | | 7.37 | | 6.54 | | 6.17 | | 7.21 | | 6.81 | |
| Radium-226 | 5 | 0.693 | | 0.763 | | 0.722 | | 0.651 | | 0.691 | | 0.691 | | 0.617 | | 0.85 | | 0.731 | | 0.847 | | 0.67 | | 0.778 | | 0.857 | | 0.727 | | 0.645 | | 0.75 | | 0.517 | | 0.419 | UI |
| Sodium-22 | NA | -0.0108 | U | -0.00929 | U | -0.00743 | U | -0.00344 | U | -0.01 | U | -0.0104 | U | -0.0287 | U | 0.0104 | U | -0.00443 | U | 0.0181 | U | 0.01 | U | -0.00357 | U | 0.023 | U | -0.00496 | U | -0.00972 | U | -0.0116 | U | -0.00307 | U | -0.0071 | U |
| Thorium-228 | NA | NR | | NR | | NR | | NR | | NR | | NR | | 0.897 | | 1.04 | | 1.01 | | 1.03 | | 0.9 | | 1.14 | | 1.06 | | 1.13 | | 1.11 | | 1.15 | | 0.994 | | 0.77 | |
| Zinc-65 | NA | 0.00661 | U | -0.00434 | U | 0.00597 | U | 0.0123 | U | -0.0389 | U | 0.0528 | U | 0.00858 | U | -0.101 | U | -0.0196 | U | 0.0286 | U | -0.00337 | U | 0.0145 | U | -0.015 | U | -0.0406 | U | 0.0475 | U | 0.0361 | U | 0.0286 | U | 0.0197 | U |

Notes:
DL - Below the dectection limit
NA - Not Applicable
NR - Not Reported
J - Indicates an estimated concentration
U - Indicates that the compound was analyzed for, but was not detected
UI -Uncertain identification for gamma spectroscopy
Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.
All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded during the analysis

**FHWMF Perimeter Area**
**Final Status Survey**
**Discrete Area Composite Sample Offsite Analytical Results**

| Parameter | Residential Cleanup Value | C1 * (pCi/g) | | C2* (pCi/g) | | C3* (pCi/g) | |
|---|---|---|---|---|---|---|---|
| Rad Gamma Spec Analysis | | | | | | | |
| Americium-241 | 39 | 0.0133 | U | -0.134 | U | -0.195 | U |
| Beryllium-7 | NA | 0.0234 | U | 0.171 | U | -0.144 | U |
| Cesium-134 | NA | 0.0437 | UI | 0.0353 | U | 0.0792 | UI |
| Cesium-137 | 23 | 2.01 | J | 5.95 | | 4.99 | |
| Cobalt-57 | NA | -0.00852 | DL | 0.0272 | U | 0.00406 | U |
| Cobalt-60 | 1,260 | -0.000939 | U | 0.00196 | U | -0.0193 | U |
| Europium-152 | NA | 0.0352 | U | -0.0472 | U | 0.0341 | U |
| Europium-154 | NA | -0.0578 | U | -0.016 | U | 0.00485 | U |
| Europium-155 | NA | 0.0777 | U | -0.0151 | U | 0.0691 | U |
| Manganese-54 | NA | 0.00452 | U | -0.0194 | U | -0.0102 | U |
| Potassium-40 | NA | NR | | 8.74 | | 6.83 | |
| Radium-226 | NA | 0.699 | | 0.737 | | 0.675 | |
| Sodium-22 | NA | -0.0201 | U | -0.00603 | U | -0.00471 | U |
| Thorium-228 | NA | NR | | 0.938 | | 0.95 | |
| Zinc-65 | NA | 0.0176 | U | 0.0476 | U | 0.0241 | U |
| Rad Alpha Spec Analysis | | | | | | | |
| Plutonium-238 | NA | NR | | 0.00714 | U | 0.0157 | U |
| Plutonium-239/240 | 40 | -0.0641 | U | -0.0051 | U | -0.00754 | U |
| Uranium-235/236 | 11 | 0.0632 | U | 0 | U | 0.101 | U |
| Uranium-238 | 9 | 0.564 | J | 0.412 | U | 0.225 | U |
| Plutonium-241 | NA | -5.92 | DL | -0.521 | U | 2.37 | U |
| Rad Liquid Scintillation Analysis | | | | | | | |
| Tritium | NA | 8.94 | U | 18.6 | U | -92.2 | U |
| Rad Gas Flow Proportional Counting | | | | | | | |
| Strontium | 15 | 0.217 | U | 0.17 | U | 0.0463 | U |
| Metals | | | | | | | |
| Mercury | 1.84 | 0.0334 | U | 0.0197 | | 0.0225 | |
| Lead | 400 | 29.3 | U | 19.3 | | 258 | |

Notes:

*C1- is a composite sample of discrete areas 31, 32, 37, 40, 41, and 42

*C2- is a composite sample of discrete areas 83, 84, 85, 86, 87, 88, 89, and 90

*C3- is a composite sample of discrete areas 91, 92, 93, and 94

DL - Below the dectection limit

NA - Not Applicable

NR - Not Reported

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

UI -Uncertain identification for gamma spectroscopy

**Bold**/Shaded text denotes concentrations exceeding OU1 Action Levels

All units are pCi/g

Gamma Spec results only reported for those parameters that were recorded during the analysis

**FHWMF Perimeter Area**
**Final Status Survey**
**Survey Grid Composite Sample Offsite Analytical Results**

| Parameter | Residential Cleanup Value | C1* (pCi/g) | | C2* (pCi/g) | | C3* (pCi/g) | | C4* (pCi/g) | | C5* (pCi/g) | | C6* (pCi/g) | | C7* (pCi/g) | | C8* (pCi/g) | | C9* (pCi/g) | | C10* (pCi/g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rad Gamma Spec Analysis | | | | | | | | | | | | | | | | | | | | | |
| Americium-241 | 39 | 0.016 | U | 0.0491 | U | -0.0214 | U | 0.818 | U | 0.0437 | U | 0.0442 | U | -0.189 | U | -0.262 | U | -0.0356 | U | 0.0151 | U |
| Beryllium-7 | NA | 0.301 | U | -0.152 | U | -0.0819 | U | 0.119 | U | -0.0908 | U | 0.107 | U | 0.0379 | U | -0.0937 | U | 0.0542 | U | -0.0473 | DL |
| Cesium-134 | NA | 0.0384 | U | 0.108 | UI | 0.0373 | U | 0.124 | UI | 0.0319 | U | 0.0745 | U | 0.0272 | U | 0.0495 | U | 0.0349 | U | 0.0591 | U |
| Cesium-137 | 23 | 1.02 | | 0.733 | | 0.786 | | 0.538 | | 0.581 | | 0.167 | | 0.506 | | 1.36 | | 0.809 | | 0.671 | |
| Cobalt-57 | NA | -0.008 | U | 0.00263 | U | 0.0158 | U | -0.00415 | U | 0.00114 | U | -0.00854 | U | 0.00444 | U | -0.00835 | U | 0.003 | U | 0.00211 | U |
| Cobalt-60 | 1260 | -0.0143 | U | 0.0235 | U | 0.0114 | U | -0.0154 | U | -0.0336 | U | 0.0187 | U | -0.0128 | U | 0.0308 | U | 0.0117 | U | -0.000291 | U |
| Europium-152 | NA | -0.0323 | U | -0.0499 | U | -0.0527 | U | 0.0778 | U | 0.0171 | U | 0.0385 | U | -0.0836 | U | 0.08 | U | -0.0194 | U | -0.0335 | U |
| Europium-154 | NA | -0.0476 | U | 0.0253 | U | -0.129 | U | -0.0183 | U | -0.0555 | U | -0.102 | U | -0.01 | U | 0.024 | U | -0.0218 | U | 0.0213 | U |
| Europium-155 | NA | -0.00778 | U | 0.00173 | U | 0.108 | UI | 0.0253 | U | 0.0232 | U | 0.00989 | U | -0.013 | U | 0.00829 | U | 0.0676 | U | 0.0465 | U |
| Manganese-54 | NA | -0.0179 | U | -0.00958 | U | -0.00708 | U | -0.00146 | U | -0.00158 | DL | -0.00169 | U | -0.00675 | U | -0.0189 | U | 0.00104 | U | 0.0241 | U |
| Potassium-40 | NA | 8.65 | | 6.98 | | 9.33 | | 10.2 | | 7.38 | | 7.59 | | 7.68 | | 6.62 | | 7.79 | | 7.42 | |
| Radium-226 | NA | 0.55 | | 0.619 | | 0.882 | | 0.804 | | 0.593 | | 0.617 | | 0.712 | | 0.775 | | 0.578 | | 0.684 | |
| Sodium-22 | NA | -0.017 | U | 0.00404 | U | -0.0462 | U | -0.00696 | U | -0.0204 | U | -0.0356 | U | 0.00778 | U | 0.015 | U | -0.00874 | U | 0.0063 | |
| Thorium-228 | NA | 0.849 | | 0.817 | | 1.11 | | 1.19 | | 1.03 | | 1.11 | | 1.02 | | 1.02 | | 1.01 | | 0.995 | |
| Zinc-65 | NA | 0.075 | U | -0.114 | U | -0.0179 | U | 0.000339 | U | -0.168 | U | 0.0128 | U | 0.0387 | U | 0.00992 | U | 0.00642 | U | -0.0664 | U |
| Rad Alpha Spec Analysis | | | | | | | | | | | | | | | | | | | | | |
| Plutonium-238 | NA | 0.0042 | U | -0.00683 | U | 0.00971 | U | 0 | U | 0 | U | -0.00626 | U | 0.0276 | U | -0.0176 | U | 0 | U | 0.0112 | U |
| Plutonium-239/240 | 40 | -0.00893 | U | 0.025 | U | 0.0705 | U | -0.00344 | U | 0.0131 | U | 0.00991 | U | 0.0106 | U | 0.08 | U | 0.0294 | U | 0.0326 | U |
| Uranium-235/236 | 11 | 0.101 | U | 0 | U | -0.0722 | U | 0.306 | U | -0.0421 | U | 0.0636 | U | -0.0471 | U | 0 | U | 0 | U | -0.0304 | U |
| Uranium-238 | 9 | 0.753 | J | 0.29 | J | 0.307 | U | 0.495 | J | 0.763 | J | 1.2 | | 0.578 | J | 0.773 | J | 0.541 | J | 0.41 | J |
| Plutonium-241 | NA | 1.11 | U | 3.01 | U | 0.414 | U | 3.7 | U | 2.27 | U | 5.27 | U | 1.91 | U | 2.04 | U | 0.248 | U | 0.55 | U |
| Rad Liquid Scintillation Analysis | | | | | | | | | | | | | | | | | | | | | |
| Tritium | NA | 3.78 | U | -31.2 | U | -46.6 | U | -32.5 | U | 0 | U | -22.5 | U | 21.2 | U | -25 | U | 109 | U | -4.04 | U |
| Rad Gas Flow Proportional Counting | | | | | | | | | | | | | | | | | | | | | |
| Strontium | 15 | 0.348 | U | 0.0802 | U | 0.118 | U | 0.135 | U | 0.311 | U | -0.0889 | U | 0.477 | U | 0.427 | U | -0.144 | U | 0.778 | U |
| Metals | | | | | | | | | | | | | | | | | | | | | |
| Mercury | 1.84 | 0.0454 | J | 0.0478 | J | 0.0319 | J | 0.0235 | J | 0.0278 | J | 0.0214 | J | 0.0363 | J | 0.0451 | | 0.015 | | 0.0281 | |
| Lead | 400 | 24.3 | | 17.9 | | 18.6 | | 10.7 | | 11.7 | | 10 | | 35.7 | | 41.6 | | 17.4 | | 42.8 | |

Notes:

*C1- is a composite sample of grids L1, L2, L3, M1, and M2

*C2- is a composite sample of grids M3, N2, N3, N4, and L4

*C3- is a composite sample of grids N1, K1, J1, I1, and H1

*C4- is a composite sample of grids H2, H3, G1, G2, and G3

*C5- is a composite sample of grids F1, F2, F3, E1, and E2

*C6- is a composite sample of grids E3, D1, D2, D3, and C2

*C7- is a composite sample of grids C3, B2, B3, A2, and A3

*C8- is a composite sample of grids A1, A4, C1, B5, and AA3

*C9- is a composite sample of grids C6, D5, D4, I3, and I2

*C10- is a composite sample of grids B4, C4, and C5

DL - Below the dectection limit

NA - Not Applicable

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

UI -Uncertain identification for gamma spectroscopy

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels

All units are pCi/g

Gamma Spec results only reported for those parameters that were recorded during the analysis

**FHWMF Perimeter Area**
**Final Status Survey**
**QA/QC Offsite Analytical Results**

| Parameter | Residential Cleanup Value | Field Blank 1 (9/22/10) (pCi/g) | | Field Duplicate 1 (9/22/10) (pCi/g) | | Field Blank 2 (9/28/10) (pCi/g) | | Field Duplicate (9/28/10) (pCi/g) | |
|---|---|---|---|---|---|---|---|---|---|
| Rad Gamma Spec Analysis | | | | | | | | | |
| Americium-241 | 39 | 0.0364 | U | -0.0641 | U | 0.0114 | U | -0.14 | U |
| Beryllium-7 | NA | -0.0163 | U | 0.0428 | U | 0.03 | U | 0.0088 | U |
| Cesium-134 | NA | 0.0447 | U | 0.0448 | U | 0.105 | | 0.031 | U |
| Cesium-137 | 23 | 0.274 | | 0.395 | | 0.428 | | 0.631 | |
| Cobalt-57 | NA | 0.00156 | U | 0.00751 | U | -0.00278 | U | -0.000622 | U |
| Cobalt-60 | 1260 | 0.00168 | U | -0.0266 | U | -0.024 | U | 0.0155 | U |
| Europium-152 | NA | -0.0566 | U | 0.0225 | U | -0.109 | U | 0.000998 | U |
| Europium-154 | NA | 0.0108 | U | -0.0257 | U | -0.0136 | U | 0.0124 | U |
| Europium-155 | NA | -0.0017 | U | 0.0377 | U | 0.0556 | U | 0.0435 | U |
| Manganese-54 | NA | 0.00285 | U | 0.00711 | U | -0.0208 | U | -0.025 | U |
| Potassium-40 | NA | 8.35 | | 7.82 | | 8.92 | | 7.39 | |
| Radium-226 | NA | 0.539 | | 0.653 | | 0.609 | | 0.694 | |
| Sodium-22 | NA | 0.00426 | U | -0.00864 | U | -0.00443 | U | 0.00439 | U |
| Thorium-228 | NA | 0.938 | | 0.696 | | 0.972 | | 1.04 | |
| Zinc-65 | NA | 0.0183 | U | -0.179 | U | -0.00355 | U | 0.0127 | U |
| Rad Alpha Spec Analysis | | | | | | | | | |
| Plutonium-238 | NA | 0.0134 | U | 0 | U | 0.018 | U | -0.0101 | U |
| Plutonium-239/240 | 40 | -0.016 | U | 0.00622 | U | -0.0104 | U | -0.00279 | U |
| Uranium-235/236 | 11 | 0 | U | -0.0485 | U | 0.117 | U | 0 | U |
| Uranium-238 | 9 | 0.248 | U | 0.249 | U | 1.05 | | 0.759 | J |
| Plutonium-241 | NA | 5.15 | U | 3.68 | U | 1.16 | U | 0.477 | U |
| Rad Liquid Scintillation Analysis | | | | | | | | | |
| Tritium | NA | -35 | U | -33.2 | U | 31.2 | U | -3.46 | U |
| Rad Gas Flow Proportional Counting | | | | | | | | | |
| Strontium | 15 | -0.00588 | U | 0.146 | U | 0.0984 | U | 0.256 | U |
| Metals | | | | | | | | | |
| Mercury | 1.84 | 0.0247 | J | 0.0356 | J | 0.0168 | | 0.0124 | J |
| Lead | 400 | 12.9 | | 28.4 | | 16.3 | | 25.2 | |

Notes:

Field Duplicate 1 is a duplicate of grid composite C7

Field Duplicate 2 is a duplicate of grid composite C9

DL - Below the dectection limit

NA - Not Applicable

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

UI -Uncertain identification for gamma spectroscopy

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.

