Radiological Impact of 2021 Operations at the Savannah River Site

B. H. Stagich

K. L. Dixon

E. D. LaBone

July 2022

SRNL-STI-2022-00323, Revision 0

DISCLAIMER

This work was prepared under an agreement with and funded by the U.S. Government. Neither the U.S. Government or its employees, nor any of its contractors, subcontractors or their employees, makes any express or implied:

1. warranty or assumes any legal liability for the accuracy, completeness, or for the use or results of such use of any information, product, or process disclosed; or
2. representation that such use or results of such use would not infringe privately owned rights; or
3. endorsement or recommendation of any specifically identified commercial product, process, or service.

Any views and opinions of authors expressed in this work do not necessarily state or reflect those of the United States Government, or its contractors, or subcontractors.

Printed in the United States of America

Prepared for
U.S. Department of Energy

SRNL-STI-2022-00323
Revision 0

Keywords: *Radiation, Assessment, Environment*

Retention: *Permanent*

Radiological Impact of 2021 Operations at the Savannah River Site

B. H. Stagich
K. L. Dixon
E. D. LaBone

July 2022

Savannah River National Laboratory is operated by Battelle Savannah River Alliance for the U.S. Department of Energy under Contract No. 89303321CEM000080.

REVIEWS AND APPROVALS

AUTHORS:

BROOKE STAGICH (Affiliate) Digitally signed by BROOKE STAGICH (Affiliate)
Date: 2022.07.07 06:25:32 -04'00'

B. H. Stagich, Environmental Sciences and Dosimetry Date

TECHNICAL REVIEW:

KENNETH DIXON (Affiliate) Digitally signed by KENNETH DIXON (Affiliate)
Date: 2022.07.11 11:04:23 -04'00'

K. L. Dixon, Environmental Sciences and Dosimetry Date

ELIZABETH LABONE (Affiliate) Digitally signed by ELIZABETH LABONE (Affiliate)
Date: 2022.07.07 08:14:42 -04'00'

E. D. LaBone, Environmental Sciences and Dosimetry Date

APPROVAL:

MARION COFER (Affiliate) Digitally signed by MARION COFER (Affiliate)
Date: 2022.07.13 14:40:51 -04'00'

M. Cofer, Manager Date
Environmental Sciences and Dosimetry

TERESA EDDY (Affiliate) Digitally signed by TERESA EDDY (Affiliate)
Date: 2022.07.14 15:59:13 -04'00'

T. P. Eddy, Manager Date
Environmental Monitoring Program

EXECUTIVE SUMMARY

This report presents the environmental dose assessment methods and the estimated potential doses to the public from 2021 Savannah River Site (SRS) air and liquid radioactive releases. Also documented are potential doses from special-case exposure scenarios, such as the consumption of wildlife or goat milk.

Dose to the Offsite Representative Person

The 2021 dose to the offsite representative person from SRS liquid releases was 0.28 mrem and from SRS air releases it was 0.017 mrem. To show compliance with the U. S. Department of Energy (DOE) all-pathway dose standard of 100 mrem/yr, SRS conservatively adds these two doses for a total representative person dose of 0.30 mrem which is 0.30% of the DOE standard.

Sportsman Doses

Onsite Hunter: SRS conducts annual hunts to control onsite deer and feral hog populations. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. Due to pandemic restrictions, there were no annual hunts held in 2021.

Creek Mouth Fisherman: SRS estimated the maximum potential dose from fish consumption at 0.43 mrem from bass collected at the mouth of Steel Creek. This dose is 0.43% of the DOE standard. SRS bases this hypothetical dose on the low probability scenario that, during 2021, a fisherman consumed 24 kg (53 lbs) of bass caught exclusively from the mouth of Steel Creek.

Release of Material Containing Residual Radioactivity

SRS did not release any real property (land or buildings) in 2021. SRS unconditionally released a total of 12,158 items of personal property (such as tools) from radiological areas in 2021. Most of these items did not leave the Site. However, all of these items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria.

Radiation Dose to Aquatic and Terrestrial Biota

SRS conducts screening evaluations of plant and animal doses for aquatic and terrestrial ecosystems. For 2021, all SRS aquatic system locations passed the initial (Level 1) screenings and no further assessments were required at those locations.

For the land-based systems evaluation, SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2021, all land-based locations passed their initial (Level 1) pathway screenings.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ALARA	As Low as Reasonably Achievable
BCG	Biota Concentration Guide
BJWSA	Beaufort-Jasper Water and Sewer Authority
BLLDF	Barnwell Low-Level Disposal Facility
COS	Center of Site
DOE	U. S. Department of Energy
EPA	U. S. Environmental Protection Agency
FGR	Federal Guidance Report
GDNR	Georgia Department of Natural Resources
ICRP	International Commission on Radiological Protection
MCL	Maximum Contaminant Levels
MEI	Maximally Exposed Individual
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
RM	River Mile
SCDHEC	South Carolina Department of Health and Environmental Control
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
TRL	Three Rivers Landfill
USGS	U. S. Geological Survey
VEGP	Georgia Power Company's Vogtle Electric Generating Plant

Introduction

This report presents environmental dose assessment methods and the estimated potential doses to the public from 2021 Savannah River Site (SRS) atmospheric and liquid radioactive releases. It also documents potential doses from special-case exposure scenarios, such as the consumption of wildlife and/or goat milk. Unless noted, the generic term "dose," as used in this report, includes both the committed effective dose (50-year committed dose) from internal deposition of radionuclides and the effective dose attributable to sources external to the body. Using the effective dose allows doses from different types of radiation and to different parts of the body to be expressed on the same basis.

Humans, plants, and animals potentially receive radiation doses from natural and man-made occurrences. The average annual "background" dose for all people living in the United States is 625 mrem. This includes an average background dose of 311 mrem from naturally occurring radionuclides (found in our bodies and in the earth) and from cosmic radiation. Man-made sources include medical procedures (300 mrem), consumer products (13 mrem), and industrial and occupational exposures (less than 1 mrem) (NCRP 2009).

The U.S. Department of Energy (DOE) has established dose limits to the public, so that DOE operations will not contribute significantly to this average annual exposure. DOE Order 458.1 (DOE 2020) establishes 100 mrem/yr (1mSv/yr) as the annual dose limit to a member of the public. As shown in Figure 1-1, radiation exposure primarily occurs through the following pathways:

Inhalation,
Ingestion,
Skin absorption, and
Direct (external) exposure to radionuclides in soil, air, and water.

1.0 Dose Assessment Methods

DOE Order 458.1 states that compliance with the DOE annual dose limit of 100 mrem (1 mSv), for a member of the public, may be demonstrated by calculating dose to the maximally exposed individual (MEI) or to a representative person. Prior to 2012, SRS used the MEI concept for dose compliance which is based on adult dose coefficients and adult male usage parameters. Beginning in 2012, SRS now uses the representative person concept for dose compliance.

1.1 Representative Person

DOE Order 458.1 defines the representative person as an individual receiving a dose that is representative of the more highly exposed individuals in the population. This term is equivalent of and replaces the "average member of the critical group." However, in the *International Commission on Radiological Protection* (ICRP) *Report 101* (ICRP 2006), the definition is extended to include the average value for the more highly exposed group or the 95th percentile of appropriate national or regional data. At SRS, the representative person who is at the 95th percentile of national usage data is now used as a replacement for the MEI. SRS believes the representative person concept is superior to the MEI concept for dose calculations because it includes all members of the population receiving dose as opposed to only adult males (as is the case for the MEI concept).

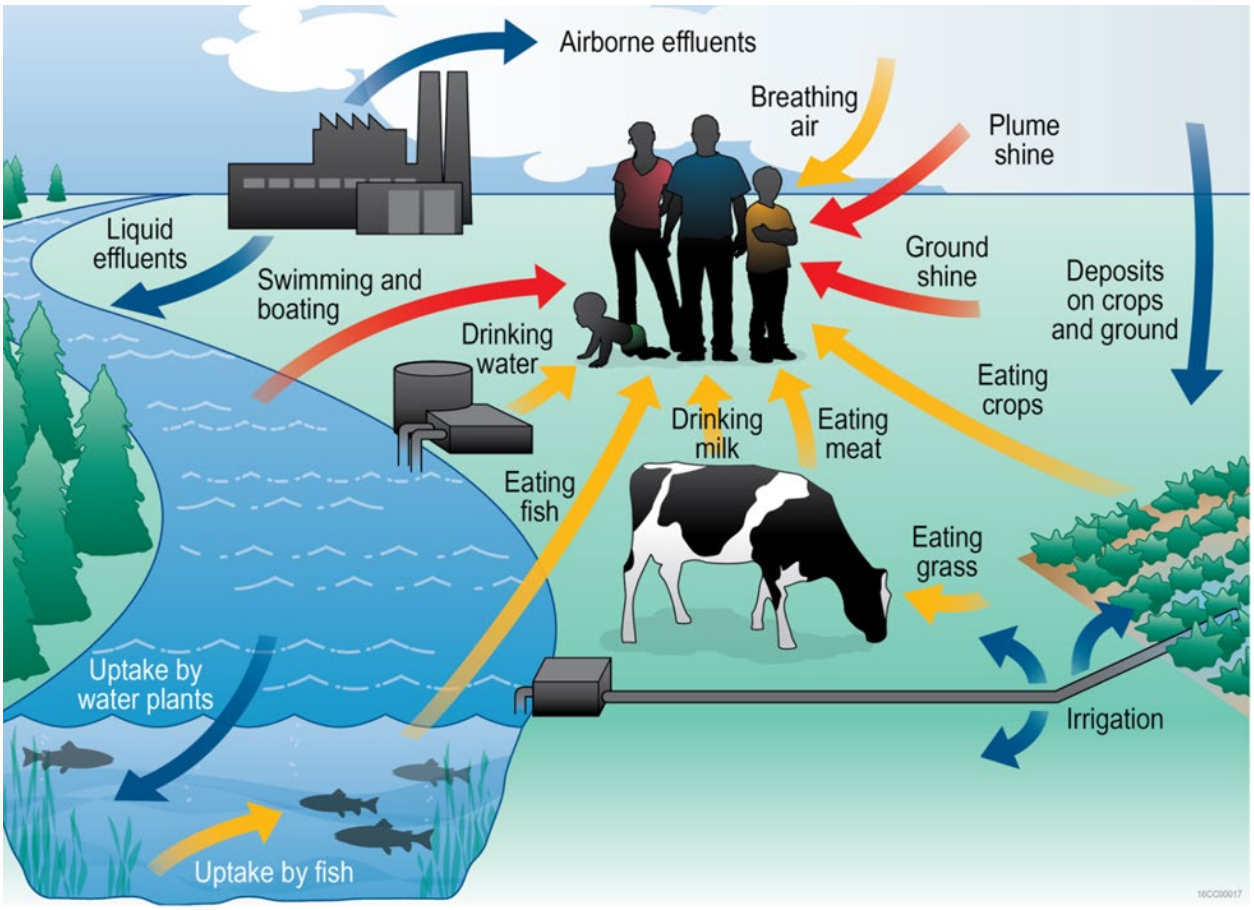


Figure 1-1. Exposure Pathways to Humans from Atmospheric and Liquid Effluents

The representative person dose is based on a reference person using exposure parameters (at the 95th percentile of national and regional data) developed specifically for SRS. The reference person is a hypothetical person with average physical and physiological characteristics— including factors such as age and gender—used internationally to standardize radiation dose calculations. The reference person is weighted, based on sex and age, and this weighting is based on the six age groups documented in Report 89 (ICRP 2002): infant (0 years), 1 year, 5 years, 10 years, 15 years, and adult. The EPA (2011) proportioned the various age- and gender-specific intake rates to correspond with these respective age groupings. The SRS-specific reference person usage parameters were developed by Stone and Jannik (2013) and are provided in Table 1-1. The applicable national and regional data used are from the Environmental Protection Agency (EPA) *Exposure Factors Handbook (Final Report)* (EPA 2011). SRS also developed reference usage parameters at the 50th percentile to calculate dose to a "typical" person for determining collective (population) doses.

The Land and Water Use Characteristics and Human Health Input Parameters for use in Environmental Dosimetry and Risk Assessments at the Savannah River Site (Jannik and Stagich 2017) documents all other applicable land- and water- use parameters used in the dose calculations. These parameters include local characteristics of food production, river recreational activities, and other human usage parameters required in the SRS dosimetry models. In addition, SRS documents the preferred elemental bioaccumulation and transfer factors to be used in human health exposure calculations in this land and water report. Data Table A-1 and Data Table A-2 provide a summary of the site-specific input parameters that are the most important to the dose calculations for the liquid and airborne pathways, respectively.

Table 1-1. SRS Representative and Typical Person Usage Parameters

	Unit	Representative Person	Typical Person
Air	m^3/y	6,400	5,000[(a)]
Water	L/y	800	300[(b)]
Meat	kg/y	81	32[(c)]
Leafy Vegetables	kg/y	31	11
Other Produce	kg/y	289	89
Milk/Dairy	L/y	260	69
Freshwater Fish	kg/y	24	3.7
Saltwater Invertebrate	kg/y	N/A	1.5

a. 1 cubic meter = 1.3 cubic yards
b. 1 liter = 1.06 quarts
c. ***1 kilogram = 2.2 pounds***

In 2017, SRS made two major changes in the locations of the representative person:

1) For the liquid pathway, the representative person was moved from river mile (RM) 118.8 (near US Hwy 301 bridge) to RM 141.5, which is slightly downriver from the Steel Creek mouth. The historical location at RM 118.8 is downriver of all SRS streams. However, SRS radiological releases into Lower Three Runs are 1) from legacy contamination and not current operations and 2) have remained small for many years. Moving the representative person to near Steel Creek is more conservative because it accounts for less dilution and gives a better indication of the potential dose from fish.
2) For the air pathway, in addition to the offsite representative person living near the Site boundary, SRS also calculated potential dose for an adult worker at the Three Rivers Landfill (TRL) located near B Area. Three Rivers Landfill is located on SRS, but it is accessed directly from public South Carolina Hwy 125 outside of the Site's security perimeter in Aiken County. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1 and with National Emissions Standards for Hazardous Pollutants Compliance (NESHAP) regulations (EPA 2006). Figure 1-2 shows the SRS representative locations.