All units are pCi/g

Gamma Spec results only reported for those parameters that were recorded during the analysis

**FHWMF Perimeter Area**
**Final Status Survey**
**100' x 100' Survey Grid**
**On-site Gamma Spectroscopy**

| Grid Coordinates | Results Cs-137 (pCi/g) |
|---|---|
| Germanium Lithide Gamma Spectroscopy | |
| AA3 | 0.33 |
| A2 | 0.26 |
| A3 | 0.24 |
| A4 | 0.37 |
| B1 | 0.86 |
| B2 | 0.19 |
| B3 | 0.22 |
| B4 | 0.41 |
| B5 | 1.20 |
| C1 | 0.62 |
| C2 | 0.08 |
| C3 | 0.51 |
| C4 | 0.44 |
| C5 | 0.60 |
| C6 | 0.60 |
| D1 | DL |
| D2 | DL |
| D3 | 0.26 |
| D4 | 0.62 |
| D5 | DL |
| E1 | 0.20 |
| E2 | 0.40 |
| E3 | DL |
| F1 | 0.42 |
| F2 | 0.23 |
| F3 | 0.26 |
| G1 | 0.11 |
| G2 | 0.23 |
| G3 | DL |
| H1 | 0.13 |
| H2 | 0.27 |
| H3 | 0.33 |
| I1 | 0.27 |
| I2 | 0.38 |
| I3 | 0.92 |
| J1 | 0.63 |
| K1 | 0.54 |
| L1 | 0.35 |
| L2 | 0.84 |
| L3 | 0.77 |
| L4 | 0.78 |
| M1 | 0.50 |
| M2 | 0.84 |
| M3 | 0.76 |
| N1 | 0.47 |
| N2 | 0.19 |
| N3 | 0.29 |
| N4 | 0.37 |

Notes:
DL - Below the dectection limit
All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2009-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 12/ 08 /09 | Time: 17:00

Survey: Remediation of Spot # 31 at GPS Grid H2, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot #31[ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 11K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 090210-009 at 982 grams, with a result of $Cs_{137}$ ( 0. 42 pCi/gm ) + bkgd. .

(D) Upon the date of completion for the remediation of this area, the calibrations for the instruments used, all were current within the year.

NDA = No Detectable Activity



**INSTRUMENTS**

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 211784 | 01/10/10 |
| LUD-2221 | 211786 | 11/25/10 |
| N/A | | |
| N/A | | |
| N/A | | |

**LEGEND**
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [H] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

**AIRBORNE ACTIVITY SURVEY**

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

**DOSE RATE (HIGHEST)**

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

**MASSLINN SURVEY RESULTS (in dpm)**

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

**SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H**

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and David Widger Date: 09/ 30 /10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2009-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 12/ 08 /09 | Time: 17:00

Survey: Remediation of Spot # 32 at GPS Grid B5 for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot #32 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 14K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 090210-007 at 752 grams, with a result of $Cs_{137}$ ( 3. 61 pCi/gm ) + bkgd. .

(D) Upon the date of completion for the remediation of this area, the calibrations for the instruments used, all were current within the year.

NDA = No Detectable Activity



| INSTRUMENTS Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 211784 | 01/10/10 |
| LUD-2221 | 211786 | 11/25/10 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | Field Analysis % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and David Widger Date: 09/ 30 /10 Reviewed By: [signature] Date: 10/25/10

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY: ☐ Routine ☒ Special Characterization ☒ RWP# 2009-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 12/08/09 | Time: 17:00

Survey: Remediation of Spot # 37 at GPS Grid B5, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot #37 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 13K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 090210-008 at 900 grams, with a result of $Cs_{137}$ ( 0. 83 pCi/gm ) + bkgd. .

(D) Upon the date of completion for the remediation of this area, the calibrations for the instruments used, all were current within the year.

NDA = No Detectable Activity



**INSTRUMENTS**

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 211784 | 01/10/10 |
| LUD-2221 | 211786 | 11/25/10 |
| N/A | | |
| N/A | | |
| N/A | | |

**LEGEND**

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION

□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION

C - CONTAMINATION * CONTACT

XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

**AIRBORNE ACTIVITY SURVEY**

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

**DOSE RATE (HIGHEST)**

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

**MASSLINN SURVEY RESULTS (in dpm)**

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4 | | 8. | |

**SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H**

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4 | | 11. | | 18. | |
| 5. | | 12. | | 19 | |
| 6. | | 13. | | 20 | |
| 7. | | 14. | | 21 | |

Surveyed By: John Aloi and David Widger Date: 09/30/10 Reviewed By: [signature] Date: 10/2/10

FS-SOP-1000 Attachment 9.2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 04/ 20 /10 | Time: 17:00

Survey: Remediation of Spot # 40 at GPS Grid H3, for the BP Solar Project Area.



Note:

(A) Post remediation of spot # 40 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 12K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5K cpm.

(C) Marinelli soil sample # 090210-004 at 789 grams, with a result of $Cs_{137}$ ( 1. 24 pCi/gm ) + bkgd. .



**INSTRUMENTS**

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 211786 | 01/07/11 |
| LUD-2221 | 211784 | 02/02/11 |
| N/A | | |
| N/A | | |
| N/A | | |

NDA = No Detectable Activity

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = counts reading Y = radiation type ZZZ = reading @ 30cm

**AIRBORNE ACTIVITY SURVEY**

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

**DOSE RATE (HIGHEST)**

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

**MASSLINN SURVEY RESULTS (in dpm)**

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

**SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H**

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9 | | 16 | |
| 3 | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5 | | 12 | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: Brian Martin and John Zamora Date: 09/ 30 /10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000 Attachment 9. 2 JOHN MARC FOR BRIAN + JOHN

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 08/26/10 | Time: 17:00

Survey: Remediation of Spot # 41 at GPS Grid I3, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot #41 [ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 10K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 090210-005 at 972 grams, with a result of $Cs_{137}$ ( 0. 48 pCi/gm ) + bkgd. .



NDA = NO DETECTABLE ACTIVITY. K Wehunt 10/25/10

| INSTRUMENTS Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 211780 | 12/08/10 |
| N/A → | | → |
| N/A → | | → |
| N/A → | | → |
| N/A → | | → |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A → | | | | | → |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16 | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi, Kim Wehunt, David Widger Date: 09/30/10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 04/20/10 | Time: 17:00

Survey: Remediation of Spot # 42 at GPS Grid I3, for the BP Solar Project Area.



Note:

(A) Post remediation of spot #42 [ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 9K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 090210-006 at 952 grams, with a result of $Cs_{137}$ ( 1. 50 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



**INSTRUMENTS**

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 211786 | 01/07/11 |
| LUD-2221 | 211784 | 02/02/11 |
| N/A | | |
| N/A | | |
| N/A | | |

**LEGEND**
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

**AIRBORNE ACTIVITY SURVEY**

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

**DOSE RATE (HIGHEST)**

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

**MASSLINN SURVEY RESULTS (in dpm)**

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

**SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H**

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5 | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: Brian Martin and John Zamora Date: 09/30/10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000 JOHN ALSO FOR MARTIN + ZAMORA
Attachment 9.2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/09/10 | Time: 17:00

Survey: Remediation of Spot # 83 at GPS Grid L3, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot # 83 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 17K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5K cpm.

(C) Marinelli soil sample # 091310-013 at 742 grams, with a result of $Cs_{137}$ ( 0. 64 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C̄ - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | Field Analysis % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] Date: 10/1/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/09/10 | Time: 17:00

Survey: Remediation of Spot # 84 at GPS Grid L3, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot # 84 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 15K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5K cpm.

(C) Marinelli soil sample # 091310-014 at 826 grams, with a result of $Cs_{137}$ ( 1. 03 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



**INSTRUMENTS**

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A → | | → |
| N/A → | | → |
| N/A → | | → |

**LEGEND**

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

**AIRBORNE ACTIVITY SURVEY**

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis nCi/ee | % DAC |
|---|---|---|---|---|---|
| N/A → | | | | | → |

**DOSE RATE (HIGHEST)**

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

**MASSLINN SURVEY RESULTS (in dpm)**

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | ↓ | 8. | ↓ |

**SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H**

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | ↓ | 14. | ↓ | 21. | ↓ |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] 10/25/10 Date:

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/ 14 /10 | Time: 17:00

Survey: Remediation of Spot # 85 at GPS Grid I3, for the BP Solar Project Area.



Note:

(A) Post remediation of spot # 85 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 12K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5K cpm.

(C) Marinelli soil sample # 091610-012 at 879 grams, with a result of $Cs_{137}$ ( 2. 99 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 11. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/ 30 /10 Reviewed By: _____ Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/16/10 | Time: 17:00

Survey: Remediation of Spot # 86 at GPS Grid H3, for the BP Solar Project Area.



Note:

(A) Post remediation of spot # 86 [ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 15K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5K cpm.

(C) Marinelli soil sample # 091610-013 at 591 grams, with a result of $Cs_{137}$ ( 3. 50 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | Field Analysis % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

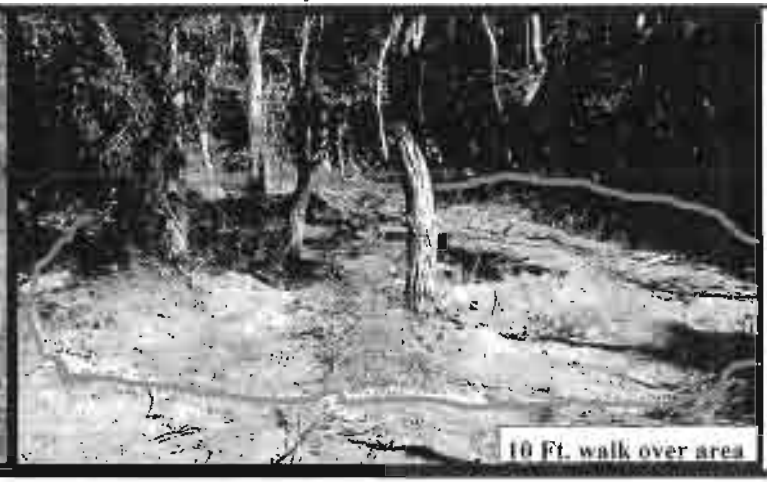
# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/15/10 | Time: 17:00

Survey: Remediation of Spot # 87 at GPS Grid L3, for the BP Solar Project Area.

| INSTRUMENTS Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |


LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Note:

(A) Post remediation of spot #87| highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 17K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 091610-014 at 838 grams, with a result of $Cs_{137}$ ( 3. 01 pCi/gm ) + bkgd. .

(D) This remediated area over laps into Spot #89, therefore the 10ft. required walk over is covered.



NDA = No Detectable Activity

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/16/10 | Time: 17:00

Survey: Remediation of Spot # 88 at GPS Grid L3, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot # 88 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 15K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5K cpm.

(C) Marinelli soil sample # 091610-015 at 743 grams, with a result of $Cs_{137}$ ( 1. 54 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



| INSTRUMENTS Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/17/10 | Time: 17:00

Survey: Remediation of Spot # 89 at GPS Grid L4, for the BP Solar Project Area.



Note:

(A) Post remediation of spot #89| highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 15K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 092110-001 at 800 grams, with a result of $Cs_{137}$ ( 1. 92 pCi/gm ) + bkgd. .

(D) This remediated area over laps into Spot #87, therefore the 10ft. required walk over is covered.

NDA = No Detectable Activity



## INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

## LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

## AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

## DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

## MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

## SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13 | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: Date:

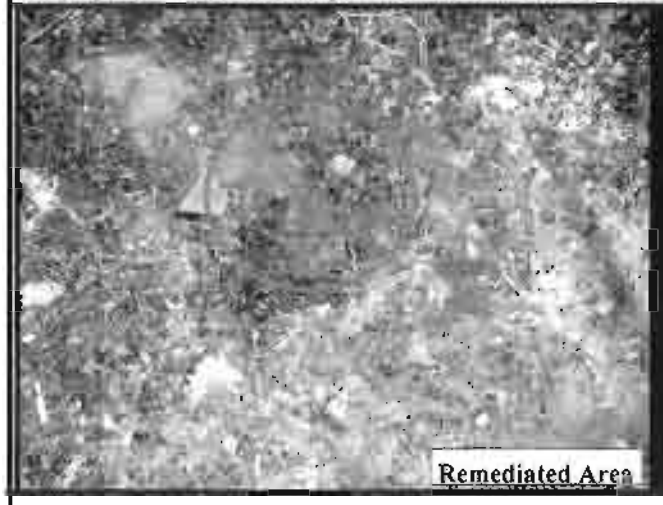
FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/17/10 | Time: 17:00

Survey: Remediation of Spot # 90 at GPS Grid L4, for the BP Solar Project Area.





Note:

(A) Post remediation of spot #90[ highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 15K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 092110 at 649 grams, with a result of $Cs_{137}$ ( 9.78 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] Date: 9/30/10

FS-SOP-1000
Attachment 9.2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/ 29 /10 | Time: 17:00

Survey: Remediation of Spot # 91 at GPS Grid C4, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot #91 | highlighted in blue |, using a 2x2 NaI probe, a one minute static count was taken with a result of 14K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 092910-002 at 627 grams, with a result of $Cs_{137}$ ( 4. 2 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/ 30 /10 Reviewed By: [signature] Date: 10/20/10

FS-SOP-1000
Attachment 9.2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/ 29 /10 | Time: 17:00

Survey: Remediation of Spot # 92 at GPS C4 Grid, for the BP Solar Project Area.


Remediated Area


10 Ft. walk over area

Note:

(A) Post remediation of spot #92 [ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 11K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 092910-003 at 887 grams, with a result of $Cs_{137}$ ( 1. 62 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



| INSTRUMENTS Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A → | | → |
| N/A → | | → |
| N/A → | | → |

LEGEND
○ SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A → | | | | | → |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5 | N/A |
| 2. | | 6 | |
| 3 | | 7. | |
| 4 | | 8 | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4 | | 11. | | 18 | |
| 5. | | 12. | | 19 | |
| 6. | | 13. | | 20. | |
| 7 | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/ 30 /10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000 - Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ____ ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/29/10 | Time: 17:00

Survey: Remediation of Spot # 93 at GPS Grid D4, for the BP Solar Project Area.


Note:

(A) Post remediation of spot #93 [ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 11K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 092910-004 at 1053 grams, with a result of $Cs_{137}$ ( 1. 24 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



| INSTRUMENTS Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION [#] - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis µCi/cc | % DAC |
|---|---|---|---|---|---|
| N/A | | | | | |

DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] Date: 10/25/10

FS-SOP-1000
Attachment 9. 2

# RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☒ Special Characterization
☒ RWP# 2010-BOP-04 ☐ WP

Location / Equipment: FHWMF Woods, 2X2 NaI Probe | Date: 09/29/10 | Time: 17:00

Survey: Remediation of Spot # 94 at GPS Grid D3, for the BP Solar Project Area.



Note:

(A) Post remediation of spot #94 [ highlighted in blue ], using a 2x2 NaI probe, a one minute static count was taken with a result of 13K cpm.

(B) Also a 100% gamma scan of the same excavated area and a walk over inclusive of 10ft. beyond the edge of the excavated area. All of the aforementioned areas were NDA above 21. 5Kcpm.

(C) Marinelli soil sample # 092910-001 at 907 grams, with a result of $Cs_{137}$ ( 4. 64 pCi/gm ) + bkgd. .

NDA = No Detectable Activity



## INSTRUMENTS

| Model # | Serial # | CAL DUE |
|---|---|---|
| LUD-2221 | 138377 | 07/28/11 |
| LUD-2221 | 149942 | 07/22/11 |
| N/A | | |
| N/A | | |
| N/A | | |

## LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATI
□ - MASSLINN SURVEY LOCATION [N] - DIRECT FRISK LOCATI
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

## AIRBORNE ACTIVITY SURVEY

| Sample # | Duration | Flow Rate | Field Analysis cpm | Field Analysis pCi/cc | % DA |
|---|---|---|---|---|---|
| N/A | | | | | |

## DOSE RATE (HIGHEST)

| | |
|---|---|
| CONTACT READING | N/A |
| GENERAL AREA READING | N/A |

## MASSLINN SURVEY RESULTS (in dpm)

| | | | |
|---|---|---|---|
| 1. | N/A | 5. | N/A |
| 2. | | 6. | |
| 3. | | 7. | |
| 4. | | 8. | |

## SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, $^3$H

| | | | | | |
|---|---|---|---|---|---|
| 1. | N/A | 8. | N/A | 15. | N/A |
| 2. | | 9. | | 16. | |
| 3. | | 10. | | 17. | |
| 4. | | 11. | | 18. | |
| 5. | | 12. | | 19. | |
| 6. | | 13. | | 20. | |
| 7. | | 14. | | 21. | |

Surveyed By: John Aloi and Sean A. Gully Date: 09/30/10 Reviewed By: [signature] Date: 10/25/1

FS-SOP-1000
Attachment 9. 2

# Appendix B
# RESRAD Results

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Summary : BP Solar-Industrial-Bkg subtract
File  : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

| Menu | Parameter | Current Value# | Base Case* | Parameter Name |
|---|---|---|---|---|
| A-1 | DCF's for external ground radiation, (mrem/yr)/(pCi/g) | | | |
| A-1 | At-218  (Source: FGR 12) | 5.847E-03 | 5.847E-03 | DCF1(  1) |
| A-1 | Ba-137m  (Source: FGR 12) | 3.606E+00 | 3.606E+00 | DCF1(  2) |
| A-1 | Bi-210  (Source: FGR 12) | 3.606E-03 | 3.606E-03 | DCF1(  3) |
| A-1 | Bi-214  (Source: FGR 12) | 9.808E+00 | 9.808E+00 | DCF1(  4) |
| A-1 | Cs-137  (Source: FGR 12) | 7.510E-04 | 7.510E-04 | DCF1(  5) |
| A-1 | Pa-234  (Source: FGR 12) | 1.155E+01 | 1.155E+01 | DCF1(  6) |
| A-1 | Pa-234m  (Source: FGR 12) | 8.967E-02 | 8.967E-02 | DCF1(  7) |
| A-1 | Pb-210  (Source: FGR 12) | 2.447E-03 | 2.447E-03 | DCF1(  8) |
| A-1 | Pb-214  (Source: FGR 12) | 1.341E+00 | 1.341E+00 | DCF1(  9) |
| A-1 | Po-210  (Source: FGR 12) | 5.231E-05 | 5.231E-05 | DCF1( 10) |
| A-1 | Po-214  (Source: FGR 12) | 5.138E-04 | 5.138E-04 | DCF1( 11) |
| A-1 | Po-218  (Source: FGR 12) | 5.642E-05 | 5.642E-05 | DCF1( 12) |
| A-1 | Ra-226  (Source: FGR 12) | 3.176E-02 | 3.176E-02 | DCF1( 13) |
| A-1 | Rn-222  (Source: FGR 12) | 2.354E-03 | 2.354E-03 | DCF1( 14) |
| A-1 | Th-230  (Source: FGR 12) | 1.209E-03 | 1.209E-03 | DCF1( 15) |
| A-1 | Th-234  (Source: FGR 12) | 2.410E-02 | 2.410E-02 | DCF1( 16) |
| A-1 | Tl-210  (Source: no data) | 0.000E+00 | -2.000E+00 | DCF1( 17) |
| A-1 | U-234  (Source: FGR 12) | 4.017E-04 | 4.017E-04 | DCF1( 18) |
| A-1 | U-238  (Source: FGR 12) | 1.031E-04 | 1.031E-04 | DCF1( 19) |
| | | | | |
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Cs-137+D | 3.190E-05 | 3.190E-05 | DCF2(  1) |
| B-1 | Pb-210+D | 2.320E-02 | 1.360E-02 | DCF2(  2) |
| B-1 | Ra-226+D | 8.594E-03 | 8.580E-03 | DCF2(  3) |
| B-1 | Th-230 | 3.260E-01 | 3.260E-01 | DCF2(  4) |
| B-1 | U-234 | 1.320E-01 | 1.320E-01 | DCF2(  5) |
| B-1 | U-238 | 1.180E-01 | 1.180E-01 | DCF2(  6) |
| B-1 | U-238+D | 1.180E-01 | 1.180E-01 | DCF2(  7) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Cs-137+D | 5.000E-05 | 5.000E-05 | DCF3(  1) |
| D-1 | Pb-210+D | 7.276E-03 | 5.370E-03 | DCF3(  2) |
| D-1 | Ra-226+D | 1.321E-03 | 1.320E-03 | DCF3(  3) |
| D-1 | Th-230 | 5.480E-04 | 5.480E-04 | DCF3(  4) |
| D-1 | U-234 | 2.830E-04 | 2.830E-04 | DCF3(  5) |
| D-1 | U-238 | 2.550E-04 | 2.550E-04 | DCF3(  6) |
| D-1 | U-238+D | 2.687E-04 | 2.550E-04 | DCF3(  7) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Cs-137+D  , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF(  1,1) |
| D-34 | Cs-137+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF(  1,2) |
| D-34 | Cs-137+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 8.000E-03 | 8.000E-03 | RTF(  1,3) |
| D-34 | | | | |
| D-34 | Pb-210+D  , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF(  2,1) |
| D-34 | Pb-210+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF(  2,2) |
| D-34 | Pb-210+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 3.000E-04 | 3.000E-04 | RTF(  2,3) |
| D-34 | | | | |

Summary : BP Solar-Industrial-Bkg subtract
File  : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

| Menu | Parameter | Current Value# | Base Case* | Parameter Name |
|---|---|---|---|---|
| D-34 | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 3,1) |
| D-34 | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,2) |
| D-34 | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | Th-230 , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 4,1) |
| D-34 | Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 4,2) |
| D-34 | Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 5.000E-06 | 5.000E-06 | RTF( 4,3) |
| D-34 | | | | |
| D-34 | U-234 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 5,1) |
| D-34 | U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 5,2) |
| D-34 | U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 5,3) |
| D-34 | | | | |
| D-34 | U-238 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 6,1) |
| D-34 | U-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 6,2) |
| D-34 | U-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 6,3) |
| D-34 | | | | |
| D-34 | U-238+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 7,1) |
| D-34 | U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 7,2) |
| D-34 | U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 7,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Cs-137+D , fish | 2.000E+03 | 2.000E+03 | BIOFAC( 1,1) |
| D-5 | Cs-137+D , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pb-210+D , fish | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1) |
| D-5 | Pb-210+D , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Ra-226+D , fish | 5.000E+01 | 5.000E+01 | BIOFAC( 3,1) |
| D-5 | Ra-226+D , crustacea and mollusks | 2.500E+02 | 2.500E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | Th-230 , fish | 1.000E+02 | 1.000E+02 | BIOFAC( 4,1) |
| D-5 | Th-230 , crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 4,2) |
| D-5 | | | | |
| D-5 | U-234 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 5,1) |
| D-5 | U-234 , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 5,2) |
| D-5 | | | | |
| D-5 | U-238 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 6,1) |
| D-5 | U-238 , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 6,2) |
| D-5 | | | | |
| D-5 | U-238+D , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 7,1) |
| D-5 | U-238+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 7,2) |

#For DCF1(xxx) only, factors are for infinite depth & area.  See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Summary : BP Solar-Industrial-Bkg subtract

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## Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 6.100E+04 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 5.000E+00 | 2.000E+00 | --- | THICK0 |
| R011 | Fraction of contamination that is submerged | 0.000E+00 | 0.000E+00 | --- | SUBMFRACT |
| R011 | Length parallel to aquifer flow (m) | 2.500E+02 | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 1.500E+01 | 3.000E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 5.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 5.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 5.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| R012 | Initial principal radionuclide (pCi/g): Cs-137 | 2.440E+00 | 0.000E+00 | --- | S1(1) |
| R012 | Initial principal radionuclide (pCi/g): Ra-226 | 1.300E-01 | 0.000E+00 | --- | S1(3) |
| R012 | Initial principal radionuclide (pCi/g): U-238 | 1.200E+00 | 0.000E+00 | --- | S1(6) |
| R012 | Concentration in groundwater (pCi/L): Cs-137 | not used | 0.000E+00 | --- | W1( 1) |
| R012 | Concentration in groundwater (pCi/L): Ra-226 | not used | 0.000E+00 | --- | W1( 3) |
| R012 | Concentration in groundwater (pCi/L): U-238 | not used | 0.000E+00 | --- | W1( 6) |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.660E+00 | 1.500E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 3.300E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 2.400E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 5.000E+03 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 4.900E+00 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 6.230E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 4.600E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 1.230E+00 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 2.600E-01 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 2.000E-01 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | 1.000E+06 | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | 1.000E-03 | 1.000E-03 | --- | EPS |
| R014 | Density of saturated zone (g/cm**3) | 1.660E+00 | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | 3.300E-01 | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | 2.400E-01 | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | 2.000E-01 | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | 2.000E+04 | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | 4.800E-03 | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | 4.900E+00 | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VWT |

Summary : BP Solar-Industrial-Bkg subtract
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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R014 | Well pump intake depth (m below water table) | 1.800E+01 | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | not used | 2.500E+02 | --- | UW |
| | | | | | |
| R015 | Number of unsaturated zone strata | 1 | 1 | --- | NS |
| R015 | Unsat. zone 1, thickness (m) | 0.000E+00 | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | 1.660E+00 | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | 3.300E-01 | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | 2.400E-01 | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | 2.000E-01 | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | 4.900E+00 | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | 5.000E+03 | 1.000E+01 | --- | HCUZ(1) |
| | | | | | |
| R016 | Distribution coefficients for Cs-137 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.800E+02 | 4.600E+03 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | 2.800E+02 | 4.600E+03 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | 2.800E+02 | 4.600E+03 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.889E-04 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| | | | | | |
| R016 | Distribution coefficients for Ra-226 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+02 | 7.000E+01 | --- | DCNUCC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+02 | 7.000E+01 | --- | DCNUCU( 3,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+02 | 7.000E+01 | --- | DCNUCS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.618E-04 | ALEACH( 3) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 3) |
| | | | | | |
| R016 | Distribution coefficients for U-238 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCC( 6) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCU( 6,1) |
| R016 | Saturated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCS( 6) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.721E-03 | ALEACH( 6) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 6) |
| | | | | | |
| R016 | Distribution coefficients for daughter Pb-210 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 8.082E-04 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| | | | | | |
| R016 | Distribution coefficients for daughter Th-230 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCNUCC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCNUCU( 4,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCNUCS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.349E-06 | ALEACH( 4) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 4) |

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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R016 | Distribution coefficients for daughter U-234 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCC( 5) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCU( 5,1) |
| R016 | Saturated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCS( 5) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.721E-03 | ALEACH( 5) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 5) |
| | | | | | |
| R017 | Inhalation rate (m**3/yr) | 7.300E+03 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 2.500E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 4.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 8.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 1.700E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 6.000E-02 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |
| | | | | | |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R017 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R017 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| | | | | | |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | not used | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | not used | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | not used | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | not used | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 3.650E+01 | 3.650E+01 | --- | SOIL |

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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R018 | Drinking water intake (L/yr) | 3.500E+02 | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | 1.000E+00 | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | not used | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | not used | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | not used | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | not used | -1 | --- | FPLANT |
| R018 | Contamination fraction of meat | not used | -1 | --- | FMEAT |
| R018 | Contamination fraction of milk | not used | -1 | --- | FMILK |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | not used | 5.000E-01 | --- | LSI |
| R019 | Mass loading for foliar deposition (g/m**3) | not used | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | not used | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | not used | 1.000E+00 | --- | FGWIR |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | not used | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | not used | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | not used | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | not used | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | not used | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | not used | 8.000E-02 | --- | TE(3) |
| R19B | Translocation Factor for Non-Leafy | not used | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | not used | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | not used | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | not used | 2.000E+01 | --- | WLAM |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |

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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| | | | | | |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| | | | | | |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |
| TITL | Maximum number of integration points for dose | 17 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 257 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | suppressed |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | suppressed |
| 7 -- drinking water | active |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | active |

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

| Contaminated Zone Dimensions | | Initial Soil Concentrations, pCi/g | |
|---|---|---|---|
| Area: | 61000.00 square meters | Cs-137 | 2.440E+00 |
| Thickness: | 5.00 meters | Ra-226 | 1.300E-01 |
| Cover Depth: | 0.00 meters | U-238 | 1.200E+00 |

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 1.879E+00 | 1.854E+00 | 1.763E+00 | 1.666E+00 | 1.316E+00 | 9.187E-01 | 3.115E-01 | 1.934E-01 |
| M(t): | 1.253E-01 | 1.236E-01 | 1.175E-01 | 1.110E-01 | 8.776E-02 | 6.124E-02 | 2.076E-02 | 1.289E-02 |

Maximum TDOSE(t): 1.879E+00 mrem/yr at t = 0.000E+00 years

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.557E+00 | 0.8286 | 5.605E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.012E-03 | 0.0005 |
| Ra-226 | 2.755E-01 | 0.1466 | 8.475E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.563E-03 | 0.0008 |
| U-238 | 3.455E-02 | 0.0184 | 1.030E-03 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.701E-03 | 0.0014 |
| Total | 1.867E+00 | 0.9936 | 1.039E-03 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.276E-03 | 0.0028 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 4.072E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.558E+00 | 0.8291 |
| Ra-226 | 4.689E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.770E-01 | 0.1475 |
| U-238 | 5.697E-03 | 0.0030 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.398E-02 | 0.0234 |
| Total | 5.706E-03 | 0.0030 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.879E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.521E+00 | 0.8202 | 5.475E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.889E-04 | 0.0005 |
| Ra-226 | 2.753E-01 | 0.1485 | 9.132E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.801E-03 | 0.0010 |
| U-238 | 3.439E-02 | 0.0185 | 1.025E-03 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.688E-03 | 0.0014 |
| Total | 1.830E+00 | 0.9872 | 1.034E-03 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.478E-03 | 0.0030 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.204E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.522E+00 | 0.8207 |
| Ra-226 | 3.104E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.772E-01 | 0.1495 |
| U-238 | 1.711E-02 | 0.0092 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.520E-02 | 0.0298 |
| Total | 1.715E-02 | 0.0092 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.854E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.385E+00 | 0.7855 | 4.986E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.006E-04 | 0.0005 |
| Ra-226 | 2.747E-01 | 0.1558 | 1.155E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.680E-03 | 0.0015 |
| U-238 | 3.374E-02 | 0.0191 | 1.006E-03 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.638E-03 | 0.0015 |
| Total | 1.693E+00 | 0.9604 | 1.018E-03 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.218E-03 | 0.0035 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 4.036E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.386E+00 | 0.7860 |
| Ra-226 | 3.639E-04 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.777E-01 | 0.1575 |
| U-238 | 6.222E-02 | 0.0353 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.960E-02 | 0.0565 |
| Total | 6.262E-02 | 0.0355 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.763E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.232E+00 | 0.7397 | 4.436E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.011E-04 | 0.0005 |
| Ra-226 | 2.739E-01 | 0.1644 | 1.416E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.628E-03 | 0.0022 |
| U-238 | 3.296E-02 | 0.0198 | 9.821E-04 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.576E-03 | 0.0015 |
| Total | 1.539E+00 | 0.9239 | 9.967E-04 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.005E-03 | 0.0042 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 6.866E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.233E+00 | 0.7402 |
| Ra-226 | 1.190E-03 | 0.0007 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.787E-01 | 0.1673 |
| U-238 | 1.174E-01 | 0.0705 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.539E-01 | 0.0924 |
| Total | 1.187E-01 | 0.0713 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.666E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 4.833E-01 | 0.3671 | 1.740E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.143E-04 | 0.0002 |
| Ra-226 | 2.675E-01 | 0.2032 | 2.471E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.477E-03 | 0.0057 |
| U-238 | 2.729E-02 | 0.0207 | 8.132E-04 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.133E-03 | 0.0016 |
| Total | 7.781E-01 | 0.5911 | 8.381E-04 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.924E-03 | 0.0075 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.305E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.838E-01 | 0.3675 |
| Ra-226 | 1.276E-02 | 0.0097 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.878E-01 | 0.2186 |
| U-238 | 5.147E-01 | 0.3910 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.449E-01 | 0.4139 |
| Total | 5.276E-01 | 0.4008 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.316E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.501E-01 | 0.1633 | 5.403E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.757E-05 | 0.0001 |
| Ra-226 | 2.597E-01 | 0.2827 | 2.734E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.467E-03 | 0.0092 |
| U-238 | 2.155E-02 | 0.0235 | 6.423E-04 | 0.0007 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.685E-03 | 0.0018 |
| Total | 4.313E-01 | 0.4695 | 6.697E-04 | 0.0007 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.025E-02 | 0.0112 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 8.130E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.502E-01 | 0.1635 |
| Ra-226 | 2.242E-02 | 0.0244 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.906E-01 | 0.3163 |
| U-238 | 4.539E-01 | 0.4941 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.778E-01 | 0.5201 |
| Total | 4.764E-01 | 0.5186 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.187E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.295E-05 | 0.0000 | 4.663E-12 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.422E-09 | 0.0000 |
| Ra-226 | 2.047E-01 | 0.6572 | 2.224E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.926E-03 | 0.0222 |
| U-238 | 3.261E-03 | 0.0105 | 9.733E-05 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.553E-04 | 0.0008 |
| Total | 2.080E-01 | 0.6677 | 1.196E-04 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.181E-03 | 0.0231 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 3.738E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.300E-05 | 0.0000 |
| Ra-226 | 2.903E-02 | 0.0932 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.407E-01 | 0.7727 |
| U-238 | 6.716E-02 | 0.2156 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.077E-02 | 0.2272 |
| Total | 9.619E-02 | 0.3088 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.115E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.078E-10 | 0.0000 | 3.880E-17 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.007E-14 | 0.0000 |
| Ra-226 | 1.520E-01 | 0.7860 | 1.652E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.144E-03 | 0.0266 |
| U-238 | 3.084E-04 | 0.0016 | 9.204E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.416E-05 | 0.0001 |
| Total | 1.523E-01 | 0.7876 | 2.572E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.168E-03 | 0.0267 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 6.764E-13 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.085E-10 | 0.0000 |
| Ra-226 | 2.979E-02 | 0.1540 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.870E-01 | 0.9667 |
| U-238 | 6.100E-03 | 0.0315 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.441E-03 | 0.0333 |
| Total | 3.589E-02 | 0.1856 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.934E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Thread Fraction | DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137+D | Cs-137+D | 1.000E+00 | 6.384E-01 | 6.237E-01 | 5.680E-01 | 5.053E-01 | 1.983E-01 | 6.157E-02 | 5.327E-06 | 4.447E-11 |
| Ra-226+D | Ra-226+D | 1.000E+00 | 2.130E+00 | 2.129E+00 | 2.124E+00 | 2.118E+00 | 2.068E+00 | 2.008E+00 | 1.584E+00 | 1.179E+00 |
| Ra-226+D | Pb-210+D | 1.000E+00 | 9.931E-04 | 3.069E-03 | 1.254E-02 | 2.635E-02 | 1.457E-01 | 2.278E-01 | 2.671E-01 | 2.597E-01 |
| Ra-226+D | äDSR(j) | | 2.131E+00 | 2.132E+00 | 2.136E+00 | 2.144E+00 | 2.214E+00 | 2.235E+00 | 1.851E+00 | 1.438E+00 |
| U-238 | U-238 | 5.400E-05 | 4.060E-07 | 8.924E-07 | 2.816E-06 | 5.169E-06 | 2.210E-05 | 1.948E-05 | 2.879E-06 | 2.611E-07 |
| U-238+D | U-238+D | 9.999E-01 | 3.665E-02 | 4.600E-02 | 8.300E-02 | 1.283E-01 | 4.540E-01 | 3.980E-01 | 5.889E-02 | 5.351E-03 |
| U-238+D | U-234 | 9.999E-01 | 1.429E-08 | 8.059E-08 | 9.054E-07 | 3.166E-06 | 6.504E-05 | 1.141E-04 | 8.390E-05 | 1.520E-05 |
| U-238+D | Th-230 | 9.999E-01 | 6.297E-14 | 3.140E-13 | 3.242E-12 | 1.066E-11 | 2.114E-10 | 7.283E-10 | 5.949E-09 | 8.230E-09 |
| U-238+D | Ra-226+D | 9.999E-01 | 9.425E-12 | 2.873E-11 | 1.269E-10 | 2.023E-10 | 1.473E-09 | 7.207E-09 | 1.789E-07 | 5.481E-07 |
| U-238+D | Pb-210+D | 9.999E-01 | 2.592E-10 | 7.899E-10 | 3.472E-09 | 5.442E-09 | 2.812E-08 | 1.111E-07 | 5.488E-07 | 1.087E-06 |
| U-238+D | äDSR(j) | | 3.665E-02 | 4.600E-02 | 8.300E-02 | 1.283E-01 | 4.541E-01 | 3.982E-01 | 5.898E-02 | 5.368E-03 |