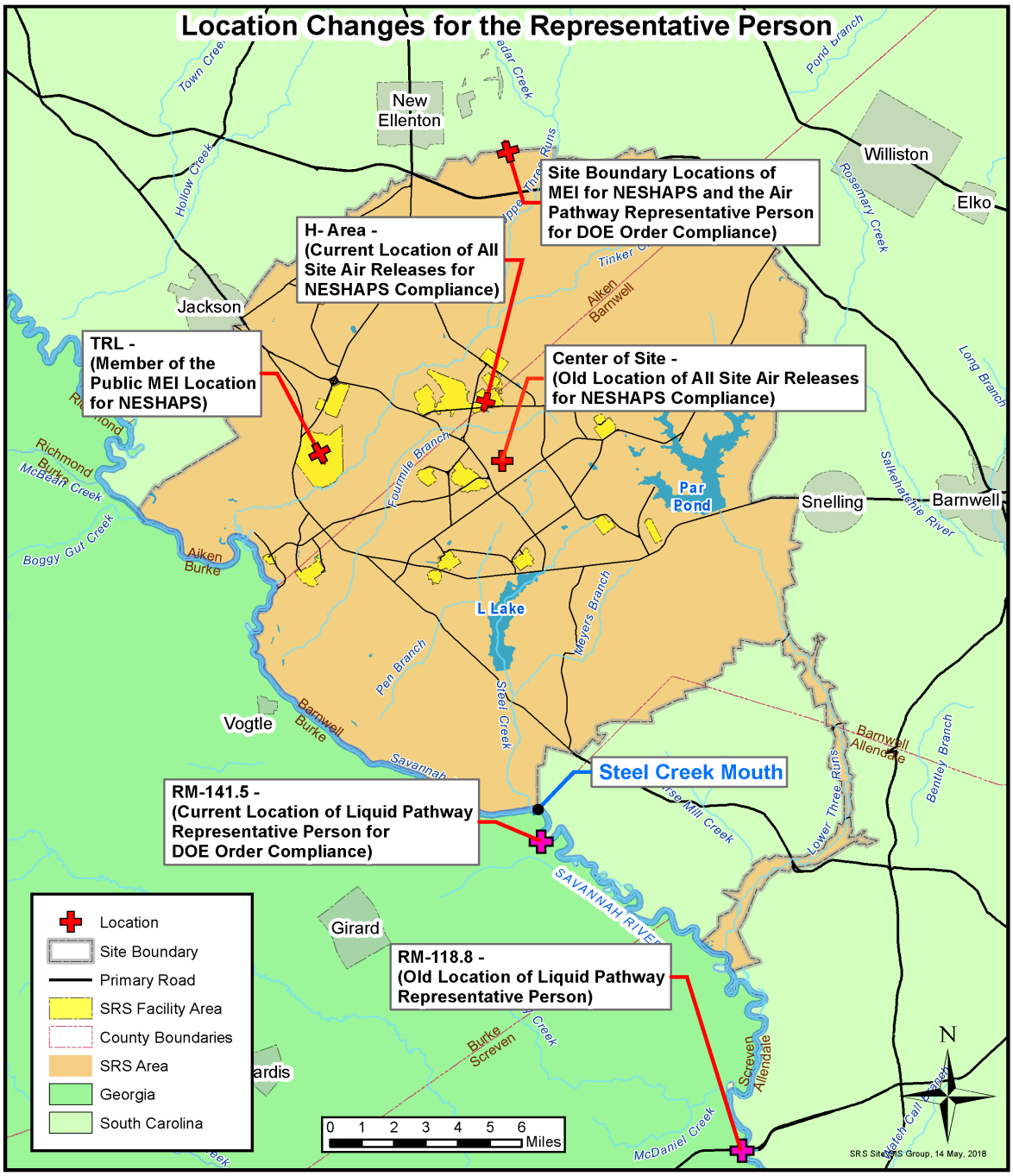


Figure 1-2. Locations of the SRS Representative Persons for Air and Liquid Releases and the MEI Locations for NESHAPS

1.2 Dose Models

SRS calculates the potential offsite doses from SRS effluent releases of radioactive materials (air and liquid) for the following scenarios for DOE public dose compliance:

Representative person living at the SRS boundary
Industrial worker at the Three Rivers Landfill located on SRS (near B Area)
Population living within a 50-mile (80-kilometer [km]) radius of SRS's H-Area

To demonstrate compliance with the DOE Order 458.1 all-pathway dose standard of 100 mrem per year, SRS conservatively combines the air pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations (Figure 1-2).

For SRS dose calculations, unspecified alpha releases were treated as plutonium-239, and unspecified beta releases as strontium-90. These radionuclides have the highest dose factors of the alpha- and beta-emitters, respectively, commonly measured in SRS waste streams.

SRS has assessed the potential effects of routine radioactive releases annually since operations began and, since 1972, has published annual offsite dose estimates in Site environmental reports made available to the public. For all routine environmental dose calculations performed since 1978, SRS has used environmental transport models based on the Nuclear Regulatory Commission (NRC) developed codes (NRC 1977). The NRC-based transport models use DOE accepted methods, consider all significant exposure pathways, and permit detailed analysis of the effects of routine operations.

For showing compliance with DOE Order 458.1 at SRS, the MAXDOSE-SR and POPDOSE-SR codes are used for air releases (representative person and population, respectively) and LADTAP XL© is used for liquid releases. The *SRS Environmental Dose Assessment Manual* (SRNL 2017) describes these models.

To demonstrate compliance with EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations (EPA 2006), SRS calculated the MEI and collective doses using 1) the CAP88 PC version 4.1.0.2 computer code, 2) the 2020 airborne-release source term (Data Table A-23), and 3) site-specific input parameters (Data Table A-24). The EPA requires the use of the MEI concept and does not allow use of the representative person concept at this time. The SRS MEI locations for NESHAPS are shown in Figure 1-2.

The EPA hard-codes most of the input parameters in the CAP88 PC program, and they cannot be changed without EPA approval. SRS uses the latest version of CAP88-PC (v.4.1.0.2) that became available from EPA in January 2020 (Stagich 2020). CAP88-PC v.4.1.0.2 includes improvements to the user interface and system capabilities. Additionally, EPA updated the radionuclide physical data, dose factors, risk factors and decay chain information from the DCFPAK Version 2.2. to the DCFPAK 3.02, both provided by Oak Ridge National Laboratory (Eckerman and Leggett 2013).

CAP88-PC allows up to six different stack heights per release. For the stack height inputs at SRS, the reference heights related to operational stack heights in the tritium production facilities located in H Area were used; 0m, 15m, 21m, 31m, 56m, 59m. If there were emissions from other areas on site at a stack height not in the six previously listed, the stack height was defaulted to the shorter stack height, as shorter stack heights produce a higher estimated dose (Minter et al. 2018).

1.3 Dose Coefficients

From 1988 through 2009, SRS used the internal and external dose conversion factors provided in DOE (1988). In 2010, the internal dose conversion factors were updated to use the dose factors from ICRP Publication 72 (ICRP 1996), and the external dose conversion factors were updated to the dose factors provided in *Federal Guidance Report 12* (FGR) (EPA 1993). In 2012, SRS changed to the reference person concept and started using the (gender- and age-averaged) ingestion and inhalation dose coefficients documented in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011). In 2019, SRS started using the external dose factors from FGR 15 (EPA 2019). FGR 15 is a revision to FGR 12 that incorporated age-specific external dose coefficients. SRS used the age-specific values to develop "reference person" external dose coefficients in a method similar to that documented in DOE (2011). The SRS report *Updated External Exposure Dose Coefficients,* SRNL-L3200-2020-00014 (Laird and Jannik 2020) documents the external dose coefficients used.

For 2021, the dose to a representative person is based on: 1) the SRS-specific reference person usage parameters at the 95th percentile of appropriate national or regional data documented in Stone and Jannik (2013), 2) the reference person (gender- and age-averaged) ingestion and inhalation dose coefficients documented in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011), and 3) the external dose coefficients derived from *Federal Guidance Report 15* (EPA 2019).

1.4 Meteorological Database

SRS calculated the potential offsite doses from radiological releases to the air with quality-assured meteorological data for A-Area, K-Area (for combined releases from C-Area, K-Area, and L-Area), and H-Area (for combined releases from all other areas) for DOE compliance. To show compliance with NESHAP regulations (EPA 2006), only the H-Area meteorological database was used in the calculations, because the EPA-required dosimetry code (CAP88 PC version 4.1.0.2) is limited to a single release location.

The current five-year meteorological datasets used in dose calculations cover the period 2014 through 2018 (Bell 2020). These datasets differ from previous five-year datasets in that they now 1) estimate atmospheric stability using the standard deviation of the vertical wind velocity and 2) use an updated surface roughness factor for SRS. Data Table A-3 shows the 2014-2018 meteorological database for H-Area. Figure 1-3 is the H-Area wind rose for 2014-2018, with the directions shown being those toward which the wind blows. As shown, the wind blows towards the East-Northeast the highest percentage of time (about 10%).

1.5 Population Database and Distribution

SRS calculates the collective (population) doses from air releases for the population within a 50-mile radius of H-Area, which is the location of most of the Site's radiological releases. Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of H-Area is 803,370. This translates to an average population density of about 107 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area. Data Table A-4a and Data Table A-4b show the population distribution around the SRS Center of Site (COS) and H-Area, respectively.

SRS also calculates the collective doses resulting from SRS liquid releases for the populations served by the City of Savannah Industrial and Domestic Water Supply Plant (City of Savannah I&D), near Port Wentworth, Georgia, and for the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea and Purrysburg Water Treatment Plants, both near Beaufort, South Carolina. According to the treatment plant operators, the population served by the City of Savannah I&D facility during 2021 was 36,667 people while the BJWSA Chelsea facility served 102,000 people and the BJWSA Purrysburg facility served 81,000 people. The total population dose resulting from routine SRS liquid releases is the sum of five contributing categories: 1) BJWSA water consumers, 2) City of Savannah I&D water consumers, 3) consumption of fish and invertebrates of Savannah River origin, 4) recreational activities on the Savannah River, and 5) irrigation of foodstuffs using river water near River Mile (RM) 141.5 (Down river near the Steel Creek mouth).

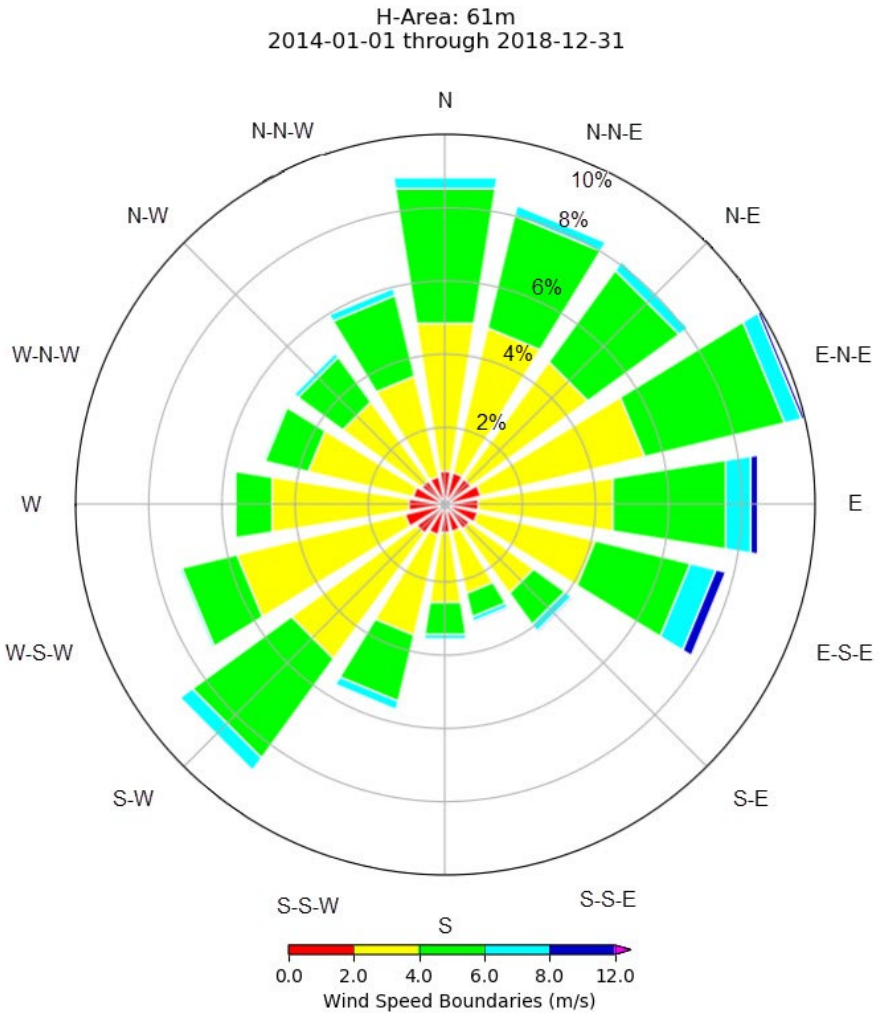


Figure 1-3. 2014-2018 Wind Rose for H-Area (Direction is toward which the wind blows)

1.6 Savannah River Flow Rate Data

SRS determines the Savannah River annual average flow rates using the recorded water elevation at a U.S. Geological Survey (USGS) gauging station #02197500, near RM 118.8. Data Table A-5 provides river flow rates measured at this location from 1954 through 2021. Figure 1-4 shows that the average river flow rate for these years is about 10,032 cubic feet per second (cfs). However, apart from 2020, there has been a downward trend in these data, with an average measured flow rate of 9,045 cfs during the past 10 years.