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| Cs-137 | 2.349E+01 | 2.405E+01 | 2.641E+01 | 2.969E+01 | 7.566E+01 | 2.436E+02 | 2.816E+06 | 3.373E+11 |
| Ra-226 | 7.039E+00 | 7.036E+00 | 7.021E+00 | 6.997E+00 | 6.776E+00 | 6.710E+00 | 8.102E+00 | 1.043E+01 |
| U-238 | 4.093E+02 | 3.261E+02 | 1.807E+02 | 1.169E+02 | 3.303E+01 | 3.767E+01 | 2.543E+02 | 2.794E+03 |

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

| Nuclide (i) | Initial (pCi/g) | tmin (years) | DSR(i,tmin) (pCi/g) | G(i,tmin) (pCi/g) | DSR(i,tmax) (pCi/g) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Cs-137 | 2.440E+00 | 0.000E+00 | 6.384E-01 | 2.349E+01 | 6.384E-01 | 2.349E+01 |
| Ra-226 | 1.300E-01 | 89.2 ñ 0.2 | 2.237E+00 | 6.706E+00 | 2.131E+00 | 7.039E+00 |
| U-238 | 1.200E+00 | 55.5 ñ 0.1 | 4.918E-01 | 3.050E+01 | 3.665E-02 | 4.093E+02 |

Summary : BP Solar-Industrial-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-BKG-SUBTRACT.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | THF(i) | DOSE(j,t), mrem/yr t= 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | Cs-137 | 1.000E+00 | 1.558E+00 | 1.522E+00 | 1.386E+00 | 1.233E+00 | 4.838E-01 | 1.502E-01 | 1.300E-05 | 1.085E-10 |
| Ra-226 | Ra-226 | 1.000E+00 | 2.769E-01 | 2.768E-01 | 2.761E-01 | 2.753E-01 | 2.688E-01 | 2.610E-01 | 2.060E-01 | 1.532E-01 |
| Ra-226 | U-238 | 9.999E-01 | 1.131E-11 | 3.448E-11 | 1.523E-10 | 2.428E-10 | 1.768E-09 | 8.648E-09 | 2.147E-07 | 6.578E-07 |
| Ra-226 | äDOSE(j) | | 2.769E-01 | 2.768E-01 | 2.761E-01 | 2.753E-01 | 2.688E-01 | 2.610E-01 | 2.060E-01 | 1.532E-01 |
| Pb-210 | Ra-226 | 1.000E+00 | 1.291E-04 | 3.989E-04 | 1.630E-03 | 3.425E-03 | 1.893E-02 | 2.961E-02 | 3.472E-02 | 3.375E-02 |
| Pb-210 | U-238 | 9.999E-01 | 3.110E-10 | 9.479E-10 | 4.167E-09 | 6.530E-09 | 3.375E-08 | 1.333E-07 | 6.585E-07 | 1.305E-06 |
| Pb-210 | äDOSE(j) | | 1.291E-04 | 3.989E-04 | 1.630E-03 | 3.425E-03 | 1.893E-02 | 2.961E-02 | 3.472E-02 | 3.376E-02 |
| U-238 | U-238 | 5.400E-05 | 4.872E-07 | 1.071E-06 | 3.379E-06 | 6.203E-06 | 2.653E-05 | 2.338E-05 | 3.455E-06 | 3.133E-07 |
| U-238 | U-238 | 9.999E-01 | 4.398E-02 | 5.520E-02 | 9.960E-02 | 1.539E-01 | 5.448E-01 | 4.777E-01 | 7.067E-02 | 6.421E-03 |
| U-238 | äDOSE(j) | | 4.398E-02 | 5.520E-02 | 9.960E-02 | 1.539E-01 | 5.448E-01 | 4.777E-01 | 7.067E-02 | 6.421E-03 |
| U-234 | U-238 | 9.999E-01 | 1.715E-08 | 9.671E-08 | 1.087E-06 | 3.800E-06 | 7.805E-05 | 1.369E-04 | 1.007E-04 | 1.824E-05 |
| Th-230 | U-238 | 9.999E-01 | 7.556E-14 | 3.768E-13 | 3.891E-12 | 1.280E-11 | 2.537E-10 | 8.740E-10 | 7.138E-09 | 9.876E-09 |

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | THF(i) | S(j,t), pCi/g t= 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | Cs-137 | 1.000E+00 | 2.440E+00 | 2.384E+00 | 2.171E+00 | 1.931E+00 | 7.575E-01 | 2.352E-01 | 2.030E-05 | 1.689E-10 |
| Ra-226 | Ra-226 | 1.000E+00 | 1.300E-01 | 1.299E-01 | 1.296E-01 | 1.292E-01 | 1.262E-01 | 1.225E-01 | 9.655E-02 | 7.170E-02 |
| Ra-226 | U-238 | 9.999E-01 | 0.000E+00 | 2.205E-15 | 2.729E-13 | 2.156E-12 | 2.441E-10 | 1.728E-09 | 8.886E-08 | 2.856E-07 |
| Ra-226 | äS(j): | | 1.300E-01 | 1.299E-01 | 1.296E-01 | 1.292E-01 | 1.262E-01 | 1.225E-01 | 9.655E-02 | 7.170E-02 |
| Pb-210 | Ra-226 | 1.000E+00 | 0.000E+00 | 3.976E-03 | 1.865E-02 | 3.449E-02 | 9.912E-02 | 1.163E-01 | 9.589E-02 | 7.121E-02 |
| Pb-210 | U-238 | 9.999E-01 | 0.000E+00 | 1.704E-17 | 1.030E-14 | 1.582E-13 | 7.255E-11 | 8.217E-10 | 7.629E-08 | 2.663E-07 |
| Pb-210 | äS(j): | | 0.000E+00 | 3.976E-03 | 1.865E-02 | 3.449E-02 | 9.912E-02 | 1.163E-01 | 9.589E-02 | 7.121E-02 |
| U-238 | U-238 | 5.400E-05 | 6.480E-05 | 6.449E-05 | 6.329E-05 | 6.181E-05 | 5.118E-05 | 4.042E-05 | 6.116E-06 | 5.773E-07 |
| U-238 | U-238 | 9.999E-01 | 1.200E+00 | 1.194E+00 | 1.172E+00 | 1.145E+00 | 9.477E-01 | 7.484E-01 | 1.133E-01 | 1.069E-02 |
| U-238 | äS(j): | | 1.200E+00 | 1.194E+00 | 1.172E+00 | 1.145E+00 | 9.477E-01 | 7.484E-01 | 1.133E-01 | 1.069E-02 |
| U-234 | U-238 | 9.999E-01 | 0.000E+00 | 3.386E-06 | 1.661E-05 | 3.245E-05 | 1.343E-04 | 2.121E-04 | 1.604E-04 | 3.026E-05 |
| Th-230 | U-238 | 9.999E-01 | 0.000E+00 | 1.526E-11 | 3.768E-10 | 1.484E-09 | 3.275E-08 | 1.124E-07 | 9.356E-07 | 1.295E-06 |

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 18.45 seconds

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Summary : BP Solar-Industrial-NO-Bkg subtract
File  : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

| Menu | Parameter | Current Value# | Base Case* | Parameter Name |
|---|---|---|---|---|
| A-1 | DCF's for external ground radiation, (mrem/yr)/(pCi/g) | | | |
| A-1 | At-218 (Source: FGR 12) | 5.847E-03 | 5.847E-03 | DCF1( 1) |
| A-1 | Ba-137m (Source: FGR 12) | 3.606E+00 | 3.606E+00 | DCF1( 2) |
| A-1 | Bi-210 (Source: FGR 12) | 3.606E-03 | 3.606E-03 | DCF1( 3) |
| A-1 | Bi-214 (Source: FGR 12) | 9.808E+00 | 9.808E+00 | DCF1( 4) |
| A-1 | Cs-137 (Source: FGR 12) | 7.510E-04 | 7.510E-04 | DCF1( 5) |
| A-1 | Pa-234 (Source: FGR 12) | 1.155E+01 | 1.155E+01 | DCF1( 6) |
| A-1 | Pa-234m (Source: FGR 12) | 8.967E-02 | 8.967E-02 | DCF1( 7) |
| A-1 | Pb-210 (Source: FGR 12) | 2.447E-03 | 2.447E-03 | DCF1( 8) |
| A-1 | Pb-214 (Source: FGR 12) | 1.341E+00 | 1.341E+00 | DCF1( 9) |
| A-1 | Po-210 (Source: FGR 12) | 5.231E-05 | 5.231E-05 | DCF1( 10) |
| A-1 | Po-214 (Source: FGR 12) | 5.138E-04 | 5.138E-04 | DCF1( 11) |
| A-1 | Po-218 (Source: FGR 12) | 5.642E-05 | 5.642E-05 | DCF1( 12) |
| A-1 | Ra-226 (Source: FGR 12) | 3.176E-02 | 3.176E-02 | DCF1( 13) |
| A-1 | Rn-222 (Source: FGR 12) | 2.354E-03 | 2.354E-03 | DCF1( 14) |
| A-1 | Th-230 (Source: FGR 12) | 1.209E-03 | 1.209E-03 | DCF1( 15) |
| A-1 | Th-234 (Source: FGR 12) | 2.410E-02 | 2.410E-02 | DCF1( 16) |
| A-1 | Tl-210 (Source: no data) | 0.000E+00 | -2.000E+00 | DCF1( 17) |
| A-1 | U-234 (Source: FGR 12) | 4.017E-04 | 4.017E-04 | DCF1( 18) |
| A-1 | U-238 (Source: FGR 12) | 1.031E-04 | 1.031E-04 | DCF1( 19) |
| | | | | |
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Cs-137+D | 3.190E-05 | 3.190E-05 | DCF2( 1) |
| B-1 | Pb-210+D | 2.320E-02 | 1.360E-02 | DCF2( 2) |
| B-1 | Ra-226+D | 8.594E-03 | 8.580E-03 | DCF2( 3) |
| B-1 | Th-230 | 3.260E-01 | 3.260E-01 | DCF2( 4) |
| B-1 | U-234 | 1.320E-01 | 1.320E-01 | DCF2( 5) |
| B-1 | U-238 | 1.180E-01 | 1.180E-01 | DCF2( 6) |
| B-1 | U-238+D | 1.180E-01 | 1.180E-01 | DCF2( 7) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Cs-137+D | 5.000E-05 | 5.000E-05 | DCF3( 1) |
| D-1 | Pb-210+D | 7.276E-03 | 5.370E-03 | DCF3( 2) |
| D-1 | Ra-226+D | 1.321E-03 | 1.320E-03 | DCF3( 3) |
| D-1 | Th-230 | 5.480E-04 | 5.480E-04 | DCF3( 4) |
| D-1 | U-234 | 2.830E-04 | 2.830E-04 | DCF3( 5) |
| D-1 | U-238 | 2.550E-04 | 2.550E-04 | DCF3( 6) |
| D-1 | U-238+D | 2.687E-04 | 2.550E-04 | DCF3( 7) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 1,1) |
| D-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 1,2) |
| D-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 8.000E-03 | 8.000E-03 | RTF( 1,3) |
| D-34 | | | | |
| D-34 | Pb-210+D , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1) |
| D-34 | Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 8.000E-04 | 8.000E-04 | RTF( 2,2) |
| D-34 | Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 3.000E-04 | 3.000E-04 | RTF( 2,3) |
| D-34 | | | | |

Summary : BP Solar-Industrial-NO-Bkg subtract
File  : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

| Menu | Parameter | Current Value# | Base Case* | Parameter Name |
|---|---|---|---|---|
| D-34 | Ra-226+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 3,1) |
| D-34 | Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,2) |
| D-34 | Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-03 | 1.000E-03 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | Th-230 , plant/soil concentration ratio, dimensionless | 1.000E-03 | 1.000E-03 | RTF( 4,1) |
| D-34 | Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 4,2) |
| D-34 | Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 5.000E-06 | 5.000E-06 | RTF( 4,3) |
| D-34 | | | | |
| D-34 | U-234 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 5,1) |
| D-34 | U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 5,2) |
| D-34 | U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 5,3) |
| D-34 | | | | |
| D-34 | U-238 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 6,1) |
| D-34 | U-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 6,2) |
| D-34 | U-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 6,3) |
| D-34 | | | | |
| D-34 | U-238+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 7,1) |
| D-34 | U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 7,2) |
| D-34 | U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 7,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Cs-137+D , fish | 2.000E+03 | 2.000E+03 | BIOFAC( 1,1) |
| D-5 | Cs-137+D , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pb-210+D , fish | 3.000E+02 | 3.000E+02 | BIOFAC( 2,1) |
| D-5 | Pb-210+D , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Ra-226+D , fish | 5.000E+01 | 5.000E+01 | BIOFAC( 3,1) |
| D-5 | Ra-226+D , crustacea and mollusks | 2.500E+02 | 2.500E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | Th-230 , fish | 1.000E+02 | 1.000E+02 | BIOFAC( 4,1) |
| D-5 | Th-230 , crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 4,2) |
| D-5 | | | | |
| D-5 | U-234 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 5,1) |
| D-5 | U-234 , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 5,2) |
| D-5 | | | | |
| D-5 | U-238 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 6,1) |
| D-5 | U-238 , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 6,2) |
| D-5 | | | | |
| D-5 | U-238+D , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 7,1) |
| D-5 | U-238+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 7,2) |

#For DCF1(xxx) only, factors are for infinite depth & area.  See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Summary : BP Solar-Industrial-NO-Bkg subtract
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## Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 6.100E+04 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 5.000E+00 | 2.000E+00 | --- | THICK0 |
| R011 | Fraction of contamination that is submerged | 0.000E+00 | 0.000E+00 | --- | SUBMFRACT |
| R011 | Length parallel to aquifer flow (m) | 2.500E+02 | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 1.500E+01 | 3.000E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 5.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 5.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 5.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| R012 | Initial principal radionuclide (pCi/g): Cs-137 | 2.440E+00 | 0.000E+00 | --- | S1(1) |
| R012 | Initial principal radionuclide (pCi/g): Ra-226 | 6.900E-01 | 0.000E+00 | --- | S1(3) |
| R012 | Initial principal radionuclide (pCi/g): U-238 | 1.200E+00 | 0.000E+00 | --- | S1(6) |
| R012 | Concentration in groundwater (pCi/L): Cs-137 | not used | 0.000E+00 | --- | W1( 1) |
| R012 | Concentration in groundwater (pCi/L): Ra-226 | not used | 0.000E+00 | --- | W1( 3) |
| R012 | Concentration in groundwater (pCi/L): U-238 | not used | 0.000E+00 | --- | W1( 6) |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.660E+00 | 1.500E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 3.300E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 2.400E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 5.000E+03 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 4.900E+00 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 6.230E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 4.600E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 1.230E+00 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 2.600E-01 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 2.000E-01 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | 1.000E+06 | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | 1.000E-03 | 1.000E-03 | --- | EPS |
| R014 | Density of saturated zone (g/cm**3) | 1.660E+00 | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | 3.300E-01 | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | 2.400E-01 | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | 2.000E-01 | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | 2.000E+04 | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | 4.800E-03 | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | 4.900E+00 | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VWT |

Summary : BP Solar-Industrial-NO-Bkg subtract
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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R014 | Well pump intake depth (m below water table) | 1.800E+01 | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | not used | 2.500E+02 | --- | UW |
| | | | | | |
| R015 | Number of unsaturated zone strata | 1 | 1 | --- | NS |
| R015 | Unsat. zone 1, thickness (m) | 0.000E+00 | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | 1.660E+00 | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | 3.300E-01 | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | 2.400E-01 | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | 2.000E-01 | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | 4.900E+00 | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | 5.000E+03 | 1.000E+01 | --- | HCUZ(1) |
| | | | | | |
| R016 | Distribution coefficients for Cs-137 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.800E+02 | 4.600E+03 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | 2.800E+02 | 4.600E+03 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | 2.800E+02 | 4.600E+03 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.889E-04 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| | | | | | |
| R016 | Distribution coefficients for Ra-226 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+02 | 7.000E+01 | --- | DCNUCC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+02 | 7.000E+01 | --- | DCNUCU( 3,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+02 | 7.000E+01 | --- | DCNUCS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.618E-04 | ALEACH( 3) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 3) |
| | | | | | |
| R016 | Distribution coefficients for U-238 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCC( 6) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCU( 6,1) |
| R016 | Saturated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCS( 6) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.721E-03 | ALEACH( 6) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 6) |
| | | | | | |
| R016 | Distribution coefficients for daughter Pb-210 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 8.082E-04 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| | | | | | |
| R016 | Distribution coefficients for daughter Th-230 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCNUCC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCNUCU( 4,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCNUCS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.349E-06 | ALEACH( 4) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 4) |

Summary : BP Solar-Industrial-NO-Bkg subtract
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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R016 | Distribution coefficients for daughter U-234 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCC( 5) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCU( 5,1) |
| R016 | Saturated zone (cm**3/g) | 1.700E+01 | 5.000E+01 | --- | DCNUCS( 5) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.721E-03 | ALEACH( 5) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 5) |
| R017 | Inhalation rate (m**3/yr) | 7.300E+03 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 2.500E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 4.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 8.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 1.700E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 6.000E-02 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R017 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R017 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | not used | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | not used | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | not used | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | not used | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 3.650E+01 | 3.650E+01 | --- | SOIL |

Summary : BP Solar-Industrial-NO-Bkg subtract
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Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R018 | Drinking water intake (L/yr) | 3.500E+02 | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | 1.000E+00 | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | not used | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | not used | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | not used | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | not used | -1 | --- | FPLANT |
| R018 | Contamination fraction of meat | not used | -1 | --- | FMEAT |
| R018 | Contamination fraction of milk | not used | -1 | --- | FMILK |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | not used | 5.000E-01 | --- | LSI |
| R019 | Mass loading for foliar deposition (g/m**3) | not used | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | not used | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | not used | 1.000E+00 | --- | FGWIR |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | not used | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | not used | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | not used | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | not used | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | not used | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | not used | 8.000E-02 | --- | TE(3) |
| R19B | Translocation Factor for Non-Leafy | not used | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | not used | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | not used | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | not used | 2.000E+01 | --- | WLAM |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| | | | | | |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| | | | | | |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |
| TITL | Maximum number of integration points for dose | 17 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 257 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | suppressed |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | suppressed |
| 7 -- drinking water | active |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | active |

Summary : BP Solar-Industrial-NO-Bkg subtract

File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

| Contaminated Zone Dimensions | | Initial Soil Concentrations, pCi/g | |
|---|---|---|---|
| Area: | 61000.00 square meters | Cs-137 | 2.440E+00 |
| Thickness: | 5.00 meters | Ra-226 | 6.900E-01 |
| Cover Depth: | 0.00 meters | U-238 | 1.200E+00 |

Total Dose TDOSE(t), mrem/yr

Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 3.072E+00 | 3.048E+00 | 2.960E+00 | 2.866E+00 | 2.556E+00 | 2.170E+00 | 1.348E+00 | 9.988E-01 |
| M(t): | 2.048E-01 | 2.032E-01 | 1.973E-01 | 1.911E-01 | 1.704E-01 | 1.447E-01 | 8.988E-02 | 6.659E-02 |

Maximum TDOSE(t): 3.072E+00 mrem/yr at t = 0.000E+00 years

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.557E+00 | 0.5067 | 5.605E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.012E-03 | 0.0003 |
| Ra-226 | 1.462E+00 | 0.4759 | 4.498E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.297E-03 | 0.0027 |
| U-238 | 3.455E-02 | 0.0112 | 1.030E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.701E-03 | 0.0009 |
| Total | 3.053E+00 | 0.9939 | 1.075E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.201E-02 | 0.0039 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 4.072E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.558E+00 | 0.5071 |
| Ra-226 | 2.489E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.470E+00 | 0.4786 |
| U-238 | 5.697E-03 | 0.0019 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.398E-02 | 0.0143 |
| Total | 5.726E-03 | 0.0019 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.072E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.521E+00 | 0.4989 | 5.475E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.889E-04 | 0.0003 |
| Ra-226 | 1.461E+00 | 0.4794 | 4.847E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.561E-03 | 0.0031 |
| U-238 | 3.439E-02 | 0.0113 | 1.025E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.688E-03 | 0.0009 |
| Total | 3.016E+00 | 0.9896 | 1.074E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.324E-02 | 0.0043 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.204E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.522E+00 | 0.4993 |
| Ra-226 | 1.647E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.471E+00 | 0.4826 |
| U-238 | 1.711E-02 | 0.0056 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.520E-02 | 0.0181 |
| Total | 1.728E-02 | 0.0057 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.048E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.385E+00 | 0.4679 | 4.986E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.006E-04 | 0.0003 |
| Ra-226 | 1.458E+00 | 0.4926 | 6.131E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.422E-02 | 0.0048 |
| U-238 | 3.374E-02 | 0.0114 | 1.006E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.638E-03 | 0.0009 |
| Total | 2.877E+00 | 0.9719 | 1.067E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.776E-02 | 0.0060 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 4.036E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.386E+00 | 0.4683 |
| Ra-226 | 1.931E-03 | 0.0007 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.474E+00 | 0.4981 |
| U-238 | 6.222E-02 | 0.0210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.960E-02 | 0.0337 |
| Total | 6.419E-02 | 0.0217 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.960E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.232E+00 | 0.4299 | 4.436E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.011E-04 | 0.0003 |
| Ra-226 | 1.454E+00 | 0.5072 | 7.517E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.925E-02 | 0.0067 |
| U-238 | 3.296E-02 | 0.0115 | 9.821E-04 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.576E-03 | 0.0009 |
| Total | 2.719E+00 | 0.9485 | 1.058E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.263E-02 | 0.0079 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 6.866E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.233E+00 | 0.4302 |
| Ra-226 | 6.316E-03 | 0.0022 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.479E+00 | 0.5161 |
| U-238 | 1.174E-01 | 0.0410 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.539E-01 | 0.0537 |
| Total | 1.238E-01 | 0.0432 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.866E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 4.833E-01 | 0.1891 | 1.740E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.143E-04 | 0.0001 |
| Ra-226 | 1.420E+00 | 0.5555 | 1.312E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.968E-02 | 0.0155 |
| U-238 | 2.729E-02 | 0.0107 | 8.132E-04 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.133E-03 | 0.0008 |
| Total | 1.930E+00 | 0.7552 | 9.445E-04 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.213E-02 | 0.0165 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.305E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.838E-01 | 0.1893 |
| Ra-226 | 6.773E-02 | 0.0265 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.527E+00 | 0.5976 |
| U-238 | 5.147E-01 | 0.2014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.449E-01 | 0.2132 |
| Total | 5.825E-01 | 0.2279 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.556E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.501E-01 | 0.0691 | 5.403E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.757E-05 | 0.0000 |
| Ra-226 | 1.378E+00 | 0.6350 | 1.451E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.494E-02 | 0.0207 |
| U-238 | 2.155E-02 | 0.0099 | 6.423E-04 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.685E-03 | 0.0008 |
| Total | 1.550E+00 | 0.7141 | 7.875E-04 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.672E-02 | 0.0215 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 8.130E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.502E-01 | 0.0692 |
| Ra-226 | 1.190E-01 | 0.0548 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.542E+00 | 0.7106 |
| U-238 | 4.539E-01 | 0.2091 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.778E-01 | 0.2201 |
| Total | 5.730E-01 | 0.2640 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.170E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.295E-05 | 0.0000 | 4.663E-12 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.422E-09 | 0.0000 |
| Ra-226 | 1.086E+00 | 0.8058 | 1.181E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.676E-02 | 0.0273 |
| U-238 | 3.261E-03 | 0.0024 | 9.733E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.553E-04 | 0.0002 |
| Total | 1.090E+00 | 0.8083 | 2.154E-04 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.702E-02 | 0.0275 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | | | | | | | | | | | | | | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 3.738E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.300E-05 | 0.0000 |
| Ra-226 | 1.541E-01 | 0.1143 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.277E+00 | 0.9475 |
| U-238 | 6.716E-02 | 0.0498 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.077E-02 | 0.0525 |
| Total | 2.213E-01 | 0.1641 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.348E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

| | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 1.078E-10 | 0.0000 | 3.880E-17 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.007E-14 | 0.0000 |
| Ra-226 | 8.069E-01 | 0.8078 | 8.768E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.730E-02 | 0.0273 |
| U-238 | 3.084E-04 | 0.0003 | 9.204E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.416E-05 | 0.0000 |
| Total | 8.072E-01 | 0.8081 | 9.688E-05 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.732E-02 | 0.0274 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 6.764E-13 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.085E-10 | 0.0000 |
| Ra-226 | 1.581E-01 | 0.1583 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.924E-01 | 0.9936 |
| U-238 | 6.100E-03 | 0.0061 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.441E-03 | 0.0064 |
| Total | 1.642E-01 | 0.1644 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.988E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Thread Fraction | DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137+D | Cs-137+D | 1.000E+00 | 6.384E-01 | 6.237E-01 | 5.680E-01 | 5.053E-01 | 1.983E-01 | 6.157E-02 | 5.327E-06 | 4.447E-11 |
| Ra-226+D | Ra-226+D | 1.000E+00 | 2.130E+00 | 2.129E+00 | 2.124E+00 | 2.118E+00 | 2.068E+00 | 2.008E+00 | 1.584E+00 | 1.179E+00 |
| Ra-226+D | Pb-210+D | 1.000E+00 | 9.931E-04 | 3.069E-03 | 1.254E-02 | 2.635E-02 | 1.457E-01 | 2.278E-01 | 2.671E-01 | 2.597E-01 |
| Ra-226+D | äDSR(j) | | 2.131E+00 | 2.132E+00 | 2.136E+00 | 2.144E+00 | 2.214E+00 | 2.235E+00 | 1.851E+00 | 1.438E+00 |
| U-238 | U-238 | 5.400E-05 | 4.060E-07 | 8.924E-07 | 2.816E-06 | 5.169E-06 | 2.210E-05 | 1.948E-05 | 2.879E-06 | 2.611E-07 |
| U-238+D | U-238+D | 9.999E-01 | 3.665E-02 | 4.600E-02 | 8.300E-02 | 1.283E-01 | 4.540E-01 | 3.980E-01 | 5.889E-02 | 5.351E-03 |
| U-238+D | U-234 | 9.999E-01 | 1.429E-08 | 8.059E-08 | 9.054E-07 | 3.166E-06 | 6.504E-05 | 1.141E-04 | 8.390E-05 | 1.520E-05 |
| U-238+D | Th-230 | 9.999E-01 | 6.297E-14 | 3.140E-13 | 3.242E-12 | 1.066E-11 | 2.114E-10 | 7.283E-10 | 5.949E-09 | 8.230E-09 |
| U-238+D | Ra-226+D | 9.999E-01 | 9.425E-12 | 2.873E-11 | 1.269E-10 | 2.023E-10 | 1.473E-09 | 7.207E-09 | 1.789E-07 | 5.481E-07 |
| U-238+D | Pb-210+D | 9.999E-01 | 2.592E-10 | 7.899E-10 | 3.472E-09 | 5.442E-09 | 2.812E-08 | 1.111E-07 | 5.488E-07 | 1.087E-06 |
| U-238+D | äDSR(j) | | 3.665E-02 | 4.600E-02 | 8.300E-02 | 1.283E-01 | 4.541E-01 | 3.982E-01 | 5.898E-02 | 5.368E-03 |

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| Cs-137 | 2.349E+01 | 2.405E+01 | 2.641E+01 | 2.969E+01 | 7.566E+01 | 2.436E+02 | 2.816E+06 | 3.373E+11 |
| Ra-226 | 7.039E+00 | 7.036E+00 | 7.021E+00 | 6.997E+00 | 6.776E+00 | 6.710E+00 | 8.102E+00 | 1.043E+01 |
| U-238 | 4.093E+02 | 3.261E+02 | 1.807E+02 | 1.169E+02 | 3.303E+01 | 3.767E+01 | 2.543E+02 | 2.794E+03 |

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

| Nuclide (i) | Initial (pCi/g) | tmin (years) | DSR(i,tmin) (pCi/g) | G(i,tmin) (pCi/g) | DSR(i,tmax) (pCi/g) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Cs-137 | 2.440E+00 | 0.000E+00 | 6.384E-01 | 2.349E+01 | 6.384E-01 | 2.349E+01 |
| Ra-226 | 6.900E-01 | 89.2 ñ 0.2 | 2.237E+00 | 6.706E+00 | 2.131E+00 | 7.039E+00 |
| U-238 | 1.200E+00 | 55.5 ñ 0.1 | 4.918E-01 | 3.050E+01 | 3.665E-02 | 4.093E+02 |

Summary : BP Solar-Industrial-NO-Bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\BP-SOLAR-IND-NO-BKG-SUBTRACT.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | THF(i) | DOSE(j,t), mrem/yr t= 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | Cs-137 | 1.000E+00 | 1.558E+00 | 1.522E+00 | 1.386E+00 | 1.233E+00 | 4.838E-01 | 1.502E-01 | 1.300E-05 | 1.085E-10 |
| Ra-226 | Ra-226 | 1.000E+00 | 1.470E+00 | 1.469E+00 | 1.465E+00 | 1.461E+00 | 1.427E+00 | 1.385E+00 | 1.093E+00 | 8.132E-01 |
| Ra-226 | U-238 | 9.999E-01 | 1.131E-11 | 3.448E-11 | 1.523E-10 | 2.428E-10 | 1.768E-09 | 8.648E-09 | 2.147E-07 | 6.578E-07 |
| Ra-226 | äDOSE(j) | | 1.470E+00 | 1.469E+00 | 1.465E+00 | 1.461E+00 | 1.427E+00 | 1.385E+00 | 1.093E+00 | 8.132E-01 |
| Pb-210 | Ra-226 | 1.000E+00 | 6.852E-04 | 2.117E-03 | 8.651E-03 | 1.818E-02 | 1.005E-01 | 1.572E-01 | 1.843E-01 | 1.792E-01 |
| Pb-210 | U-238 | 9.999E-01 | 3.110E-10 | 9.479E-10 | 4.167E-09 | 6.530E-09 | 3.375E-08 | 1.333E-07 | 6.585E-07 | 1.305E-06 |
| Pb-210 | äDOSE(j) | | 6.852E-04 | 2.117E-03 | 8.651E-03 | 1.818E-02 | 1.005E-01 | 1.572E-01 | 1.843E-01 | 1.792E-01 |
| U-238 | U-238 | 5.400E-05 | 4.872E-07 | 1.071E-06 | 3.379E-06 | 6.203E-06 | 2.653E-05 | 2.338E-05 | 3.455E-06 | 3.133E-07 |
| U-238 | U-238 | 9.999E-01 | 4.398E-02 | 5.520E-02 | 9.960E-02 | 1.539E-01 | 5.448E-01 | 4.777E-01 | 7.067E-02 | 6.421E-03 |
| U-238 | äDOSE(j) | | 4.398E-02 | 5.520E-02 | 9.960E-02 | 1.539E-01 | 5.448E-01 | 4.777E-01 | 7.067E-02 | 6.421E-03 |
| U-234 | U-238 | 9.999E-01 | 1.715E-08 | 9.671E-08 | 1.087E-06 | 3.800E-06 | 7.805E-05 | 1.369E-04 | 1.007E-04 | 1.824E-05 |
| Th-230 | U-238 | 9.999E-01 | 7.556E-14 | 3.768E-13 | 3.891E-12 | 1.280E-11 | 2.537E-10 | 8.740E-10 | 7.138E-09 | 9.876E-09 |