The SRS liquid dose calculations typically do not use these data. Instead, SRS uses an "effective" flow rate based on 1) the measured annual release of tritium and 2) the annual average tritium concentrations measured from RM 141.5 and from the downriver water treatment plants. Data Table A-6 provides the effective river flow rate calculations.

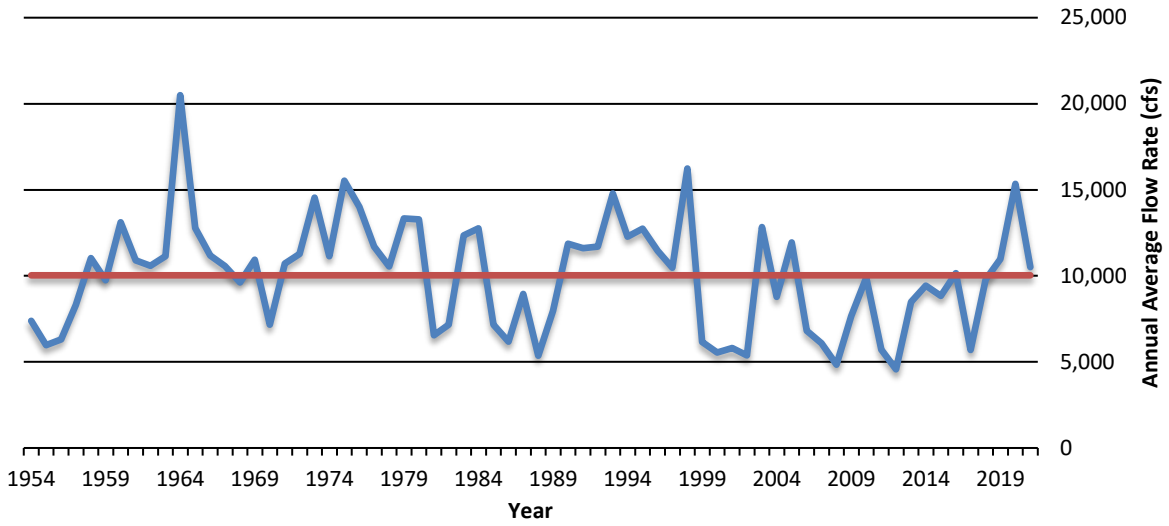


Figure 1-4. Savannah River Annual Average Flow Rates at River Mile 118.8

The effective flow rates used in the dose calculations are usually more conservative (that is, lead to higher dose estimates) than the measured flow rates because it accounts for less dilution. However, if SRS calculates an effective flow that is more than the measured value at RM 118.8, then the measured value is used.

For 2021, SRS used an effective Savannah River flow rate of 8,456 cfs in the dose calculations. The 2021 effective flow rate is 19% less than the 2020 effective flow rate of 10,501 cfs. This estimated flow rate (based on actual measured tritium concentrations in the river) is more conservative than the 2021 USGS measured flow rate (at RM 118.8) of 10,534 cfs.

2.0 Dose Calculation Results

2.1 Liquid Pathway Doses

No known large-scale uses of Savannah River water downstream of SRS exist for agricultural irrigation purposes. However, the potential for agricultural irrigation does exist, especially for individual garden use. Therefore, the totals for the SRS representative person and collective dose include doses from the irrigation pathway.

2.1.1 Liquid Release Source Terms

Table 2-1 shows, by radionuclide, the 2021 radioactive liquid release quantities used as the source term in SRS dose calculations and Data Table A-7 shows these liquid releases by Site stream. Data Table A-8 provides a five-year history of SRS liquid radioactive releases.

Tritium accounts for more than 99% of the total amount of radioactivity the Site released to the Savannah River. In 2021, SRS released a total of 483 curies of tritium to the river, a 7% decrease from the 2020 amount of 519 curies.

In 2021, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 986 curies of tritium to the Savannah River and 29 curies migrated from the Barnwell Low-Level Disposal Facility (BLLDF) for an overall total of 1,918 curies of tritium (SRS plus VEGP plus BLLDF). This is a 37% decrease from the combined total of 3,029 curies in 2020.

2.1.2 Radionuclide Concentrations in Savannah River Water, Drinking Water, and Fish

At several locations along the Savannah River, SRS measures the tritium concentrations in the river water and cesium-137 in fish. SRS uses these measurements to make dose determinations. The amounts of all other radionuclides released from SRS are so small that their concentration in the Savannah River usually cannot be detected using conventional analytical techniques. SRS calculates concentrations in the river based on the annual release amounts and river flow rates using the LADTAP XL code, version 2020 (Dixon 2020).

2.1.2.1 Radionuclide Concentrations in River Water and Treated Drinking Water

Table 2-1 shows the measured tritium concentrations in the Savannah River near RM 141.5 and at the BJWSA Purrysburg Water Treatment Facility, which is representative of the BJWSA Chelsea and the City of Savannah I&D water treatment plants. These downriver tritium concentrations include tritium releases from SRS, VEGP, and BLLDF. Table 2-1 also provides the calculated concentrations for the other released radionuclides and a comparison of these concentrations to the Safe Drinking Water Act, 40 CFR 141 (EPA 2000) maximum contaminant level (MCL) for each radionuclide.

In 2021, the 12-month average tritium concentration measured in Savannah River water near RM 141.5 was 254 picocuries per liter (pCi/L). This reflects a 21% decrease from the 323 pCi/L measured in 2020. SRS attributes this decrease to the 37% decrease in the combined (SRS plus VEGP plus BLLDF) total of tritium released to the Savannah River in 2021.

Table 2-1 indicates that all individual radionuclide concentrations at the three downriver community drinking water systems, as well as at RM 141.5, were below the EPA MCLs. Because SRS releases more than one radionuclide, the sum-of-the-fractions of the reported concentration of each radionuclide divided by its corresponding MCL must not exceed 1.0. As Data Table A-9 shows, the sum-of-the-fractions for the water treatment plants (determined at the BJWSA Purrysburg plant) was 0.0168, which is below the 1.0 sum-of-the-fractions requirement.

2.1.2.2 Radionuclide Concentrations in Fish

At SRS, an important dose pathway for the representative person is from the consumption of fish. Fish exhibit a high degree of bioaccumulation for certain elements. For cesium (including radioactive isotopes of cesium, such as cesium-137), the bioaccumulation factor for Savannah River fish is 3,000, meaning that the concentration of cesium in fish flesh is about 3,000 times the concentration of cesium found in the water in which the fish live (Carlton et al. 1994).

Because of this high bioaccumulation factor, SRS can detect cesium-137 more easily in fish flesh than in river water. Therefore, when conservative to do so, SRS will base the fish pathway dose from cesium-137 directly on the analysis of the fish collected near RM 141.5, the assumed location of the hypothetical representative person. As shown in Data Table A-10, the 2021 cesium-137 release value of 0.390 Ci is based on analysis of fish in the river.

Table 2-1. 2021 Radioactive Liquid Releases and 12-Month Average Downriver Radionuclide Concentrations Compared to the EPA's Drinking Water Maximum Contaminant Levels (MCL)

Nuclide	Curies Released	12-Month Average Concentration (pCi/L)		
		Below SRS[a]	at BJWSA Purrysburg Plant[b]	EPA MCL[c]
H-3[d]	1.92E+03	2.54E+02	2.35E+02	2.00E+04
C-14	5.80E-04	7.67E-05	7.10E-05	2.00E+03
Mn-54	9.70E-06	1.28E-06	1.19E-06	3.00E+02
Co-58	1.61E-04	2.13E-05	1.97E-05	3.00E+02
Sr-90	2.15E-02	2.85E-03	2.63E-03	8.00E+00
Tc-99	3.42E-02	4.52E-03	4.18E-03	9.00E+02
I-129	2.19E-02	2.90E-03	2.68E-03	1.00E+00
Cs-137	3.90E-01	5.15E-02	4.77E-02	2.00E+02
U-234	3.28E-02	4.34E-03	4.02E-03	1.03E+01
U-235	3.85E-04	5.09E-05	4.71E-05	4.67E-01
U-238	3.34E-02	4.41E-03	4.08E-03	1.00E+01
Np-237	1.17E-04	1.55E-05	1.43E-05	1.50E+01
Pu-238	3.98E-04	5.26E-05	4.87E-05	1.50E+01
Pu-239	2.01E-05	2.66E-06	2.46E-06	1.50E+01
Am-241	3.18E-05	4.21E-06	3.89E-06	1.50E+01
Cm-244	1.46E-04	1.93E-05	1.79E-05	1.50E+01
Alpha	6.22E-03	8.23E-04	7.61E-04	1.50E+01
Beta	5.27E-02	6.97E-03	6.45E-03	8.00E+00

a. Near Savannah River Mile 141.5, downriver of SRS

b. Beaufort-Jasper Water and Sewer Authority, drinking water at the Purrysburg Plant

c. MCLs for uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

d. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations. They include contributions from VEGP and Barnwell Low-Level Disposal Facility. All other radionuclide concentrations are calculated based on the effective or measured river flow rate.

2.1.2.3 Dose to the Representative Person

Data Table A-11 shows the 2021 dose to the representative person from all liquid pathways, including irrigation, was estimated at 0.28 mrem (0.0028 mSv), which is a 20% decrease from the 0.35 mrem dose in 2020. Table 2-2 shows that this total dose is 0.28% of the all-pathway public dose standard of 100 mrem/yr (1 mSv/yr).

Table 2-2. Potential Dose to the Representative Person from SRS Liquid Releases in 2021

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.20		
Irrigation Pathways	0.086		
Total Liquid Pathways	0.28	100[a]	0.28

a. All-pathway dose standard: 100 mrem/yr (DOE Order 458.1)

About 30% of the 2021 all liquid pathways total dose to the representative person resulted from the irrigation pathway (Data Table A-11). This pathway is based on the ingestion of meat, milk, and vegetables that have been exposed to irrigation water from the Savannah River. The fish consumption pathway, based on concentrations in fish from Steel Creek, accounted for 66% and the drinking water pathway accounted for 4%. Figure 2-1 shows, cesium-137 (71%), technetium-99 (13%), nonvolatile beta (4%) and iodine-129 (4%) were the major contributors to the total dose. Data Table A-12 provides a five-year history of SRS liquid pathway doses.

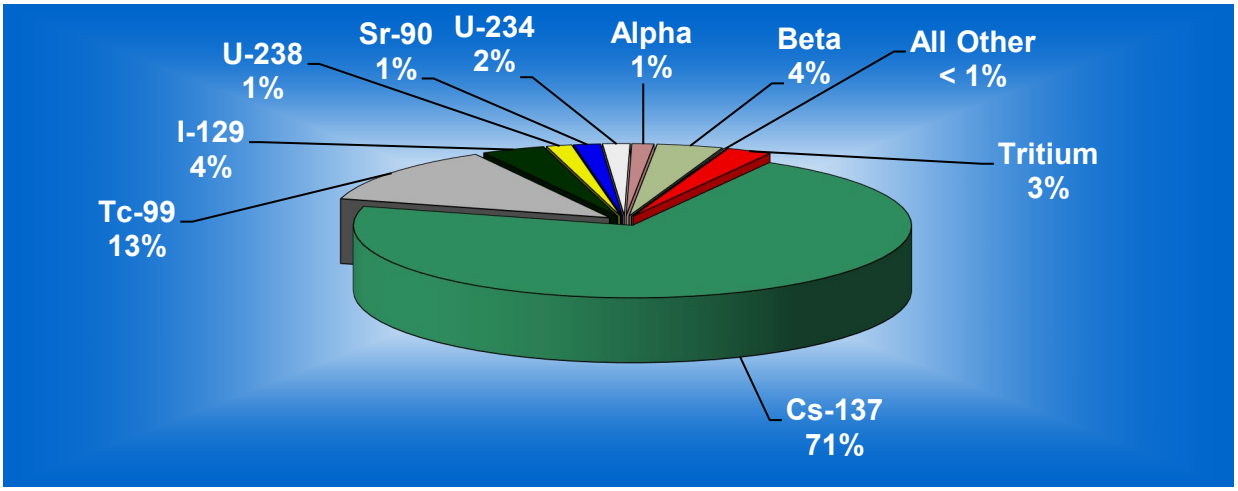


Figure 2-1. Radionuclide Contributions to the 2021 SRS Representative Person Total Liquid Pathway Dose of 0.28 mrem (0.0028 mSv)

2.1.2.4 Drinking Water Pathway Dose

People living downriver of SRS may receive some dose by consuming drinking water that contains radioactive releases from the Site and from VEGP and BLLDF. In 2021, SRS estimated the maximum potential drinking water dose from all sources to be 0.022 mrem (0.00022 mSv). Tritium in downriver drinking water represented the highest percentage of the dose (about 71%) to customers of the three downriver water treatment plants.

Data Table A-13 shows the 2021 SRS-only releases were responsible for a maximum potential drinking water dose of 0.010 mrem (0.00010 mSv). This dose is 9% less than the 2020 dose of 0.011 mrem (0.00011 mSv). SRS attributes this decrease to decreases in tritium, cesium-137, and strontium-90 liquid releases during 2021. DOE and EPA do not have a specific regulatory drinking water dose standard, but the EPA MCLs, defined in 40 CFR 141 (EPA 2000), assume a potential dose of 4 mrem/yr for beta and gamma emitters. The 2021 maximum drinking water dose of 0.010 mrem is well below this value.

2.1.2.5 Collective (Population) Dose

SRS calculates the collective drinking water consumption dose for the separate population groups that the BJWSA and City of Savannah I&D water treatment plants serve (Data Table A-14).

Calculations of collective doses from agricultural irrigation assume that 1,000 acres of land are used for each of the major food types grown in the SRS area (vegetables, milk, and meat) with the population within 50 miles of SRS consuming all the food produced on these 1,000-acre parcels. Historically, SRS limited the food consumption pathway dose to the smaller of 1) the total foodstuffs actually produced in the SRS 50-mile radius or 2) the total foodstuffs produced on the 1,000-acre parcels (based on regional productivity rates) (Jannik and Stagich 2017). The total amount of foodstuff produced in the SRS area (which is difficult to determine because of under reporting by small farms and individual gardens) has typically been less than

the amount produced on 1,000-acre parcels. Beginning in 2016, SRS now conservatively uses only the amount produced on the 1,000-acre irrigated parcels for collective dose estimates.

In 2021, the collective dose from all liquid pathways was 3.3 person-rem (0.033 person-Sv) (Data Table A-15). Person-rem is calculated as the dose to a "typical" person multiplied by the number of people exposed. This is a 11% decrease from the comparable 2020 collective dose of 3.7 person-rem (0.037 person-Sv). DOE Order 458.1 requires that a collective dose be calculated and reported, but there is not a separate collective dose standard for comparison.

2.2 Air Pathway Doses

2.2.1 Atmospheric Source Terms

Data Table A-16 documents the 2021 SRS radiological air releases by Site area. Data Table A-17 provides a five-year history of SRS atmospheric releases, and it shows that tritium oxide releases, which account for a majority of the offsite doses, decreased about 29% from 2020 to 2021. Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required for demonstrating compliance with EPA regulations.

2.2.2 Atmospheric Concentrations

For dose determinations, SRS uses calculated radionuclide concentrations from standard modeling of measured effluent releases instead of measured concentrations in the air surveillance samples. This is because most radionuclides SRS released in 2021 were not detected (using conventional analytical methods) in the air samples collected at the Site perimeter and offsite locations. The exception to this is tritium oxide, which can be measured at the site perimeter locations. Therefore, to confirm the dose models, SRS compares the measured concentrations of tritium oxide with the calculated concentrations from CAP88 PC and MAXDOSE. In Data Table A-18, this comparison showed that in 2021 the dose models used at SRS were about 2 times more conservative than the measured tritium oxide concentrations.

2.2.3 Dose to the Representative Person

As shown in Data Table A-19a, the 2021 estimated dose from air releases to the representative person was 0.017 mrem (0.00017 mSv), 0.17% of the DOE Order 458.1 air pathway standard of 10 mrem per year. Table 2-3 compares the representative person dose with the DOE standard. The 2021 dose was about 33% more than the 2020 dose of 0.012 mrem (0.00012 mSv). SRS attributes most of this increase to the increase in tritium oxide releases during 2021.

In 2017, SRS began to calculate the potential dose for an adult worker at the Three Rivers Landfill near B Area. As shown in Figure 1-2, Three Rivers Landfill is located on SRS, but it is accessed directly from public Hwy 125 outside of the Site's security perimeter. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1.

For this assessment, SRS assumed that an adult person worked at Three Rivers Landfill for 2000 hours during the year (8 hours/day, 5 days/week, 50 weeks/year). SRS also assumed that this worker was only exposed from the inhalation and external-exposure pathways. No locally grown food consumption was considered at this industrial location.

For 2021, SRS calculated a potential dose to a Three Rivers Landfill worker of 0.012 mrem (0.00012 mSv). This dose is less than the representative person dose of 0.017 mrem that was reported for DOE Order 458.1 compliance. Data Table A-19b shows the results of these calculations.

Table 2-3. Potential Doses to the Representative Person and to the NESHAP MEI from SRS Atmospheric Releases in 2021 and Comparison to the Applicable Dose Standard

	MAXDOSE-SR Site Boundary DOE 458.1	CAP88-PC (EPA NESHAP) Site Boundary	CAP88-PC (EPA NESHAP) TRL Worker
Calculated dose (mrem)	0.017	0.019	0.020
Applicable Standard (mrem)	10[a]	10[b]	10[a]
Percent of Standard (%)	0.17	0.19	0.20

a. DOE: DOE Order 458.1
b. EPA: (NESHAP) 40 CFR 61, Subpart H

As shown in Figure 2-2, tritium oxide releases accounted for nearly 72% of the dose to the representative person. Iodine-129 contributed 13% to the dose while krypton-85 and cesium-137 contributed 6% and 4%, respectively. Strontium-90 contributed about 2% with Plutonium-239 contributing 1% to the dose. No other individual radionuclide accounted for more than 1% of the representative person dose. Data Table A-19a shows that the major pathways through which a representative person received radioactivity from atmospheric releases were vegetable consumption (36%), inhalation (34%), and cow milk consumption (21%). As shown in Data Table A-20 and in Figure 2-3, the due north sector (0.0165 mrem) of the Site was slightly higher than the north northwest sector (0.0156 mrem) making it the location of the highest dose to the representative person.

Because of the potential in the SRS vicinity for the consumption of goat milk, additional calculations of the dose to the representative person were performed substituting goat milk for the customary cow milk pathway. As shown in Data Table A-21, SRS estimated that the potential dose to the representative person using the goat milk pathway is 0.019 mrem (0.00019 mSv). SRS provides this dose for reference only.

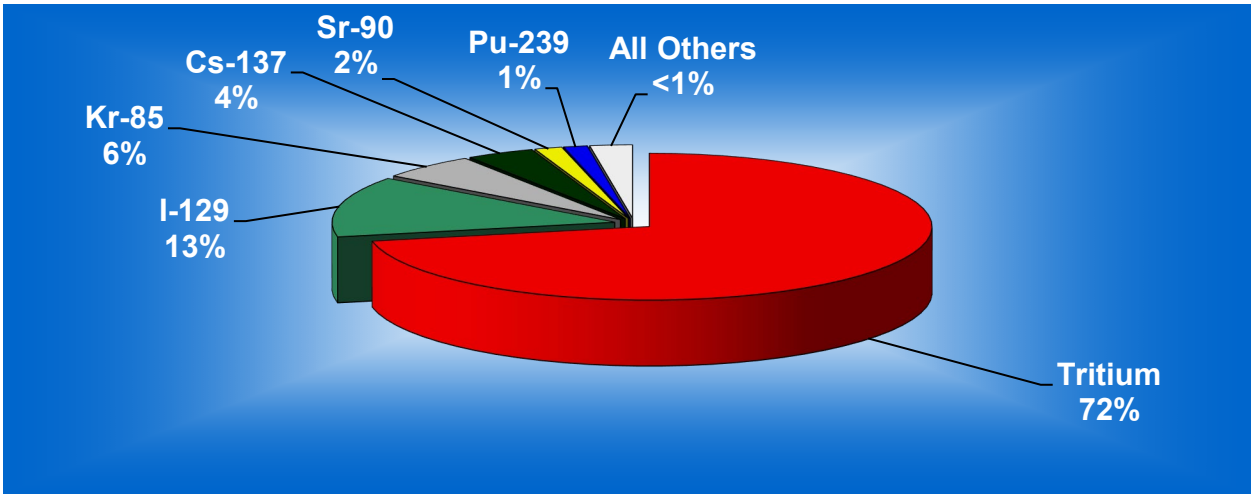


Figure 2-2. Radionuclide Contributions to the 2021 SRS Air Pathway Dose of 0.017 mrem (0.00017 mSv)

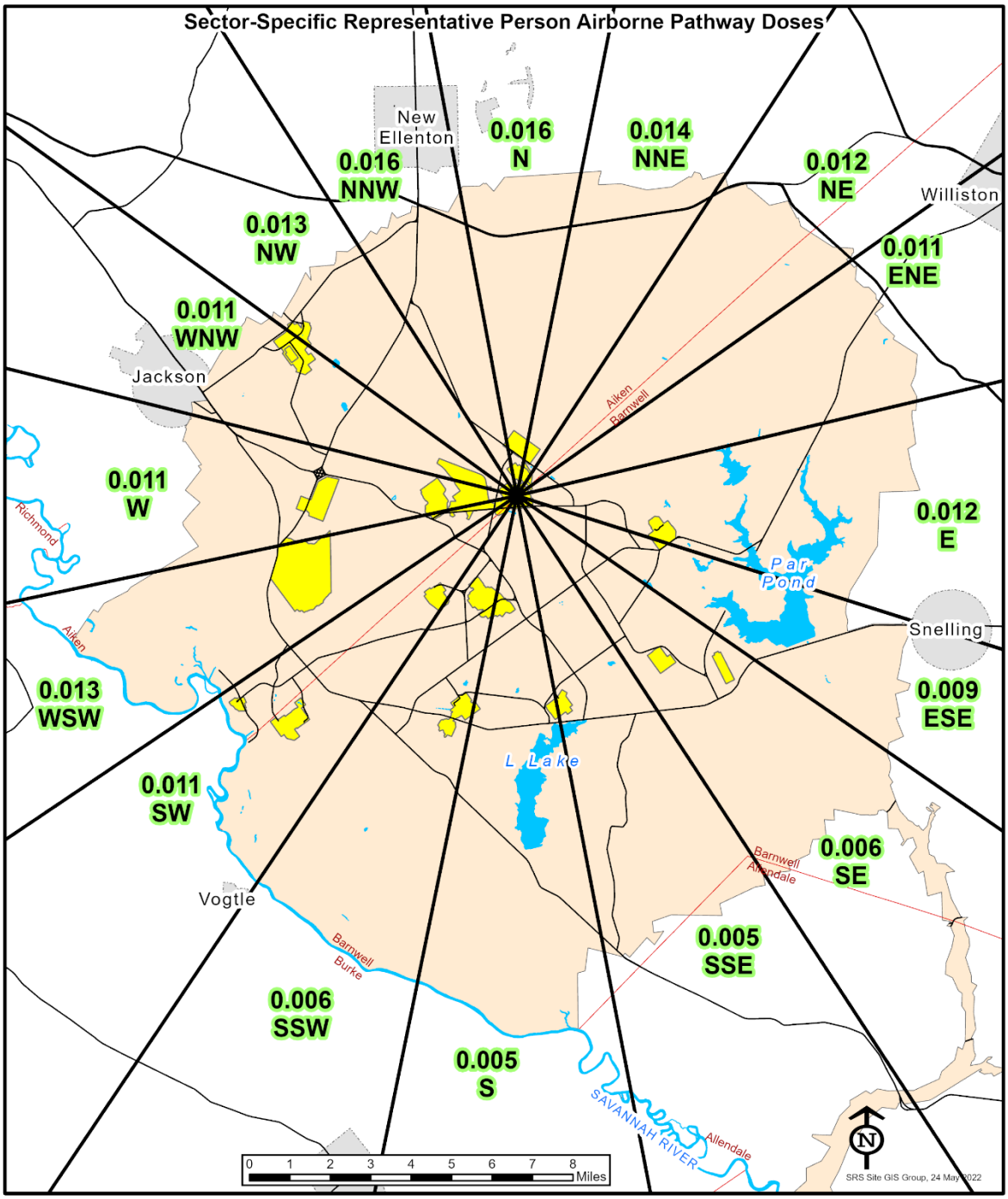


Figure 2-3. Sector-specific Representative Person Site Boundary Doses

2.2.4 Collective (Population) Dose

SRS calculates the air-pathway collective dose for the entire 803,370 population living within 50 miles of SRS's H-Area. Data Table A-4a and Data Table A-4b shows the population distribution around the SRS COS and H-Area, respectively.

In 2021, SRS estimated the air-pathway collective dose at 0.73 person-rem (0.0073 person-Sv), which is less than 0.01% of the annual collective dose from natural sources of radiation (about 234,000 person-rem). Data Table A-22 shows the 2021 air-pathway collective doses by radionuclide and pathway. Tritium oxide releases accounted for 74% of the collective dose.

2.2.5 National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance

2.2.5.1 Maximally Exposed Individual Dose

To demonstrate compliance with NESHAP regulations (EPA 2006), SRS calculated MEI and collective doses using 1) CAP88 PC version 4.1.0.2 computer code, 2) the 2020 air-release source term shown in Data Table A-23, and 3) Site-specific input parameters shown in Data Table A-24. The EPA requires the use of the MEI concept and does not allow use of the representative person concept. The EPA specifies most of the input parameters in the CAP88 PC program; they cannot be changed without specific EPA approval.

For 2021, SRS used CAP88 PC (version 4.1.0.2, dated January 2020) to demonstrate compliance with the EPA's 10 mrem/yr (0.1 mSv/yr) public dose standard for airborne emissions from DOE sites. For 2021, the Site boundary MEI dose (Data Table A-25a) was estimated at 0.0192 mrem (0.000192 mSv), or 0.19% of the 10-mrem/yr EPA standard, as shown in Table 2-3.