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | THF(i) | S(j,t), pCi/g t= 0.000E+00 | 1.000E+00 | 5.000E+00 | 1.000E+01 | 5.000E+01 | 1.000E+02 | 5.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | Cs-137 | 1.000E+00 | 2.440E+00 | 2.384E+00 | 2.171E+00 | 1.931E+00 | 7.575E-01 | 2.352E-01 | 2.030E-05 | 1.689E-10 |
| Ra-226 | Ra-226 | 1.000E+00 | 6.900E-01 | 6.896E-01 | 6.880E-01 | 6.859E-01 | 6.698E-01 | 6.501E-01 | 5.124E-01 | 3.806E-01 |
| Ra-226 | U-238 | 9.999E-01 | 0.000E+00 | 2.205E-15 | 2.729E-13 | 2.156E-12 | 2.441E-10 | 1.728E-09 | 8.886E-08 | 2.856E-07 |
| Ra-226 | äS(j): | | 6.900E-01 | 6.896E-01 | 6.880E-01 | 6.859E-01 | 6.698E-01 | 6.501E-01 | 5.124E-01 | 3.806E-01 |
| Pb-210 | Ra-226 | 1.000E+00 | 0.000E+00 | 2.110E-02 | 9.897E-02 | 1.831E-01 | 5.261E-01 | 6.175E-01 | 5.089E-01 | 3.780E-01 |
| Pb-210 | U-238 | 9.999E-01 | 0.000E+00 | 1.704E-17 | 1.030E-14 | 1.582E-13 | 7.255E-11 | 8.217E-10 | 7.629E-08 | 2.663E-07 |
| Pb-210 | äS(j): | | 0.000E+00 | 2.110E-02 | 9.897E-02 | 1.831E-01 | 5.261E-01 | 6.175E-01 | 5.089E-01 | 3.780E-01 |
| U-238 | U-238 | 5.400E-05 | 6.480E-05 | 6.449E-05 | 6.329E-05 | 6.181E-05 | 5.118E-05 | 4.042E-05 | 6.116E-06 | 5.773E-07 |
| U-238 | U-238 | 9.999E-01 | 1.200E+00 | 1.194E+00 | 1.172E+00 | 1.145E+00 | 9.477E-01 | 7.484E-01 | 1.133E-01 | 1.069E-02 |
| U-238 | äS(j): | | 1.200E+00 | 1.194E+00 | 1.172E+00 | 1.145E+00 | 9.477E-01 | 7.484E-01 | 1.133E-01 | 1.069E-02 |
| U-234 | U-238 | 9.999E-01 | 0.000E+00 | 3.386E-06 | 1.661E-05 | 3.245E-05 | 1.343E-04 | 2.121E-04 | 1.604E-04 | 3.026E-05 |
| Th-230 | U-238 | 9.999E-01 | 0.000E+00 | 1.526E-11 | 3.768E-10 | 1.484E-09 | 3.275E-08 | 1.124E-07 | 9.356E-07 | 1.295E-06 |

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 18.55 seconds

# Appendix C
# ORISE IVS Report

November 15, 2010

Ms. Terri Kneitel
U.S. Department of Energy
Brookhaven Site Office
53 Bell Ave., Building 464
Upton, NY 11973

**SUBJECT: DOE CONTRACT NO. DE-AC05-06OR23100**
**FINAL REPORT— INDEPENDENT VERIFICATION SURVEY REPORT FOR THE LONG ISLAND SOLAR FARM, BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK**
**DCN: 5119-SR-01-0**

Dear Ms. Kneitel:

The Oak Ridge Institute for Science and Education (ORISE) is pleased to provide the enclosed final independent verification survey report for the Long Island Solar Farm. My contact information is provided below or you may contact Phyllis Weaver at 865.576.5321 should you have any questions.

Sincerely,

Evan M. Harpenau
Health Physicist/Assistant Project Manager
IEAV Survey Projects

EMH:bf

Enclosure:

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# INDEPENDENT VERIFICATION SURVEY REPORT FOR THE LONG ISLAND SOLAR FARM BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

**E. M. Harpenau**

Prepared for the
U.S. Department of Energy

ORISE
Oak Ridge Institute for Science and Education

The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 98 colleges and universities.

# INDEPENDENT VERIFICATION SURVEY REPORT FOR THE LONG ISLAND SOLAR FARM BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

Prepared by: Evan M Harpenau Date: 11/12/10
E. M. Harpenau, Assistant Project Manager
Independent Environmental Assessment and Verification

Reviewed by: Phyllis D Vitkus for Date: 11/12/10
T. J. Vitkus, IEAV Associate Director
Director Survey Operations
Independent Environmental Assessment and Verification

Reviewed by: R. D. Condra Date: 11/12/10
R. D. Condra, Laboratory Group Manager
Independent Environmental Assessment and Verification

Reviewed by: Ann Templon Date: 11/15/10
F. A. Templon, Director BusOps and QA
Independent Environmental Assessment and Verification

# INDEPENDENT VERIFICATION SURVEY REPORT FOR THE LONG ISLAND SOLAR FARM BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

Prepared by

E. M. Harpenau


Independent Environmental Assessment and Verification Program
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0017

Prepared for the
U.S. Department of Energy

**FINAL REPORT**

**NOVEMBER 2010**

This report is based on work performed by the Oak Ridge Institute for Science and Education
Under contract number DE-AC05-06OR23100 with the U.S. Department of Energy.

## ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

### FIELD AND SUPPORT

E. M. Harpenau
T. D. Herrera
E. Montalvo

### LABORATORY

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## LIST OF TABLES

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AEC | Atomic Energy Commission |
| AOC | area of concern |
| BKG | background |
| BHSO | Brookhaven Site Office |
| BNL | Brookhaven National Laboratory |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| cm | centimeter |
| cpm | counts per minute |
| $DCGL_W$ | derived concentration guideline level |
| DOE | U.S. Department of Energy |
| EPA | Environmental Protection Agency |
| FIPS | Federal Information Processing Standard |
| FHWMF | Former Hazardous Waste Management Facility |
| FSP | Field Sampling Plan |
| FSS | final status survey |
| GPS | global positioning system |
| HFBR | High Flux Beam Reactor |
| ISM | Integrated Safety Management |
| ITP | Intercomparison Testing Program |
| IV | independent verification |
| JHA | job hazard analysis |
| LIPA | Long Island Power Authority |
| LISF | Long Island Solar Farm |
| MAPEP | Mixed Analyte Performance Evaluation Program |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MDC | minimum detectable concentration |
| MeV | million electron volts |
| $m^2$ | square meter |
| NaI | sodium iodide |
| NIST | National Institute of Standards and Technology |
| NRIP | NIST Radiochemistry Intercomparison Program |
| ORAU | Oak Ridge Associated Universities |
| ORISE | Oak Ridge Institute for Science and Education |
| OU | Operable Unit |
| pCi/g | picocuries per gram |
| PSP | project-specific plan |
| RCRA | Resource Conservation and Recovery Act |
| RSS | ranked set sampling |
| SPCS | State Plane Coordinate System |
| SU | survey unit |
| TAP | total absorption peak |
| VSP | Visual Sampling Plan |

# INDEPENDENT VERIFICATION SURVEY REPORT FOR THE LONG ISLAND SOLAR FARM BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

## 1.0 INTRODUCTION

The Brookhaven National Laboratory (BNL) located in Upton, Suffolk County, New York conducts research and development for the U.S. Department of Energy (DOE) Figure A-1. The BNL site was originally occupied by the U.S. Army as Camp Upton during both World Wars I and II. In 1947, the site was transferred to the Atomic Energy Commission (AEC). The AEC was resolved into the Energy Research and Development Administration, and later into the U.S. Department of Energy.

On December 21, 1989, BNL was included on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List. The DOE-Brookhaven Site Office (BHSO) entered into an agreement to establish the framework and schedule for characterizing, assessing, and remediating the site in accordance with CERCLA and the Resource Conservation and Recovery Act (RCRA) requirements. BNL generated the Response Strategy Document that identified various Areas of Concern (AOC) and grouped each AOC into seven "Operable Units" (OU). OU-1 is the Former Hazardous Waste Management Facility (FHWMF); and just to the south is an 11-acre site that DOE will provide as an easement to the Long Island Power Authority (LIPA) to establish and operate the Long Island Solar Farm (LISF): a large-scale solar energy facility.

The LISF will eventually have the capacity to generate up to 32MW of power to LIPA consumers. At its peak capacity, the LISF will utilize at least 200 acres of BNL unused land resources. During the initial start-up, the LISF project will install ground mounted crystalline solar photovoltaic modules in an area of 11 acres just east of the FHWMF (BNL 2010).

DOE-BHSO is responsible for oversight of remedial actions that are conducted at the BNL. It is the policy of the DOE to perform independent (third party) verification of final status survey (FSS) activities (DOE 2006). The purpose of independent verification (IV) is to confirm that remedial actions have been effective in meeting established guidelines and that documentation accurately and adequately describes the final site conditions. Oak Ridge Institute for Science and Education (ORISE) has been requested by DOE-BHSO to perform IV of the LISF. Through a third party,

DOE can provide a level of assurance to the stakeholders that the as-left radiological concentration in the LISF will be well below the approved remediation guidelines.

ORISE conducted IV of accessible areas to confirm that the FSS sampling results could be independently verified. ORISE implemented various survey activities that included walk-over gamma scans and soil sampling. The elements of the IV were based on the objectives specified in the project-specific plan (PSP) (ORISE 2010a).

The primary contaminants are cesium-137 and strontium-90. However, radium-226 has been identified at BNL in limited areas and in small quantities (Table 1).

## 2.0 SITE DESCRIPTION

The primary area of the LISF consists of 11 acres. The main section is located to the east of the FHWMF (Figure A-2). The smaller area is across Brookhaven Avenue on the north side of the road.

## 3.0 OBJECTIVES

The objective of the verification survey was to obtain evidence by means of measurements and sampling to confirm that the final radiological conditions were less than the cleanup goals. This objective was achieved via multiple verification components including document reviews to determine the accuracy and adequacy of FSS documentation.

## 4.0 DOCUMENT REVIEW

ORISE has reviewed various supporting documents for the LISF Project. Documents reviewed include the Addendum to the Field Sampling Plan (FSP) for the FHWMF, LISF Project Fact Sheet, and survey data results (BNL 2009 and 2010). The sample data were evaluated to assure that the residual activity levels in the soil satisfied the cleanup goals.

## 5.0 PROCEDURES

ORISE personnel visited the BNL site from September 25 through October 1, 2010, to perform visual inspections, independent measurements, and sampling. The verification activities were conducted in accordance with the project-specific verification plan and the IEAV Survey Procedures and Quality Program Manuals (ORISE 2010a and 2008, and ORAU 2009). The two verified site areas consisted of 11 acres divided by Brookhaven Avenue. Because the verified survey unit (SU)

had the potential of being contaminated, it was designated as a Class 2 area in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance (NRC 2000). From September 25 through 29, 2010, ORISE personnel performed medium-density walk-over surveys and conducted IV soil samples.

### 5.1 REFERENCE SYSTEM

ORISE used a global positioning system (GPS) for documenting survey area boundaries and tracking data. The specific geographic coordinate system used was the State Plane Coordinate System (SPCS) New York Long Island Federal Information Processing Standard (FIPS) 3104. A shape file of the area to be verified was not provided prior to verification survey activities. ORISE performed a walk-over survey with a GPS system along the boundary of the 11 acres to create the necessary shape file required to document scans and generate sample locations. Coordinate measurements collected using the GPS were accurate to within one meter.

### 5.2 SURFACE SCANS

Medium density surface scans for gamma radiation were conducted over the accessible Class 2 areas. Surface scans were performed using sodium iodide (NaI) scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Detectors were coupled to GPS systems that enable real-time gamma count rate and position data capture (Figure A-3). Lead shields were inadvertently left on the detectors from previous IV survey activities around the High Flux Beam Reactor (HFBR). Upon discovery, this issue was immediately resolved by removing the shielding on the detectors in use. Scan surveys and direct measurement collection were finished using unshielded detectors. The data collected with the shielded detectors were normalized onsite to determine the correct locations to be sampled. The normalization method used is discussed in "Results and Findings." Any locations of elevated direct radiation, exhibiting the presence of residual contamination, were to be marked and identified for further investigation.

### 5.3 SOIL SAMPLING

The Visual Sampling Plan (VSP) software was used to generate random coordinates for gamma measurements and soil sampling. These measurement/sample points were downloaded to the GPS and were based upon the reference grid system established for the site. The predetermined random

field assessment and the resultant soil sample locations were designed and generated based on the ranked set sampling (RSS) approach (EPA 2006).

RSS provides a methodology to determine the necessary number of soil samples to estimate the mean concentration of a population; however, it does not require the assumption of a normal distribution. The process combines random sampling with the use of professional judgment to select sampling locations. Professional judgment relies upon the ability to assess the relative magnitude of gamma radiation levels between randomly selected locations. In this case, the gamma count rate data collected at randomly selected locations provided the measurable field screening method that correlates with the relative concentrations of the gamma-emitting contaminants of concern. The count rate data obtained were then used to select a specific sampling location.

VSP systematic planning process uses a replication method on a larger random population from which the locations for the resulting samples can be selected. Replication refers to the number of cycles (*r)* for performing a set size (*m*) of field measurement. The number of field assessment locations per cycle, is a function of the set size and is simply $m^2$. The total number of field assessment locations is then defined as $m^2 \times r$ or in this example $3^2 \times 3 = 27$. These measurements are grouped into cycle/sets and distributed in the survey area. The first location in cycle 1 of set 1 would be designated as 1-1-1. Mapping is color coded (based on cycle ID) using geometric shapes (based on set ID) to visually show the population of assessment locations. Specific measurement locations are generated via either a pseudo- or quasi-random approach. Figures 1 and A-4 represent the RSS measurement/sampling plan developed for use for the LISF.

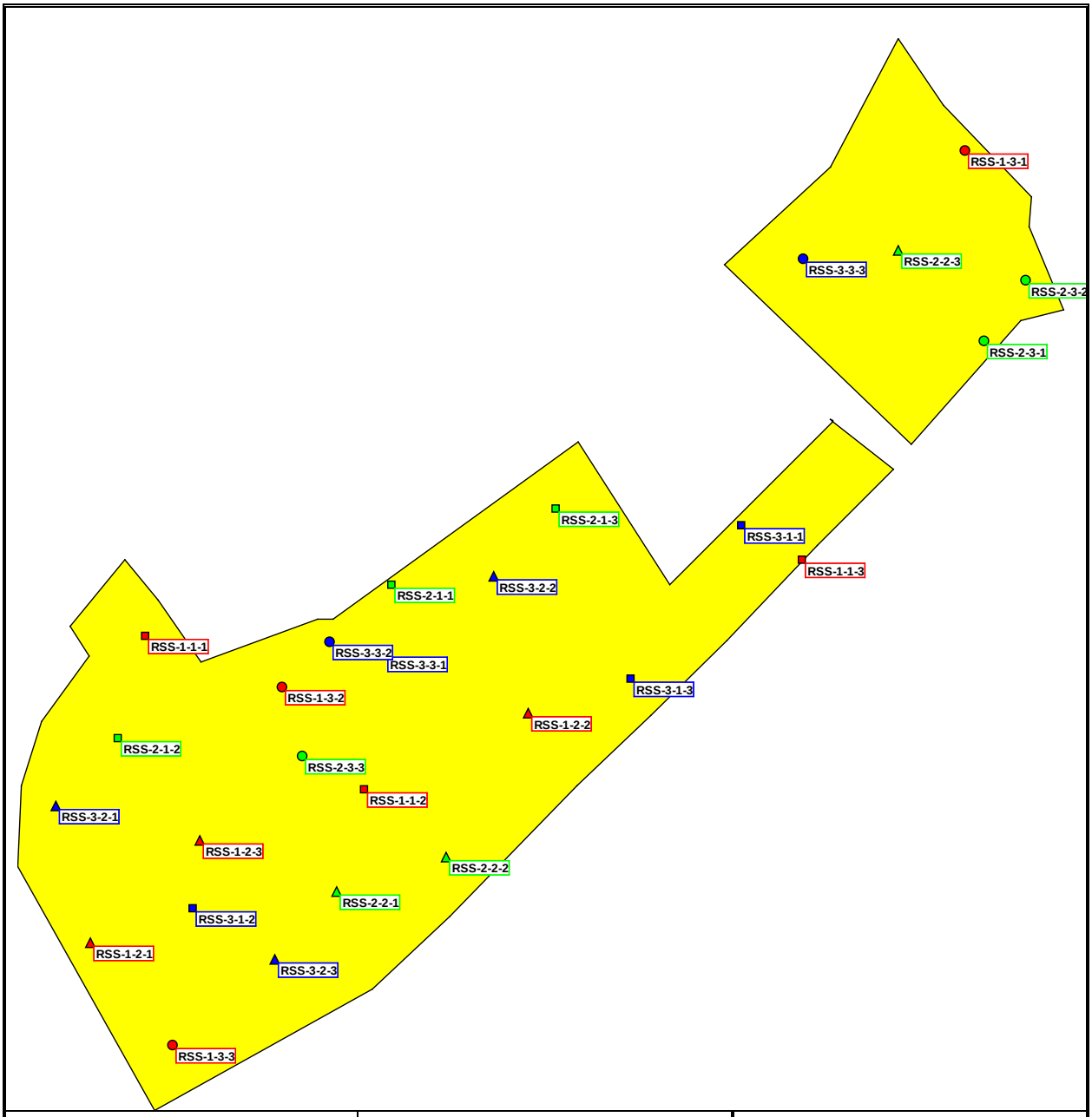


**Figure 1: LISF Survey Unit Ranked Set Sampling-Cycle, Sets, and Locations**

A one-minute static gamma count rate measurement was performed at each of the 27 assessment locations (Figures 1 and A-4). The data within a given cycle-set are then ranked as exhibiting either the lowest, medium, or highest gamma count. Nine soil samples were collected from the survey unit (Figure A-5). The following process was used to select the specific sampling location within each of

the three cycles: Set 1, lowest gamma radiation location; Set 2, medium location; Set 3, highest location. Table B-1 provides the RSS cycle set with field assessment data and ranked set soil sample identification.