SRS estimated the MEI dose for the Three Rivers Landfill worker (Data Table A-25b) to be 0.0199 mrem (0.000199 mSv). For 2021, SRS reported the slightly higher TRL worker dose of 0.0199 mrem for NESHAP compliance. This dose is 0.20% of the 10-mrem/yr EPA standard, as Table 2-3 shows.

Data Table A-25a shows tritium oxide releases accounted for about 73% of the MEI dose and elemental tritium accounted for 15%. The CAP88 PC model very conservatively treats elemental tritium the same as tritium oxide. The 2021 NESHAP compliance dose (TRL dose) was about 29% more than the 2020 dose of 0.0154 mrem (0.000154 mSv). NESHAP regulations require separate dose reporting from diffuse and fugitive releases. Data Table A-26a shows the MEI dose for the TRL worker from diffuse and fugitive releases was about 0.00173 mrem (0.0000173 mSv). The diffuse and fugitive releases account for about 9% of the total 2021 MEI dose. Data Table A-26b provides the MEI dose and the TRL Worker location from diffuse and fugitive releases.

2.2.5.2 Collective Dose

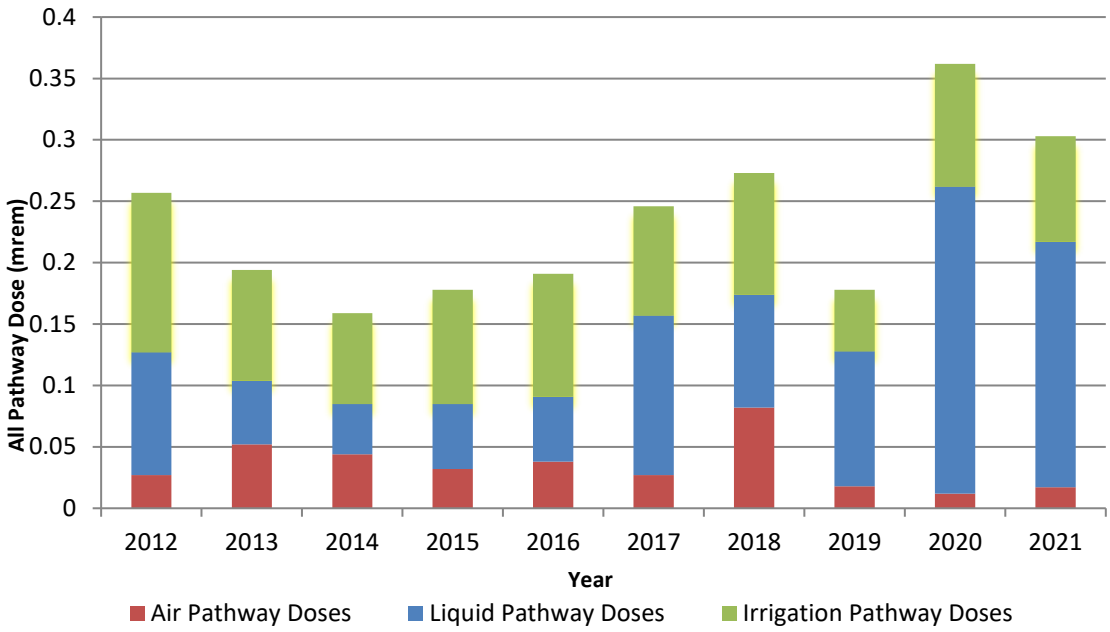
The CAP88 PC-determined collective (population) dose for 2021 was estimated at 1.9 person-rem (0.019 person-Sv), which is 36% more than the 2020 collective dose of 1.4 person-rem (0.014 person-Sv). Tritium releases accounted for 86% of the NESHAP collective dose.

For the population dose (Data Table A-28), the CAP88 PC version 4.1.0.2 estimates a higher dose compared to POPDOSE-SR, mainly because 1) it assumes the general population has the same inhalation and consumption rates as the maximally exposed individual, and 2) it assumes a one-to-one ratio between tritium oxide in air and tritium oxide in plant leaves (whereas POPDOSE-SR assumes a 50% ratio).

2.3 All-Pathway Dose

As stated in DOE Order 458.1, the all-pathway dose standard is 100 mrem/yr. SRS ensures a conservative estimate by combining the representative person airborne pathway and liquid pathway dose estimates, even though the two estimated doses are for hypothetical individuals residing at different geographic locations (Figure 1-2).

For 2021, the potential representative person all-pathway dose was 0.30 mrem (0.0030 mSv), calculated as 0.017 mrem from air pathways plus 0.28 mrem from liquid pathways. The all-pathway dose is 0.30% of the 100 mrem/yr (1 mSv/yr) DOE dose standard. The 2021 all-pathway dose is about 17% less than the 2020 total dose of 0.36 mrem (0.0036 mSv). Data Table A-12 provides a five-year history of the SRS all-pathway doses. Figure 2-4 shows a 10-year history of SRS's all-pathway (airborne, liquid, and irrigation pathways) doses to the MEI/representative person.



1. Beginning in 2011, the irrigation pathway dose is included in the liquid pathway dose. Previous years do not include the irrigation pathway dose.
2. Beginning in 2012, SRS began using the representative person dose instead of the MEI dose.

Figure 2-4. Ten-Year History of SRS Maximum Potential All-Pathway Dose

2.4 Sportsman Dose

DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem/yr includes the dose a person receives from routine DOE operations through all exposure pathways. Additionally, SRS considers and quantifies unique exposure pathways that are not included in the standard calculations of the doses to the representative person. This is because they apply to unlikely scenarios, such as eating fish caught only from the mouths of SRS streams ("creek-mouth fish"), or to special scenarios, such as onsite volunteer hunters.

In addition to deer, hog, fish, and turkey consumption, SRS considered the following exposure pathways for an offsite hunter and an offsite fisherman on Creek Plantation, a privately-owned portion of the Savannah River Swamp.

External exposure to contaminated soil,
Incidental ingestion of contaminated soil, and
Incidental inhalation of renewed suspension of contaminated soil.

2.4.1 Onsite Hunter Dose

2.4.1.1 Deer and Hog Consumption Pathway

SRS holds annual hunts for the public to control the Site's deer and wild pig populations and to reduce animal-vehicle accidents. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. Due to pandemic restrictions, there were no annual hunts held in 2021.

2.4.1.2 Turkey Consumption Pathway

SRS typically hosts a special turkey hunt during April for hunters with mobility impairments. However, due to pandemic restrictions, there were no turkey hunts in 2021.

2.4.2 Hypothetical Offsite Hunter Doses

2.4.2.1 Deer and Hog Consumption Pathway

The deer and hog consumption pathways considered were for hypothetical offsite individuals whose entire intake of meat (81 kg) during the year was either deer or hog meat. SRS assumes these individuals harvested deer or hogs that had resided on SRS during the year and then moved offsite prior to hunting season.

Based on these unlikely assumptions and on the measured average concentration of cesium-137 in all deer (1.23 pCi/g) and hogs (1.77 pCi/g) harvested from SRS during 2020 and 2021, respectively, the potential maximum doses from this pathway were estimated at 2.97 mrem (0.0297 mSv) for the offsite deer hunter and 5.17 mrem (0.0517 mSv) for the offsite hog hunter. Data Table A-29 documents these dose calculations.

Beginning in 2013, a background cesium-137 concentration of 0.5 pCi/g is subtracted from the onsite average concentrations, before calculating the offsite hunter doses. The 0.5 pCi/g background concentration is based on the median value determined by South Carolina Department of Health and Environmental Control (SCDHEC) for South Carolina deer, from 2008 through 2012 (SCDHEC 2013).

2.4.2.2 Savannah River Swamp Hunter Soil Exposure Pathway

SRS estimated the potential dose to a recreational hunter exposed to SRS legacy contamination on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman hunted for 120 hours during the year (8 hours per day for 15 days) at the location of maximum radionuclide contamination. Table 2-4 shows the offsite hog consumption pathway 5.17 mrem, and the Savannah River swamp hunter soil exposure pathway 1.86 mrem were conservatively added together to obtain a total offsite hunter dose of 7.03 mrem (0.0703 mSv). This potential dose is 7.0% of the DOE 100 mrem/yr all-pathway dose standard.

2.4.3 Hypothetical Offsite Fisherman Dose and Risk

2.4.3.1 Creek-Mouth Fish Consumption Pathway

For 2021, SRS analyzed four species of fish (panfish, catfish, flathead catfish, and bass) taken from the mouths of four SRS streams. Using these concentrations, SRS estimated the maximum potential dose from fish consumption at 0.426 mrem (0.00426 mSv) from bass collected at the mouth of Steel Creek. SRS bases this hypothetical dose on the low-probability scenario that, during 2021, a fisherman consumed 24 kg (53 lbs) of bass caught exclusively from the mouth of Steel Creek. All this potential dose was from cesium-137. Data Table A-30a and Data Table A-30b, respectively, show the measured concentrations and resulting doses for each location and species combination.

2.4.3.2 Savannah River Swamp Fisherman Soil Exposure Pathway

Using the RESRAD code (Yu et al. 2001), SRS calculated the potential dose to a recreational fisherman exposed to SRS legacy contamination in Savannah River Swamp soil on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman fished on the South Carolina bank of the Savannah River, near the mouth of Steel Creek, for 250 hours during the year.

Using the radionuclide concentrations measured in soil at this location, SRS estimated the potential dose to a fisherman from a combination of 1) external exposure to the contaminated soil, 2) incidental ingestion of the soil, and 3) incidental inhalation of renewed suspension soil to be 2.08 mrem (0.00208 mSv).

Table 2-4 shows how SRS conservatively combined the maximum Steel Creek fish consumption dose (0.43 mrem) and the Savannah River Swamp fisherman soil exposure pathway (2.08 mrem) to obtain a total offsite fisherman dose of 2.51 mrem (0.0251 mSv). This potential dose is 2.51% of the DOE 100 mrem/yr all-pathway dose standard.

2.4.3.3 Potential Risk from Consumption of SRS Creek-Mouth Fish

During 1991 and 1992, in response to a U.S. House of Representatives Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed a fish monitoring plan in conjunction with the EPA, the Georgia Department of Natural Resources (GDNR), and SCDHEC. This plan ensures SRS assesses the radiological risk from the consumption of Savannah River fish and requires that SRS present a summary of the results in the SRS Annual Site Environmental Report.

Table 2-4. 2021 Representative Person All-Pathways and Sportsman Doses Compared to the DOE All-Pathways Dose Standard

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
Representative Person Dose			
All-Pathways (Liquid Plus Airborne Pathways)	0.30	100	0.30
Sportsman Dose			
Onsite Hunter	0.00	100	0.00
Creek-Mouth Fisherman[b]	0.43	100	0.43
Savannah River Swamp Hunter			
Offsite Hog Consumption	5.17		
Offsite Deer Consumption	2.97		
Soil Exposure[c]	1.86		
Total Offsite Hunter Dose (Hog + Soil Exposure)	7.03	100	7.03
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.426		
Soil Exposure[d]	2.08		
Total Offsite Fisherman Dose (Fish + Soil Exposure)	2.51	100	2.51

a. All-pathway dose standard; 100 mrem/yr (DOE Order 458.1)
b. In 2021, the maximum dose to a hypothetical fisherman resulted from the consumption of bass from the mouth of Steel Creek
c. Includes the dose from a combination of external exposure to and incidental ingestion and inhalation of the worst-case Savannah River swamp soil
d. Includes the dose from a combination of external exposure and incidental ingestion and inhalation of Savannah River swamp soil near the mouth of Steel Creek

2.4.3.4 Risk Comparisons

For 2021, SRS compared the maximum potential radiation doses and lifetime fatal and nonfatal cancer risks (from the consumption of SRS creek-mouth fish for 1-year, 30-year, and 50-year exposure durations) to the radiation risks associated with the DOE Order 458.1 all-pathway dose standard of 100 mrem/yr (1.0 mSv/yr) in Table 2-5. SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (EPA 1999). The assumed maximum fish consumption rate is 24 kg per year (Table 1-1).

In 2021, the maximum dose and risk to a hypothetical fisherman resulted from the consumption of bass from the mouth of Steel Creek (Data Table A-30b and Data Table A-30c). Figure 2-5 shows the history (1994-2021) of the annual potential radiation doses from consumption of Savannah River fish. Over the past ten years, there are no apparent trends in these data. This is because of the relatively large variability in the radionuclide concentrations measured in fish from the same location, due to differences in the following:

- Size of the fish collected each year,
- Mobility and location within the stream mouth from which they are collected,
- Time of year they are collected,
- Amount of radionuclides in the stream water and sediments in which they live that are chemically and physically available to the fish,
- Water quality at each SRS stream mouth, caused by annual changes in stream flow rates (turbulence) and water chemistry.

Table 2-5. Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards

	Committed Dose (mrem)	Potential Risk[(a)]
2021 Savannah River Fish		
1-Year Exposure	0.43	3.2E-07
30-Year Exposure	12.8	9.7E-06
50-Year Exposure	21.3	1.6E-05
Dose Standard		
100 mrem/yr All Pathway		
1-Year Exposure	100	7.3E-05
30-Year Exposure	3,000	2.2E-03
50-Year Exposure	5,000	3.7E-03

a. All radiological risk factors are based on observed and documented health effects to actual people who have received high doses (more than 10,000 mrem) of radiation, such as the Japanese atomic bomb survivors. Radiological risks at low doses (less than 10,000 mrem) are theoretical and are estimated by extrapolating the observed health effects at high doses to the low-dose region by using a linear, no-threshold model. However, cancer and other health effects have not been observed consistently at low radiation doses because the health risks either do not exist or are so low that they are undetectable by current scientific methods.

As indicated in Table 2-5, the 50-year maximum potential lifetime risk from consumption of SRS creek-mouth fish was 2.1E-05, well below the 50-year risk (3.7E-03) associated with the 100 mrem/yr dose standard.

If a potential lifetime risk is less than 1.0E-06 (i.e., one additional case of cancer over that expected in a group of 1,000,000 people), the risk is considered minimal and the corresponding contaminant concentrations are considered negligible. If a calculated risk is more than 1.0E-04 (one additional case of cancer in a population of 10,000), some form of corrective action or remediation may be required. However, if a calculated risk falls between 1.0E-04 and 1.0E-06 (the case with the maximum potential lifetime risks from the consumption of Savannah River fish), then the risk may be deemed acceptable, if it is kept 'as low as reasonably achievable' (ALARA). At SRS, an environmental ALARA program (3Q 18.5) is in place, to ensure that the potential doses and risks from Site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) are kept ALARA (SRS 2015).

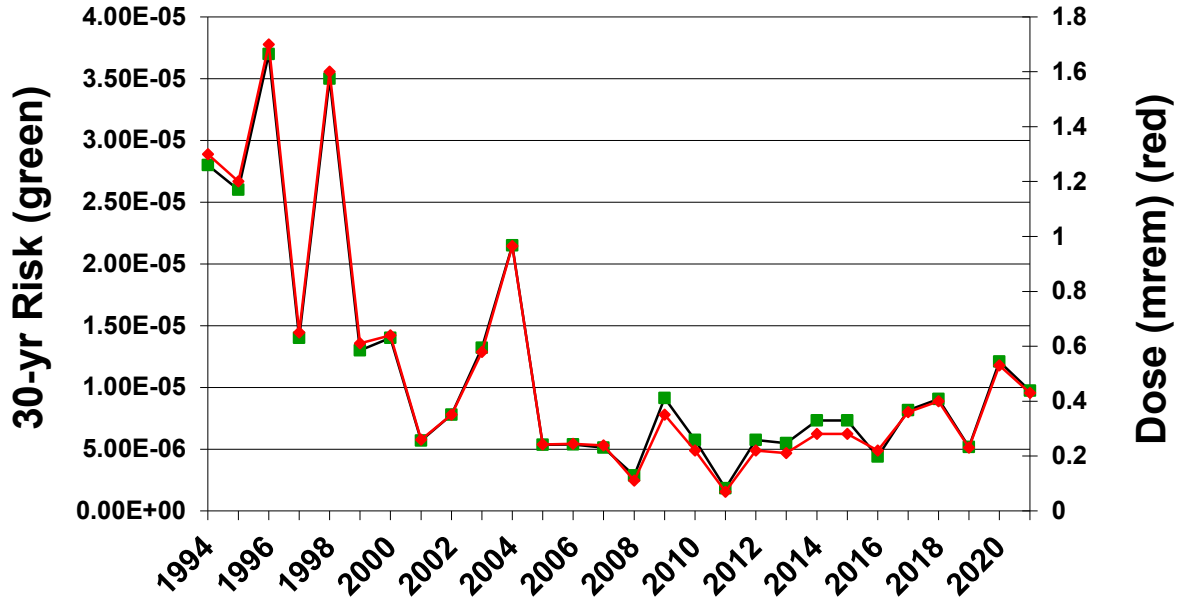


Figure 2-5. History of SRS Maximum Potential Fisherman Doses and 30-y Projected Risks

3.0 Release of Material Containing Residual Radioactivity

DOE Order 458.1 establishes authorized surface contamination limits, which, in turn, allow SRS to release personal and real property unconditionally. This order defines personal property as, "*property of any kind, except for real property" and defines real property as "land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures, or other such items, that would be personal property if not attached.*" SRS handles unconditional release of real property on a case-by-case basis, which requires specific approval from DOE. SRS did not release any real property in 2021, so the following discussion is associated with release of personal property from SRS. DOE Order 458.1 specifies that SRS must prepare and submit an annual summary of cleared property to the Field Element Manager (i.e., DOE-SR Manager).

3.1 Property Release Methodology

Through the use of procedures, SRS governs the unconditional release of equipment and material. Following a radiological survey, SRS can unconditionally release an item if it meets specific documented limits. For items meeting unconditional release criteria, SRS generates a form and electronically attaches it to the applicable radiological survey, via the Site's Visual Survey Data System. To determine the amount of material and equipment released from SRS facilities in 2021, SRS subsequently compiled these electronic forms and coordinated a site-wide review. These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 458.1.

In 2021, SRS unconditionally released a total of 12,158 items of personal property from radiological areas. Most of these items did not leave the Site. Therefore, all of these items required no additional radiological controls, post-survey, as they met DOE Order 458.1 release criteria. The recently implemented DOE Order 458.1 allows using DOE Order 5400.5 derived supplemental limits for unconditional release of equipment and materials.

In 2003, DOE approved an SRS request to use supplemental limits for releasing material from the Site, with no further DOE controls. These supplemental release limits, provided in Data Table A-31, are dose-based. These limits are such, that if any member of the public received any exposure, it would be less than 1 mrem/yr. The supplemental limits include both surface and volume concentration criteria. The surface criteria are very similar to those used in previous years. The volume criteria allow SRS the option to dispose of potentially volume-contaminated material in Three Rivers Landfill, an onsite sanitary waste facility. In 2021, an unrestricted release to the onsite Three Rivers landfill of volumetrically contaminated grit that occurred on October 28, 2020, was identified, and found to be below the approved supplemental release limits.

4.0 Radiation Dose to Aquatic and Terrestrial Biota

DOE Order 458.1 requires that SRS conduct Site operations in a manner that protects the local biota from adverse effects due to radiation and radioactive material releases. To demonstrate compliance with this requirement, SRS uses the approved DOE Standard, DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2019).

The biota dose rate limits specified in this standard are:

Aquatic animals	1.0 rad/day (0.01 gray/day),
Riparian animals	0.1 rad/day (0.001 gray/day),
Terrestrial plants	1.0 rad/day (0.01 gray/day), and
Terrestrial animals	0.1 rad/day (0.001 gray/day).

4.1 DOE Biota Concentration Guides

SRS evaluates biota doses for aquatic and terrestrial systems using the RESRAD Biota model (version 1.8) (DOE 2004), which directly implements the DOE (2019) guidance.

For aquatic systems (aquatic and riparian animals), the RESRAD Biota model performs a combined water-plus-sediment evaluation. SRS performed initial screenings in 2021 using maximum (for Level 1) radionuclide concentration data from the 14 SRS environmental monitoring stream and sediment sampling locations that are co-located. These screenings determine the biota concentration guide (BCG) sum-of-the-fractions for each of the 14 assessed aquatic systems. A sum-of-the-fractions less than 1.0 indicates the sampling site has passed its initial pathway screening. This means that the biota dose rate limits were not exceeded, and that no further assessments are needed.

Data Table A-32 presents the results of the 2021 biota dose assessment. For 2021, all SRS aquatic system locations passed the initial (Level 1) pathway screenings, and no further assessments were required.

To evaluate the terrestrial systems (terrestrial plants and animals), SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2021, all terrestrial locations passed their initial (Level 1) pathway screenings (Data Table A-32).

5.0 References

Bell, E.S. 2020. Creation of CAP88 and MAXDOSE Meteorological Datasets (2014-2018) for Regulatory Dose Assessment. SRNL-STI-2020-00259, Revision 0. July, 2020. Savannah River National Laboratory, Aiken, SC.

Carlton, W.H., C.E. Murphy, Jr., and A.G. Evans. "Radiocesium in the Savannah River Site Environment," Health Physics, Volume 67, Number 3, Williams & Wilkins, Baltimore, MD; 1994.

Dixon, K.L. "Verification of LADTAP 2020," SRNL-L3220-2020-00006, Savannah River National Laboratory, Savannah River Site, Aiken, SC; 2020.

Eckerman, K.F. and R.W. Leggett. "User Guide to DCFPAK 3.0," Oak Ridge National Laboratory, Oak Ridge, TN; 2013.

International Commission on Radiological Protection. "Age dependent dosses to members of the public from intake of radionuclides: part 5 compilation of ingestion and inhalation dose coefficients," Oxford: ICRP; Publication 72, Ann. 26(1); 1996.

International Commission on Radiological Protection. "Basic anatomical and physiological data for use in radiological protection reference values," Oxford: ICRP; Publication 89, Ann. ICRP 32 (3-4); 2002.

International Commission on Radiological Protection. "Assessing dose of the representative person for the purpose of radiation protection of the public," Oxford: ICRP; Publication 101, Ann. ICRP 36 (No. 3); 2006.

Jannik, G.T., and B.H. Stagich. "Land and Water Use Characteristics and Human Health Input Parameters for Use in Environmental Dosimetry and Risk Assessments at the Savannah River Site - 2017 Update," SRNL-STI-2016-00456, Revision 1, Savannah River National Laboratory, Savannah River Site, Aiken, SC; 2017.

Laird, M. G., and G. T. Jannik. "Updated External Exposure Dose Coefficients," SRNL-L3200-2020-00014, Savannah River National Laboratory, Savannah River Site, Aiken, SC; 2020.

Minter, K. M., G. T. Jannik, B. H. Stagich, K. L. Dixon, and J. R. Newton. 'Comparison of the Current Center of Site Annual NESHAP Dose Modeling at the Savannah River Site with Other Assessment Methods," Health Physics, v144(4), April 2018.

National Council on Radiation Protection and Measurements (NCRP). "Ionizing Radiation Exposure of the Population of the United States," NCRP Report No. 160, Bethesda, MD, 2009.

Savannah River National Laboratory. "Environmental Dose Assessment Manual," SRNL-TR-2010-00274, Revision 2, Savannah River National Laboratory, Aiken, SC; 2017.

Savannah River Site, "Savannah River Site Environmental Monitoring Program Management Plan," SRS Manual 3Q1-101, Revision 7, Savannah River Site, Aiken, SC; 2015.

South Carolina Department of Health and Environmental Control. "Environmental Surveillance and Oversight Program, 2012 Data Report," CR-004111, 2013, Columbia, SC; 2013.

Stagich, B.H. "CAP88-PC Version 4.1 Verification (U)," SRNL-L3200-2020-00028, Savannah River National Laboratory, Savannah River Site, Aiken, SC; 2020.

Stone, D. K., Jannik, G. T. "Site Specific Reference Person Parameters and Derived Concentration Standards for the Savannah River Site," SRNL-STI-2013-00115, Savannah River National Laboratory. Aiken, SC: 2013.

U.S. Department of Energy. "External and Internal Dose Conversion Factors for Calculation of Dose to the Public", DOE/EH-0070 & 71, Washington, D.C., 1988

U.S. Department of Energy. "RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluation," DOE/EH-0676, January 2004, Washington, DC; 2004.

U.S. Department of Energy. "DOE Derived Concentration Technical Standard," DOE-STD-1196-2011, Washington, DC; 2011.

U.S. Department of Energy. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," DOE Standard, DOE-STD-1153-2019, Washington, DC; 2019.

U.S. Department of Energy. "Radiation protection of the public and the environment, Change #4," Washington, DC: U.S. DOE Order 458.1; 2020.

U.S. Environmental Protection Agency. "External Exposure to Radionuclides in Air, Water, and Soil," Federal Guidance Report No. 12, USEPA 402-R-93-081, Washington, DC; 1993.

U.S. Environmental Protection Agency. "Cancer Risk Coefficients for Environmental Exposure to Radionuclides," Federal Guidance Report No.13, USEPA 402-R-99-001, September 1999, Washington, DC; 1999.

U.S. Environmental Protection Agency. "National Primary Drinking Water Regulations," Title 40 Code of Federal Regulations, Part 141, December 2000, Washington, DC; 2000.

U.S. Environmental Protection Agency (EPA). "National Emissions Standards for Hazardous Air Pollutants; Radionuclides," Title 40 Code of the Federal Regulations, Part 61, Washington, D.C. 2006.

U.S. Environmental Protection Agency. "Exposure factors handbook 2011 edition (final report)," Washington, DC: U.S. Environmental Protection Agency; EPA/600/R-09/052F; 2011.

U.S. Environmental Protection Agency. "External Exposure to Radionuclides in Air, Water, and Soil," Federal Guidance Report No. 15, USEPA 402-R-19-002, Washington, DC; 2019.

U.S. Nuclear Regulatory Commission. "Regulatory Guide 1.109 - Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, Washington, DC; 1977.

Yu, C., A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, Amish, A. Wallo III, W.A. Williams, and H. Peterson, "User's Manual for RESRAD," Version 6, Environmental Assessment Division, Argonne National Laboratory, July 2001, Argonne, IL; 2001.