## 6.0 SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to the ORISE laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2010b). Soil samples were analyzed by gamma spectroscopy for radium-226 and cesium-137. The spectra were reviewed for other identifiable photopeaks. Strontium-90 was quantified by radiochemical separation and counting on a low background proportional counter. Soil sample results were reported in units of picocuries per gram (pCi/g) (Table B-2). The data generated were compared with the cleanup goals established for the LISF (BNL 2009).

## 7.0 APPLICABLE SITE GUIDELINES

The radiological contaminants of concern and the soil cleanup levels for the LISF are shown in Table 1 and have been previously identified in the FSP FHWMF Perimeter Area (BNL 2009). This FSP relies on the previously developed cleanup goals and derived concentration guideline levels ($DCGL_W$), because the LISF was originally a portion of the FHWMF Perimeter Area. Because multiple contaminants are present, application of the unity rule is involved requiring calculation of the sum-of-ratios in accordance with the following equation:

$$\frac{Conc._{Ra-226}}{DCGL_{Ra-226}} + \frac{Conc._{Cs-137}}{DCGL_{Cs-137}} + \frac{Conc._{Sr-90}}{DCGL_{Sr-90}} + \leq 1$$

**TABLE 1: RADIONUCLIDES OF CONCERN IN THE LONG ISLAND SOLAR FARM BROOKHAVEN NATIONAL LABORATORY**

| Radionuclide | LISF (pCi/g) |
|---|---|
| Cs-137 | 23 |
| Sr-90 | 15 |
| Ra-226 | 5 |

## 8.0 FINDINGS AND RESULTS

The results for each verification component at the LISF are discussed below.

### 8.1 DOCUMENT REVIEW

The supporting documents reviewed for the LISF Project included the scan survey data and limited gamma spectroscopy results. Complete FSS information and results were not available at the time of the verification survey. Due to incomplete FSS data results, ORISE increased the soil verification sample number to ensure adequate coverage for the LISF.

### 8.2 SURFACE SCANS

Gamma surface scan ranges for the LISF were typically 5,500 to 10,000 gross counts per minute (cpm) with a few small areas exhibiting counts up to approximately 18,000 cpm. As previously mentioned, shielded detectors were inadvertently used for the initial verification surveys of the LISF. The ratio of 1.55 was developed by re-establishing an unshielded background. The unshielded background average was divided by the average shielded background value. The 1.55 ratio was then applied to the data recorded with shielded detectors. The methodology for applying the 1.55 ratio to normalize the shielded measurement data was evaluated using Q-Q Plots generated in ProUCL Version 4.0 to verify the accuracy of the corrected background. The data in Table B-1 represents the normalized data collected during IV surveys.

Due to natural foliage and limited satellite reception, survey data for the gamma scan is sparsely represented in Figure A-3. A background reference area was not defined by ORISE prior to the survey; therefore, all point measurements contain gross data results. Figure A-6 provides a frequency histogram of the gamma scan count rate population.

### 8.3 RADIONUCLIDE CONCENTRATIONS IN SOIL AND ROOF SAMPLES

The gamma count rate data used for selecting the appropriate random sample locations can be found in Table B-1. The data for the radionuclide concentrations in individual samples are provided in Table B-2. The concentration of radium-226 in random samples ranged from 0.50 to 1.15 pCi/g and cesium-137 ranged from 0.22 to 1.27 pCi/g. Strontium-90 results were considered to be in equilibrium and derived from the surrogate lead-214. Radionuclide concentration results for strontium-90 ranged from -0.11 to 0.19 pCi/g.

## 9.0 COMPARISON OF RESULTS WITH GUIDELINES

The final radionuclide concentration for the LISF meets the cleanup goals as described in the FSP. All values were less than the corresponding $DCGL_W$. Soil sample concentrations were less than 25% of the respective $DCGL_W$ values for all radionuclides of concern.

## 10.0 SUMMARY

During the period between September 25 through 29, 2010, ORISE conducted independent measurements and sampling of the LISF on the BNL site. The portion of the LISF verified by this survey is an 11-acre area just east of the FHWMF that DOE will provide as an easement to the LIPA to establish and operate the LISF; a large-scale solar energy facility. It consists of a Class 2 survey unit divided into two parts (north and south) by Brookhaven Avenue. A majority of the scan results for the survey area were not distinguishable from background; and the elevated areas detected during IV surveys were investigated and determined to meet the cleanup goals. The results from soil sample analysis were less than 25% of respective $DCGL_W$ for the radionuclides of concern. Verification survey activities validated the licensee's classifications, radiological status, and satisfaction of the guidelines.

## 11.0 REFERENCES

Brookhaven National Laboratory (BNL). "Addendum to Field Sampling Plan for Former Hazardous Waste Management Facility Perimeter Area." Upton, New York; September 8, 2010.

BNL. "Field Sampling Plan for Former Hazardous Waste Management Facility Perimeter Area." Upton, New York; August 19, 2009.

Oak Ridge Associated Universities (ORAU). "Quality Program Manual for the Independent Environmental Assessment and Verification Program." Oak Ridge, Tennessee; June 30, 2009.

Oak Ridge Institute for Science and Education (ORISE). "Project-Specific Verification Plan for the Long Island Solar Farm at the Brookhaven National Laboratory." Upton, New York. Oak Ridge, Tennessee; October 11, 2010a.

ORISE. "Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program." Oak Ridge, Tennessee; October 8, 2010b.

ORISE. "Survey Procedures Manual for the Independent Environmental Assessment and Verification Program." Oak Ridge, Tennessee; May 1, 2008.

U.S. Department of Energy (DOE). "Environment, Safety, and Health Bulletin: A Guide to Good Practices for the Control and Release of Property." DOE/EH-0697. Washington, D.C.; July 2006.

U.S. Environmental Protection Agency (EPA). "Data Quality Assessment: Statistical Methods for Practitioners." EPA QA/G-9S; Washington, D.C.; February 2006.

U.S. Nuclear Regulatory Commission (NRC). "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575"; Revision 1; Washington, DC; August 2000.