Appendix A

Data Table A-1. Parameters Used for Liquid Pathway Calculations

Table A-1, Parameters Used for Liquid Pathway Dose Calculations

Reference and Typical Person Consumption and Usage Rates

(Note: Values developed by Savannah River National Laboratory for SRS in Stone and Jannik, 2013)

Pathway	Reference Person 95th percentile	Typical Person 50th percentile	Units
Fish consumption	24	3.7	kg/y
Marine invertebrates	Not applicable	1.5	kg/y
Boating	44	3,110,000	h/y (person-h/y)
Swimming	14	295,000	h/y (person-h/y)
Shoreline recreation	20	822,000	h/y (person-h/y)
Water consumption	800	300	L/y
Population Served by Downriver Water Treatment Plants			
Beaufort-Jasper Purrysburg Plant		81,000	persons
Beaufort-Jasper Chelsea Plant		102,000	persons
City of Savannah Industrial & Domestic Water Supply [a]		36,677	persons
50-mile Population			
Center of Site - 2010 US Census		781,060	persons
H-Area - 2010 US Census		803,370	persons

Site-Specific Parameters Used in Liquid Dose Calculations	Value	Units
Savannah River *effective* flow rate at RM 141.5 for 2021 [b]	8,456	ft^3/s
River dilution in estuary	3	
Transport Time		
Recreation	1	d
Drinking Water	1.5	d
Fish	2	d
Treatment Plant Drinking Water	4	d
Sport Fish	10	d
Commercial Fish	13	d
Salt Water Invertebrate	13	d
Edible aquatic food harvest		
Fish - sport	8,220	person-kg/y
Fish - commercial	57,000	person-kg/y
Invertebrates - salt water	380,000	person-kg/y
Shoreline width factor	0.2	
Fish bioaccumulation factor for cesium	3,000	

a) Based on production value (http://savannahwaterquality.com/reports/2020/i-and-d) and ratio of total production to population served for Chelsea & Purrysburg

a) The effective river flow rate was based on tritium concentration measurements.
The 2021 measured river flow rate was 10,534 cfs. See Data Table 6-6 for details.

Parameters Used for Liquid Pathway Dose Calculations

Irrigation Parameter Values:

Parameter	Value	Units	Comments
50Mile Total Vegetable Production:	7122412	kg/yr	**5.30E+06***
50Mile Total Leafy Veg Production:	1780603	kg/yr	**1.40E+06***
Irrigated land area:	1000	acres	
Pop dose determined by:	area		POP or AREA
River transit time:	2	d	
Irrigation rate:	3.6	L/sq.m/d	102 L/sq.m/mo
Weathering removal constant:	0.0495	1/d	14 d half-life
Crop exposure time:	70	d	
Grass exposure time:	30	d	
Vegetable crop yield:	2.2	kg/sq.m	
Pasture grass yield:	0.7	kg/sq.m	
Milk production yield:	0.34	L/sq.m	
Meat production yield:	0.01	kd/sq.m	
Surface density of soil:	240	kg/sq.m	
Pasture grass hold-up time:	0	d	
Veg transport time (individual):	1	d	d
Veg transport time (population):	6	d	d
Milk transport time:	3	d	d
Meat transport time:	6	d	d
Fraction of fodder from irrigated field:	1.00		
Cattle consumption rate of fodder:	36	kg/d	beef
	52	kg/d	milk
Fraction of water from Savannah River:	1.00		
Cattle consumption rate of water:	28	L/d	beef
	50	L/d	milk
Individual consumption rates:	289	kg/yr	veg
	31	kg/yr	leafy
	81	kg/yr	meat
	260	L/yr	milk
Population consumption rates:	89	kg/yr	veg
	11	kg/yr	leafy
	32	kg/yr	meat
	69	L/yr	milk
Fractional retention on leaves:	0.25		all nuclides

Data Table A-2. Site-Specific Parameters Used for Airborne Pathway Dose

Data Table A-2, Site-Specific Parameters Used for Airborne Pathway Doses using MAXDOSE and POPDOSE

Pathway	Reference Person 95th Percentile (Individual)	SRS MEI Pre-2012 Adult Individual	Percent Difference	Typical Person 50th Percentile (Population)	SRS Population Pre-2012 Average Adult	Percent Difference
Fruits, vegetables, and grains (kg/yr)	289	276	↑4.7%	89	163	↓45.4%
Leafy vegetables (kg/yr)	31	43	↓27.9%	11	21	↓47.6%
Milk (L/yr)	260	230	↑13%	69	120	↓42.3%
Meat (beef) (kg/yr)	81	81	0.00%	32	43	↓25.6%
Inhalation (m^3/yr)	6,400	8,000	↓20.0%	5,000	5,548	↓9.9%
50-mile Population						
Center of Site - 2010 US Census (persons)	781,060					
H-Area - 2010 US Census (persons)	803,370					

Release Locations for Representative Person Dose				
	Reactors	**F & H**	**SRNL**	**Diffuse and Fugitive**
Release height, m	40	61	31	0
Release location (site coordinates)				
East	40740	63380	51860	58000
North	54130	71900	106670	62000
Grade Elevation	269	308	368	338

Data Table A-3. Meteorological Data (2014 – 2018)

Data Table A-3, Meteorological Data (2014-2018) **1 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class A
Extremely Unstable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.254	0.325	0.268	0.297	0.293	0.330	0.318	0.247
4.00	0.222	0.316	0.343	0.423	0.471	0.416	0.318	0.240
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.480	0.640	0.610	0.720	0.760	0.750	0.640	0.490

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class A
Extremely Unstable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.286	0.364	0.359	0.414	0.384	0.366	0.352	0.263	5.120
4.00	0.346	0.421	0.533	0.725	0.611	0.446	0.238	0.213	6.282
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.630	0.790	0.890	1.140	1.000	0.810	0.590	0.480	11.420

Data Table A-3. Meteorological Data (2014-2018) (continued) **2 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class B
Moderately Unstable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.009	0.027	0.039	0.032	0.023	0.021	0.018	0.023
4.00	0.098	0.181	0.293	0.437	0.339	0.256	0.144	0.101
6.00	0.018	0.032	0.094	0.112	0.059	0.039	0.021	0.014
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.130	0.240	0.430	0.580	0.420	0.320	0.180	0.140

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class B
Moderately Unstable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.018	0.027	0.014	0.039	0.032	0.018	0.011	0.018	0.369
4.00	0.181	0.245	0.412	0.616	0.467	0.325	0.137	0.114	4.346
6.00	0.032	0.039	0.046	0.119	0.178	0.098	0.016	0.011	0.928
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.230	0.310	0.470	0.770	0.680	0.440	0.160	0.140	5.640

Data Table A-3. Meteorological Data (2014-2018) (continued) **3 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class C
Slightly Unstable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.030	0.048	0.053	0.046	0.041	0.030	0.021	0.032
4.00	0.146	0.302	0.554	0.513	0.277	0.215	0.172	0.160
6.00	0.126	0.277	0.764	0.348	0.185	0.160	0.114	0.153
8.00	0.014	0.039	0.098	0.023	0.009	0.007	0.009	0.018
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.320	0.670	1.470	0.930	0.510	0.410	0.320	0.360

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class C
Slightly Unstable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.043	0.043	0.025	0.041	0.046	0.030	0.037	0.023	0.589
4.00	0.323	0.371	0.371	0.691	0.487	0.375	0.162	0.178	5.297
6.00	0.320	0.330	0.503	0.851	0.870	0.586	0.220	0.092	5.899
8.00	0.034	0.034	0.062	0.153	0.174	0.142	0.030	0.016	0.862
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.720	0.780	0.960	1.740	1.580	1.130	0.450	0.310	12.660

Data Table A-3. Meteorological Data (2014-2018) (continued) **4 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class D
Neutral Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.162	0.211	0.275	0.300	0.259	0.238	0.174	0.158
4.00	0.595	0.957	1.741	2.110	1.611	0.947	0.995	0.888
6.00	0.350	0.815	1.659	0.689	0.382	0.403	0.787	1.215
8.00	0.071	0.195	0.378	0.037	0.021	0.032	0.092	0.146
12.00	0.005	0.032	0.062	0.014	0.000	0.007	0.009	0.005
14.10	0.011	0.007	0.007	0.000	0.000	0.000	0.002	0.002
TOTAL	1.190	2.220	4.120	3.150	2.270	1.630	2.060	2.410

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class D
Neutral Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.204	0.162	0.156	0.153	0.153	0.158	0.151	0.112	3.026
4.00	1.451	1.114	1.149	1.211	0.963	0.870	0.609	0.403	17.614
6.00	1.625	1.094	1.249	1.421	1.231	1.213	0.423	0.245	14.801
8.00	0.224	0.204	0.133	0.279	0.460	0.478	0.162	0.105	3.017
12.00	0.021	0.018	0.039	0.071	0.156	0.268	0.030	0.050	0.787
14.10	0.002	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.035
TOTAL	3.530	2.590	2.730	3.140	2.960	2.990	1.380	0.920	39.290

Data Table A-3. Meteorological Data (2014-2018) (continued) **5 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class E
Slightly Stable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.103	0.101	0.130	0.158	0.126	0.126	0.133	0.092
4.00	0.279	0.336	0.645	1.009	0.808	0.792	0.677	0.732
6.00	0.142	0.240	0.577	0.247	0.222	0.398	0.339	0.517
8.00	0.002	0.005	0.009	0.000	0.000	0.000	0.000	0.005
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.530	0.680	1.360	1.410	1.160	1.320	1.150	1.350

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class E
Slightly Stable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.112	0.114	0.108	0.105	0.092	0.094	0.080	0.103	1.777
4.00	1.082	1.064	0.735	0.819	0.721	0.565	0.483	0.332	11.079
6.00	1.158	0.998	0.890	1.204	0.682	0.449	0.229	0.121	8.413
8.00	0.007	0.016	0.027	0.005	0.007	0.000	0.000	0.000	0.083
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	2.360	2.190	1.760	2.130	1.500	1.110	0.790	0.560	21.360

Data Table A-3. Meteorological Data (2014-2018) (continued) **6 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class F
Moderately Stable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.057	0.057	0.046	0.018	0.025	0.048	0.062	0.085
4.00	0.382	0.467	0.382	0.110	0.121	0.158	0.243	0.545
6.00	0.167	0.281	0.254	0.039	0.021	0.087	0.114	0.222
8.00	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.610	0.810	0.680	0.170	0.170	0.290	0.420	0.850

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class F
Moderately Stable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.073	0.064	0.071	0.082	0.066	0.076	0.082	0.050	0.962
4.00	0.474	0.675	0.517	0.350	0.293	0.405	0.405	0.407	5.934
6.00	0.238	0.396	0.263	0.144	0.153	0.169	0.082	0.140	2.770
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.790	1.140	0.850	0.580	0.510	0.650	0.570	0.600	9.690

Data Table A-3. Meteorological Data (2014-2018) (continued) **7 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class G
Extremely Stable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class G
Extremely Stable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Data Table A-4a. Population Distribution Around SRS Center of Site (2010 Census)

Data Table A-4a, Population Distribution Around the SRS Center of Site (2010 Census)

Dir(Miles)	5-10	10-20	20-30	30-40	40-50	TOTAL
N	29	9561	13784	4919	12842	41135
NNE	0	3572	2756	7035	32199	45562
NE	0	4791	2835	6128	18663	32417
ENE	16	1919	4524	5598	47214	59271
E	57	8029	7260	7301	4361	27008
ESE	26	2366	1371	1723	3048	8534
SE	10	536	6513	6300	9595	22954
SSE	5	122	242	431	5251	6051
S	0	306	1206	7932	3871	13315
SSW	0	1119	2149	5416	3472	12156
SW	4	1052	1634	1026	1871	5587
WSW	53	1310	10111	1226	5732	18432
W	1	3245	9710	4818	7206	24980
WNW	360	2598	115475	87020	17035	222488
NW	222	8478	93847	56513	3194	162254
NNW	449	28925	30971	10834	7737	78916
Total	1232	77929	304388	214220	183291	781060

For a 50-mile (80-km) radius around SRS Center of Site

Data Table A-4b. Population Distribution Around SRS Center of Site (2010 Census)

Data Table A-4b, Population Distribution Around SRS's H-Area (2010 Census)

Dir(Miles)	5-10	10-20	20-30	30-40	40-50	TOTAL
N	339	12400	8770	6240	14500	42249
NNE	133	3560	3610	7090	42800	57193
NE	80	3200	3110	7070	24300	37760
ENE	25	3400	3700	6880	47500	61505
E	88	5000	7750	7860	4810	25508
ESE	10	5590	1870	1880	2930	12280
SE	0	620	5630	5950	10200	22400
SSE	0	147	275	451	5760	6633
S	0	368	840	7620	3970	12798
SSW	0	770	2320	5580	2980	11650
SW	19	1290	3450	838	1670	7267
WSW	6	1120	8800	1290	5930	17146
W	146	4130	21400	4640	9170	39486
WNW	1840	3350	151000	97300	14900	268390
NW	775	12100	68900	21900	1910	105585
NNW	2510	36400	20800	12800	3010	75520
Total	5971	93445	312225	195389	196340	803370

For a 50-mile (80-km) radius around SRS's H-Area

Data Table A-5. Savannah River Mile 118.8 Flow Rates, 1954 – 2021

Data Table A-5, Savannah River Mile 118.8 Flow Rates, 1954-2021

Year	Mean Annual Flow (cfs)
1954	7,382
1955	5,974
1956	6,309
1957	8,312
1958	11,038
1959	9,748
1960	13,112
1961	10,909
1962	10,580
1963	11,138
1964	20,497
1965	12,785
1966	11,175
1967	10,573
1968	9,624
1969	10,945
1970	7,169
1971	10,715
1972	11,275
1973	14,536
1974	11,138
1975	15,533
1976	14,008
1977	11,695
1978	10,547
1979	13,333
1980	13,282
1981	6,544
1982	7,169
1983	12,348
1984	12,759
1985	7,167
1986	6,175
1987	8,955
1988	5,364
1989	7,966
1990	11,858
1991	11,598
1992	11,697
1993	14,788
1994	12,271
1995	12,750
1996	11,467
1997	10,464
1998	16,239
1999	6,160
2000	5,550
2001	5,804
2002	5,386
2003	12,842
2004	8,778
2005	11,935
2006	6,818
2007	6,088
2008	4,833
2009	7,666
2010	9,893
2011	5,714
2012	4,570
2013	8,479
2014	9,440
2015	8,833
2016	10,150
2017	5,698
2018	9,787
2019	10,968
2020	15,345
2021	10,508
Mean =	10,032
Harmonic Mean =	8984
Geometric Mean =	9513
10 year mean	9,045
15 year mean	8,531

(USGS #02197500)
Near River Mile 118.8 (Hwy 301 Bridge)

USGS #021973269
RM 160 Near Wayneboro, GA

Data Table A-6. Calculated Effective Flow Rate

Data Table A-6, Calculated Effective River Flow Rates

Savannah River Monthly Flow Rate
Based on USGS Daily Flow Rate
Average is Monthly Average

	Flow, cfs
Month	River Mile 118.8 (Hwy 301)
January	13,950
February	15,086
March	11,380
April	12,629
May	8,371
June	8,095
July	8,039
August	9,160
September	8,473
October	12,617
November	8,698
December	9,910
Average	**10,534**

Savannah River Annual Flow Rate
Annual Average Based on
USGS Daily Flow Rate

Year	River Mile 118.8
	cfs
2012	4,570
2013	8,479
2014	9,440
2015	8,833
2016	10,150
2017	5,698
2018	9,787
2019	10,968
2020	15,345
2021	**10,534**
10-y Average	**9,380**

NOTE:
The annual measured river flow rate shown in the tables above is not used in the dose calculations unless the calculated "effective" river flow rate is higher.