# APPENDIX A
# FIGURES


**Figure A-1: Location of Brookhaven National Laboratory, Upton, New York**


**Figure A-2: Plot Plan of the Long Island Solar Farm**

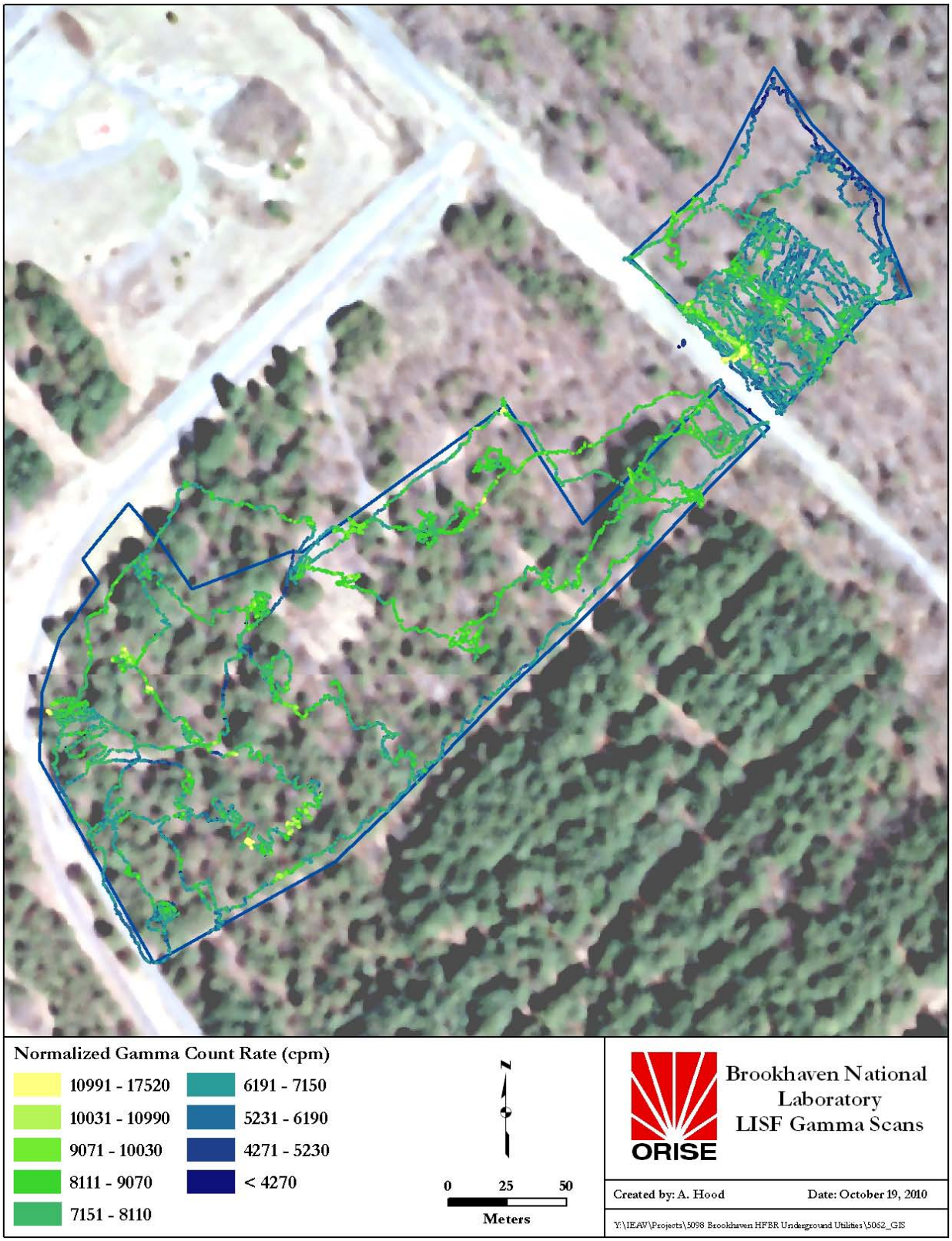


**Figure A-3: Long Island Solar Farm Gamma Scan Survey**

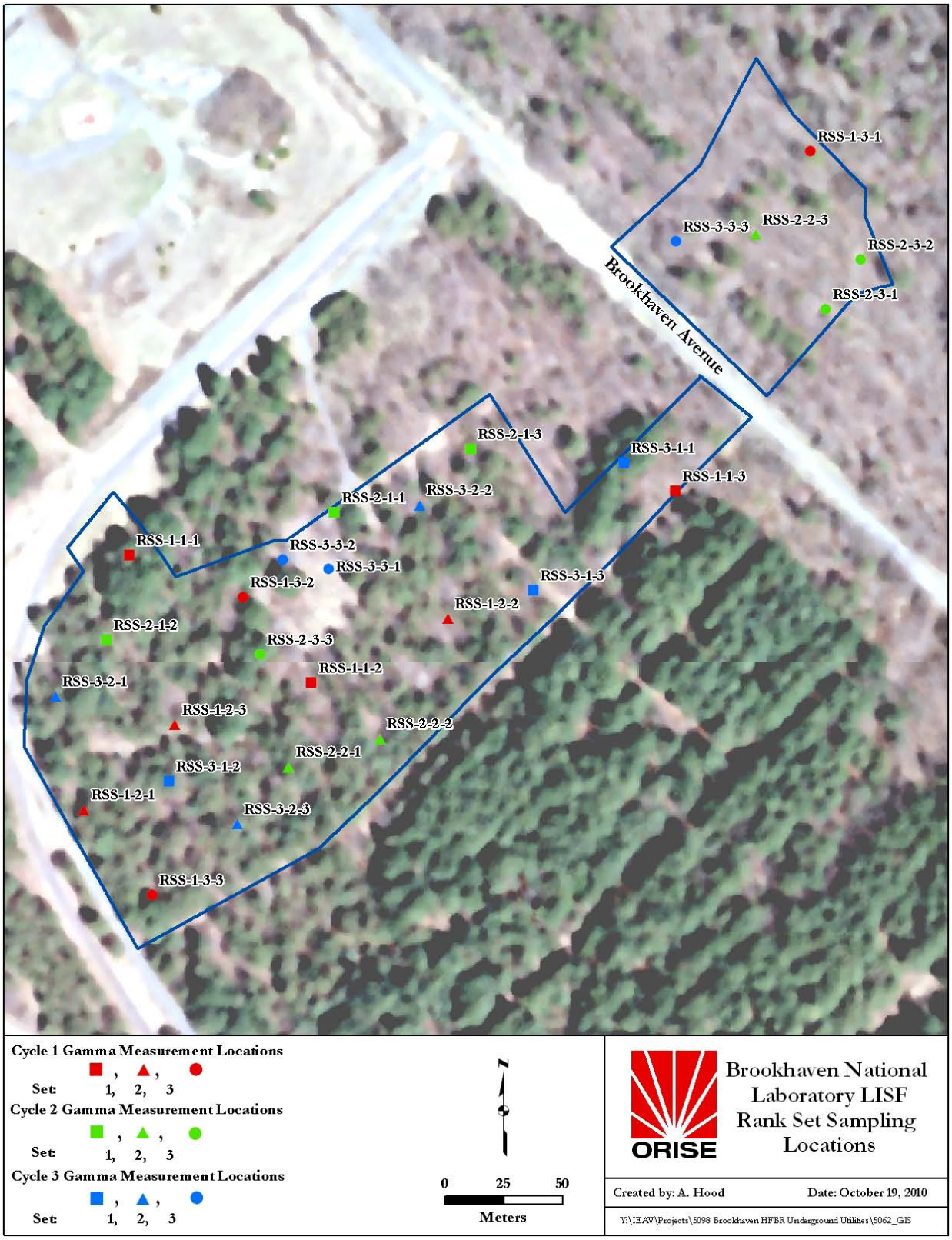


**Figure A-4: Long Island Solar Farm Ranked Set Sampling Locations**

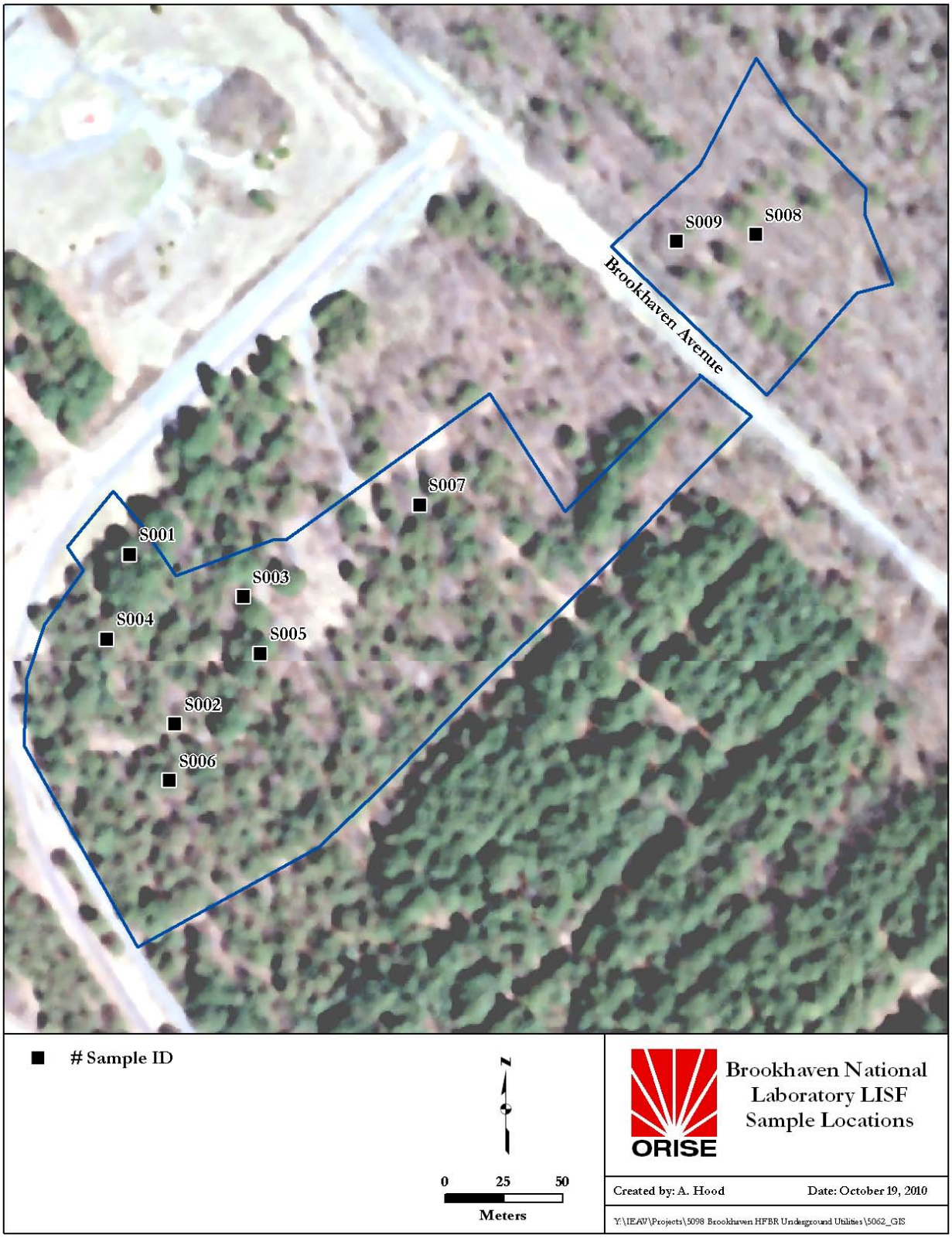


**Figure A-5: Long Island Solar Farm Soil Sample Locations**

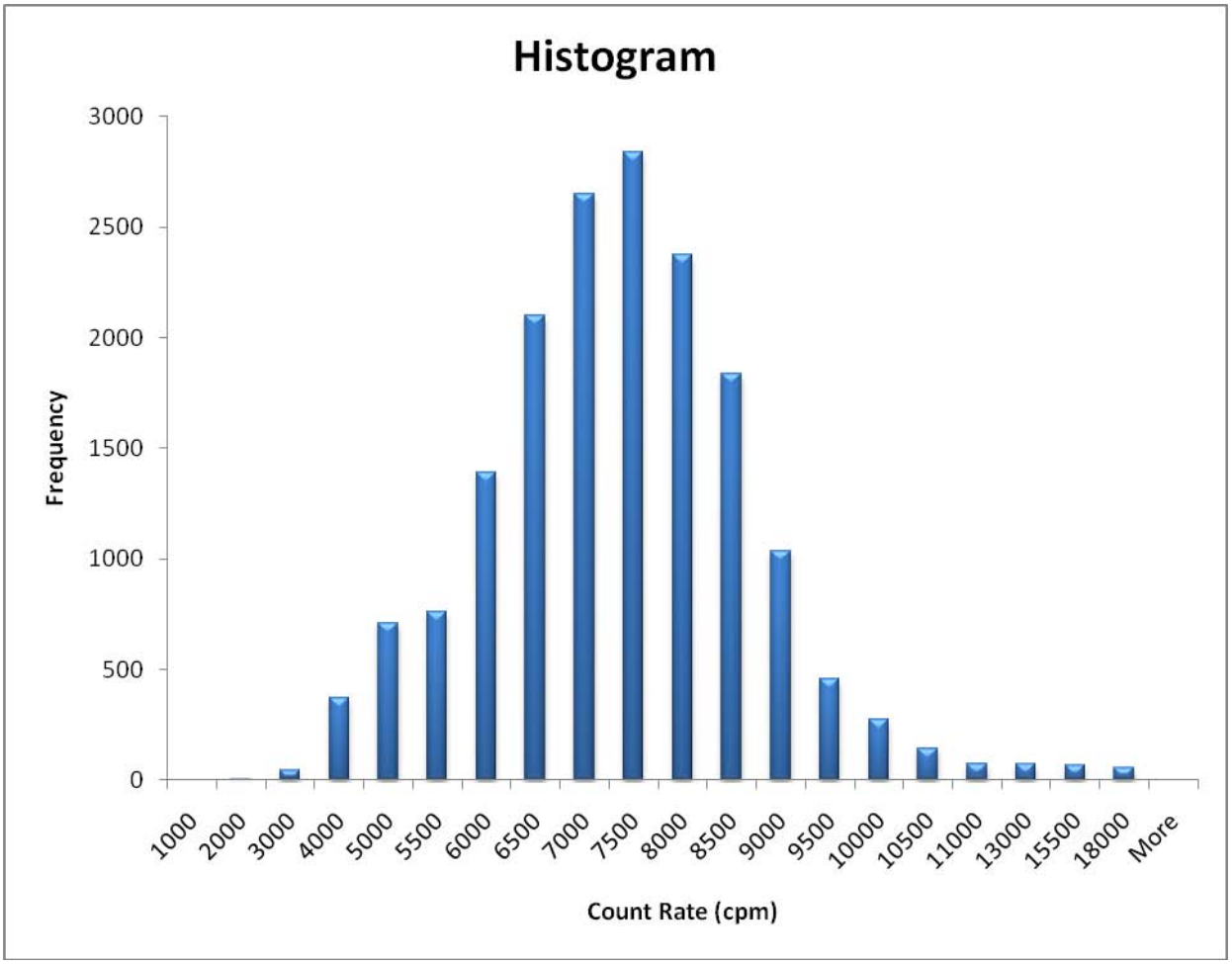


**Figure A-6: Verification Gamma Scan Count Rate Histogram (Normalized Data)**

# APPENDIX B
# TABLES

**TABLE B-1: RANKED SET SAMPLING GAMMA MEASUREMENTS
LONG ISLAND SOLAR FARM
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK**

| Northing (m) | Easting (m) | RSS Measurement Location[a] | | | | Gamma Count (c/m) | Value | Soil Sample # | Soil Gamma Count (cpm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | Set | # | Symbol | | | | |
| 254148 | 1299955 | 1 | 1 | 1 | ■ | 6995[b] | L | 5119S0001 | 8714 |
| 253971 | 1300209 | 1 | 1 | 2 | ■ | 7930[b] | | | |
| 254237 | 1300715 | 1 | 1 | 3 | ■ | 7943 | | | |
| 253793 | 1299892 | 1 | 2 | 1 | ▲ | 6484[b] | | | |
| 254060 | 1300399 | 1 | 2 | 2 | ▲ | 8352 | | | |
| 253912 | 1300019 | 1 | 2 | 3 | ▲ | 7511[b] | M | 5119S0002 | 9195 |
| 254710 | 1300903 | 1 | 3 | 1 | ● | 4980 | | | |
| 254089 | 1300114 | 1 | 3 | 2 | ● | 7638[b] | H | 5119S0003 | 9711 |
| 253675 | 1299987 | 1 | 3 | 3 | ● | 7175[b] | | | |
| 254208 | 1300240 | 2 | 1 | 1 | ■ | 8512 | | | |
| 254030 | 1299924 | 2 | 1 | 2 | ■ | 7432[b] | L | 5119S0004 | 10451 |
| 254296 | 1300430 | 2 | 1 | 3 | ■ | 8020 | | | |
| 253853 | 1300177 | 2 | 2 | 1 | ▲ | 6229[b] | | | |
| 253892 | 1300304 | 2 | 2 | 2 | ▲ | 6964[b] | | | |
| 254595 | 1300827 | 2 | 2 | 3 | ▲ | 6843 | M | 5119S0005 | 7708 |
| 254490 | 1300925 | 2 | 3 | 1 | ● | 7035 | | | |
| 254560 | 1300974 | 2 | 3 | 2 | ● | 6251 | | | |
| 254010 | 1300137 | 2 | 3 | 3 | ● | 7398[b] | H | 5119S0006 | 6403 |
| 254277 | 1300644 | 3 | 1 | 1 | ■ | 7972 | | | |
| 253833 | 1300011 | 3 | 1 | 2 | ■ | 6905[b] | L | 5119S0007 | 9280 |
| 254099 | 1300517 | 3 | 1 | 3 | ■ | 8416 | | | |
| 253951 | 1299852 | 3 | 2 | 1 | ▲ | 8341[b] | | | |
| 254217 | 1300359 | 3 | 2 | 2 | ▲ | 7796 | M | 5119S0008 | 8751 |
| 253774 | 1300106 | 3 | 2 | 3 | ▲ | 7394[b] | | | |
| 254129 | 1300232 | 3 | 3 | 1 | ● | 7577 | | | |
| 254142 | 1300169 | 3 | 3 | 2 | ● | 7814 | | | |
| 254585 | 1300716 | 3 | 3 | 3 | ● | 8218 | H | 5119S0009 | 9606 |

aRefer to Figure A-4.
[b]Gross counts were normalized to unshielded measurements by applying a multiplication factor of 1.55 to the shielded measurement result.

| TABLE B-2: RADIONUCLIDE CONCENTRATIONS IN SOIL<br>LONG ISLAND SOLAR FARM<br>BROOKHAVEN NATIONAL LABORATORY<br>UPTON, NEW YORK | | | | |
|---|---|---|---|---|
| ORISE Sample ID[a] | Radionuclide Concentration (pCi/g) | | | |
| | Ra-226 | Cs-137 | Sr-90 | Sum of Ratios |
| 5119S0001 | 0.54 ± 0.06[b] | 0.97 ± 0.09 | 0.40 ± 0.44 | 0.18 |
| 5119S0002 | 0.79 ± 0.08 | 0.65 ± 0.08 | -0.11 ± 0.47 | 0.18 |
| 5119S0003 | 0.80 ± 0.07 | 0.44 ± 0.05 | 0.04 ± 0.47 | 0.18 |
| 5119S0004 | 1.15 ± 0.10 | 0.69 ± 0.08 | -0.09 ± 0.46 | 0.25 |
| 5119S0005 | 0.50 ± 0.07 | 1.27 ± 0.12 | 0.19 ± 0.44 | 0.17 |
| 5119S0006 | 0.61 ± 0.07 | 1.19 ± 0.13 | 0.12 ± 0.46 | 0.18 |
| 5119S0007 | 0.68 ± 0.07 | 0.98 ± 0.10 | 0.10 ± 0.41 | 0.19 |
| 5119S0008 | 0.54 ± 0.06 | 0.22 ± 0.04 | -0.05 ± 0.41 | 0.11 |
| 5119S0009 | 0.65 ± 0.08 | 1.01 ± 0.10 | 0.07 ± 0.43 | 0.18 |

[a]Refer to Figure A-5.
[b]Uncertainties represent the 95% confidence level based on total propagated uncertainties.

# APPENDIX C
# MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

## C.1 SCANNING AND MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

Ludlum NaI Scintillation Detector Model 44-10, Crystal: 2 inch x 2 inch
(Ludlum Measurements, Inc., Sweetwater, TX)
Coupled to
Ludlum Ratemeter-Scaler Model 2221
Coupled to
Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

## C.2 LABORATORY ANALYTICAL INSTRUMENTATION

High-Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN)
Multichannel Analyzer
Dell Workstation and Canberra's Apex
Gamma Software (Canberra, Meriden, CT)

High-Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(AMETEK/ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
Dell Workstation and Canberra's Apex
Gamma Software (Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-30-P4, 30% Eff.
(AMETEK/ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL)
and Multichannel Analyzer
Dell Workstation and Canberra's Apex
Gamma Software (Canberra, Meriden, CT)

# APPENDIX D
# SURVEY AND ANALYTICAL PROCEDURES

## D.1 PROJECT HEALTH AND SAFETY

The survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current job hazard analyses (JHAs). All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

Presurvey activities included an overview of potential health and safety issues. Representatives with the BNL provided site-specific safety awareness training for each individual ORISE survey effort. In-process and verification surveys were performed according to the ORISE generic health and safety plan, site-specific Integrated Safety Management (ISM) prejob hazard checklist, and safety procedures discussed during the on-site training.

## D.2 QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual
- Laboratory Procedures Manual
- Quality Program Manual

The procedures contained in these manuals were developed to meet the requirements of 10 CFR 830 Subpart A, *Quality Assurance Requirements*, Department of Energy Order 414.1C, *Quality Assurance*, and the U.S. Nuclear Regulatory Commission, *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards,* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.

- Participation in Mixed Analyte Performance Evaluation Program (MAPEP), National Institute for Standards and Technology (NIST) Radiochemistry Intercomparison

Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

## D.3 CALIBRATION

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

## D.4 SURVEY PROCEDURES

### D.4.1 Surface Scans

Scans for elevated gamma radiation were performed by passing the detector slowly over the surface. The distance between the detector and surface was maintained at a nominal of about 1 to 5 centimeter (cm). NaI scintillation detectors were coupled to GPS units that enabled real-time recording of position in one-second intervals. Identification of elevated radiation levels was based on increases in the audible signal from the instrument. Positioning data files were downloaded from field data loggers for plotting using commercially available software (http://trl.trimble.com/docushare/dsweb/Get/Document-261826/GeoExpl2005_100A_GSG_ENG.pdf).

The scan minimum detectable concentrations (MDCs) for the NaI scintillation detector for the contaminants of concern in surface soil were obtained directly from NUREG-1507[1] when available or estimated using the calculation approach described in NUREG-1507. A typical NaI 2-inch by 2-inch detector MDC for Cs-137 is 6.4 pCi/g. An audible increase in the activity rate was investigated by ORISE. It is standard procedure for ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

[1]NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. U.S. Nuclear Regulatory Commission. Washington, DC; June 1998.

### D.4.2 Soil Sampling

Approximately 0.5 to 1 kilogram of soil was collected at each sample location. Collected samples were placed in plastic bags, sealed, and labeled in accordance with ORISE survey procedures.

## D.5 RADIOLOGICAL ANALYSIS

### D.5.1 Detection Limits

Detection limits, referred to as MDC, were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\ (BKG)^{1/2})$]. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

### D.5.2 Strontium Analysis

Soil samples were dissolved by a combination of potassium hydrogen fluoride and pyrosulfate fusions. The fusion cake was dissolved and strontium was coprecipitated on lead sulfate. The strontium was separated from residual calcium and lead by reprecipitating strontium sulfate from EDTA at a pH of 4.0. Strontium was separated from barium by complexing the strontium in DTPA while precipitating barium as barium chromate. The strontium was ultimately converted to strontium carbonate and counted on a low-background gas proportional counter. The typical MDC of the procedure is 0.4 pCi/g for a one hour count time.

### D.5.3 Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All total absorption peaks (TAP) associated with the radionuclides of concern were reviewed for consistency of activity. Total absorption peaks used for determining the activities of radionuclides of concern and the typical associated MDCs for a one-hour count time were:

| Radionuclide | TAP (MeV) | MDC (pCi/g) |
|---|---|---|
| Ra-226 (from Pb-214) | 0.351 | 0.08 |
| Cs-137 | 0.662 | 0.05 |
| Sr-90 | NA | 0.40 |

Spectra were also reviewed for other identifiable TAPs.

### D.5.4 Uncertainties

The uncertainties associated with the analytical data presented in the tables of this report represent the total propagated uncertainties for those data. These uncertainties were calculated based on both the gross sample count levels and the associated background count level.

# Appendix D
# Regulatory Approval Letters

**New York State Department of Environmental Conservation**
**Division of Environmental Remediation**
**Remedial Bureau A, 11th Floor**
625 Broadway, Albany, New York 12233-7015
**Phone:** (518) 402-9625 • **Fax:** (518) 402-9627
**Website:** www.dec.ny.gov

Peter M. Iwanowicz
Acting Commissioner

December 15, 2010

Mr. Mike Holland
Brookhaven Site Office Manager
Department of Energy
Brookhaven Site Office
P.O. Box 5000
Upton, NY 11973

Re: Brookhaven National Laboratory, Site # 152009
Draft Addendum to the Completion Report for the
Former Hazardous Waste Management Facility
(FHWMF) Perimeter Area

Dear Mr. Holland:

The New York State Department of Environmental Conservation and the New York State Department of Health have reviewed the above referenced document which was sent on November 23, 2010.

The purpose of this addendum is to document the cleanup of a section of the proposed Long Island Solar Farm (LISF) Project area, which is also designated as Phase II of the FHWMF cleanup areas.

The State has no comments regarding this draft document. Therefore, you may finalize the issuance of this completion report. Please contact me at (518) 402-9620 or cbng@gw.dec.state.ny.us. if you have any questions.

Sincerely yours,

Chek Beng Ng, P.E.
Environmental Engineer 2
Remedial Bureau A

cc: D. Pocze, USEPA
A. Rapiejko, SCDHS
J. Swartwout, DEC
D. O'Hehir, DEC
S. Karpinski, DOH
B. Lee, BSA
S. Kumar, BSA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

DEC 15 2010

Mr. Steven B. Feinberg
Brookhaven Project Director
Department of Energy
Brookhaven Site Office
P.O. Box 5000
Upton, NY 11973-5000

Re: Brookhaven National Laboratory, Upton NY
Former Hazardous Waste Management Facility – Closeout Report Addendum

Dear Mr. Feinberg:

With this letter the U.S. Environmental Protection Agency approves the document and the applicable response to comments entitled:

- Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report, dated November 19, 2010.

As discussed with members of your staff, notification should be made into the BNL Land Use and Institutional Control Plan to ensure that any future use of the land will be determined based upon on the degree of cleanup certainty that has been achieved to date.

Should you have any questions, please contact Douglas Pocze, of my staff, at (212) 637-4332.

Sincerely,

John S. Malleck, Chief
Federal Facilities Section