River Flow Rate Adjustment Based on Tritium Measurements

Total Tritium Released to the Savannah River: **1,918** Curies

(For 2021, this release total is from the River Transport measurements, which were the highest)

(2021 Reported: 429 Ci from SRS, 29 Ci from the Barnwell Low-Level Disposal Facility, and 986 Ci from Plant Vogtle)

Location	Finished Water Meas. Conc. pCi/ml	Calculated Total Flow ml	Effective Flow Rate cfs
River Mile 141.5 - calc [a,b]	0.254	7.55E+15	**8,456**
Beaufort-Jasper/Purrysburg - calc [a,b]	0.235	8.16E+15	**9,140**
Beaufort-Jasper/Chelsea - calc [a,b]	N/A	N/A	9,140
Savannah I&D - calc [a,b]	N/A	N/A	9,140
Estuary (1.1 x River Mile 118.8 Effective Flow Rate)[c]			9,302

a) Total flow calculated on basis of releases of tritium and measured tritium concentrations in the river using the following equation: Total flow, ml=(Q,Ci)(1.0E+12 pCi/Ci)/(Conc,pCi/ml).

b) Effective Flow rate, in cfs, is calculated using the following equation:

Flow Rate, cfs = (Total Flow, ml/yr)/(8.93E+11 ml-sec/ft^3-yr)

c) Estuary effective flow rate is used for the collective dose calculation

Data Table A-7. Radioactive Liquid Releases by Source (Curies)

Data Table 6-7, Radioactive Liquid Releases by Site Stream - (Curies)

(Used as the Source Term for the 2021 Liquid Pathway Dose Calculations)

Nuclide	Upper Three Runs (A,M,F,H)	Fourmile Branch (F,G,H,Tritium)	Steel Creek + Pen Branch (K,L)	Lower Three Runs (P,R)	Totals
H-3[a]	1.21E+02	2.44E+02	1.17E+02	4.42E-01	4.83E+02[a]
C-14	5.80E-04				5.80E-04
Mn-54	9.70E-06				9.70E-06
Co-58		1.61E-04			1.61E-04
Sr-90	1.27E-06	2.15E-02			2.15E-02
Tc-99		3.42E-02			3.42E-02
I-129		2.19E-02			2.19E-02
Cs-137[b]	1.09E-02	1.28E-02			3.90E-01[b]
U-234	3.08E-02	2.01E-03			3.28E-02
U-235	2.76E-04	1.09E-04			3.85E-04
U-238	3.08E-02	2.55E-03			3.34E-02
Np-237		1.17E-04			1.17E-04
Pu-238	1.04E-05	3.87E-04			3.98E-04
Pu-239	1.79E-06	1.83E-05			2.01E-05
Am-241		3.18E-05			3.18E-05
Cm-244		1.46E-04			1.46E-04
Alpha[c]	6.65E-04	1.68E-03	1.37E-03	2.51E-03	6.22E-03
Beta-Gamma[d]	1.77E-03	5.59E-03	2.63E-02	1.90E-02	5.27E-02
Flow Volume (L)	1.74E+11	1.57E+10	4.10E+10	1.47E+10	

a) Depending which one is higher, the tritium release total includes direct + migration releases or tritium transport in streams totals.

The higher one is used in the dose calculations for determining SRS-only impacts.

It does not include releases to the Savannah River from the Vogtle Electric Generating Plant or migration releases into

Lower Three Runs from the Barnwell Low-Level Radioactive Waste Disposal Facility.

b) Depending on which value is higher, the Cs-137 release is based on concentrations measured in Steel Creek (mouth) fish or on the actual measured effluent + migration release total from the site. Refer to data table 6-10 for more information.

c,d) For dose calculations, unspecified alpha and beta releases are assumed to be Pu-239 and Sr-90, respectively.

Data Table A-8. Radioactive Liquid Releases, 2017 – 2021 (Curies)

Data Table A-8, Radioactive Liquid Releases, 2017-2021 (curies)

Radionuclide	2017	2018	2019	2020	2021	2020 to 2021 Percent Change
H-3	4.94E+02	5.31E+02	4.24E+02	5.19E+02	**4.83E+02**	-7%
C-14	1.09E-02	6.22E-04	1.53E-02	5.32E-04	**5.80E-04**	9%
Mn-54					**9.70E-06**	
Co-58					**1.61E-04**	
Sr-89,90	2.13E-02	3.18E-02	1.31E-02	1.43E-01	**2.15E-02**	-85%
Tc-99	1.51E-02	2.84E-02	1.66E-02	3.59E-02	**3.42E-02**	-5%
I-129	2.18E-02	1.66E-02	8.92E-03	2.87E-02	**2.19E-02**	-24%
Cs-137	5.78E-03	8.06E-03	8.24E-03	2.49E-01	**2.37E-02**	-90%
Ra-226	7.27E-04	1.03E-03	2.32E-03	2.50E-03		-100%
U-234	3.48E-02	2.95E-02	1.93E-02	2.56E-02	**3.28E-02**	28%
U-235	1.23E-03	5.74E-04	3.62E-04	1.03E-03	**3.85E-04**	-63%
U-238	3.61E-02	3.22E-02	2.20E-02	2.93E-02	**3.34E-02**	14%
Np-237	5.57E-05	1.82E-06	8.61E-05	1.05E-04	**1.17E-04**	12%
Pu-238	2.33E-04	5.35E-05	1.21E-04	1.00E-04	**3.98E-04**	297%
Pu-239	2.00E-05	5.45E-06	9.38E-06	7.89E-06	**2.01E-05**	155%
Am-241	5.62E-03	1.36E-04	1.16E-05	1.11E-04	**3.18E-05**	-71%
Cm-244	1.49E-04	6.81E-05	2.17E-06	1.79E-05	**1.46E-04**	714%
Alpha	2.45E-03	3.21E-03	4.91E-03	7.33E-03	**6.22E-03**	-15%
Beta-Gamma	5.50E-02	4.51E-02	4.18E-02	5.77E-02	**5.27E-02**	-9%

Measured liquid releases only, no tritium transport or cesium-137 adjustment from fish

Data Table A-9. Radionuclide Concentrations at Downriver Drinking Water Plants Compared to EPA MCLs

Data Table A-9, Radionuclide Concentrations at the Downriver Drinking Water Plants Compared to EPA MCLs

		12-Month Average Concentrations			
Nuclide	EPA MCL (pCi/L)	Below SRS [a] (pCi/L)	Fraction of EPA MCL (unitless)	BJWSA Purrysburg [b] (pCi/L)	Fraction of EPA MCL (unitless)
H-3[c]	2.00E+04	2.54E+02	1.27E-02	2.35E+02	1.17E-02
C-14	2.00E+03	7.67E-05	3.84E-08	7.10E-05	3.55E-08
Mn-54	3.00E+02	1.28E-06	4.28E-09	1.19E-06	3.96E-09
Co-58	3.00E+02	2.13E-05	7.10E-08	1.97E-05	6.57E-08
Sr-90	8.00E+00	2.85E-03	3.56E-04	2.63E-03	3.29E-04
Tc-99	9.00E+02	4.52E-03	5.02E-06	4.18E-03	4.65E-06
I-129	1.00E+00	2.90E-03	2.90E-03	2.68E-03	2.68E-03
Cs-137	2.00E+02	5.15E-02	2.58E-04	4.77E-02	2.38E-04
U-234[d]	1.03E+01	4.34E-03	4.22E-04	4.02E-03	3.90E-04
U-235[d]	4.67E-01	5.09E-05	1.09E-04	4.71E-05	1.01E-04
U-238[d]	1.00E+01	4.41E-03	4.41E-04	4.08E-03	4.08E-04
Np-237	1.50E+01	1.55E-05	1.03E-06	1.43E-05	9.56E-07
Pu-238	1.50E+01	5.26E-05	3.51E-06	4.87E-05	3.25E-06
Pu-239	1.50E+01	2.66E-06	1.77E-07	2.46E-06	1.64E-07
Am-241	1.50E+01	4.21E-06	2.80E-07	3.89E-06	2.59E-07
Cm-244	1.50E+01	1.93E-05	1.29E-06	1.79E-05	1.19E-06
Alpha	1.50E+01	8.23E-04	5.48E-05	7.61E-04	5.07E-05
Sum of the Fractions =			**1.81E-02**		**1.68E-02**

a. Near Savannah River Mile 141.5, below Steel Creek mouth

b. Beaufort-Jasper Water and Sewer Authority, finished drinking water at the Purrysburg Plant

c. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations
They include contributions from VEGP (986 Ci in 2021) and the Barnwell Low-Level Disposal Facility (29 Ci in 2021)
All other radionuclide concentrations are calculated based on the effective or measured river flow rate

d. MCLs for Uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

Data Table A-9 – *Support*. 2021 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the US EPA's Drinking Water Maximum Contaminant Levels (MCL)

2021 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the US EPA's Drinking Water Maximum Contaminant Levels (MCL)

		12-Month Average Concentration (pCi/L)			Output from LADTAP XL (uCi/mL)	
Nuclide	Curies Released	Below SRS [a]	at BJWSA Purrysburg [b]	EPA MCL[d]	Below SRS [a]	at BJWSA Purrysburg [b]
H-3[c]	1.92E+03	2.54E+02	2.35E+02	2.00E+04	2.54E-07	2.35E-07
C-14	5.80E-04	7.67E-05	7.10E-05	2.00E+03	7.67E-14	7.10E-14
Mn-54	9.70E-06	1.28E-06	1.19E-06	3.00E+02	1.28E-15	1.19E-15
Co-58	1.61E-04	2.13E-05	1.97E-05	3.00E+02	2.13E-14	1.97E-14
Sr-90	2.15E-02	2.85E-03	2.63E-03	8.00E+00	2.85E-12	2.63E-12
Tc-99	3.42E-02	4.52E-03	4.18E-03	9.00E+02	4.52E-12	4.18E-12
I-129	2.19E-02	2.90E-03	2.68E-03	1.00E+00	2.90E-12	2.68E-12
Cs-137	3.90E-01	5.15E-02	4.77E-02	2.00E+02	5.15E-11	4.77E-11
U-234	3.28E-02	4.34E-03	4.02E-03	1.03E+01	4.34E-12	4.02E-12
U-235	3.85E-04	5.09E-05	4.71E-05	4.67E-01	5.09E-14	4.71E-14
U-238	3.34E-02	4.41E-03	4.08E-03	1.00E+01	4.41E-12	4.08E-12
Np-237	1.17E-04	1.55E-05	1.43E-05	1.50E+01	1.55E-14	1.43E-14
Pu-238	3.98E-04	5.26E-05	4.87E-05	1.50E+01	5.26E-14	4.87E-14
Pu-239	2.01E-05	2.66E-06	2.46E-06	1.50E+01	2.66E-15	2.46E-15
Am-241	3.18E-05	4.21E-06	3.89E-06	1.50E+01	4.21E-15	3.89E-15
Cm-244	1.46E-04	1.93E-05	1.79E-05	1.50E+01	1.93E-14	1.79E-14
Alpha	6.22E-03	8.23E-04	7.61E-04	1.50E+01	8.23E-13	7.61E-13

a. Near Savannah River Mile 141.5, downriver of SRS.

b. Beaufort-Jasper Water and Sewer Authority, finished drinking water at the Purrysburg Plant

c. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations
They include contributions from VEGP (986 Ci in 2021) and the Barnwell Low-Level Disposal Facility (29 Ci in 2021)
All other radionuclide concentrations are calculated based on the effective or measured river flow rate

d. MCLs for Uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

Data Table A-10. Adjustment of Cs-137 Release Based on Fish Concentrations

Data Table A-10, Adjustment of Cs-137 Release Based on Fish Concentrations

Activity in Fish	**Cs-137 Conc,pCi/g**
River Mile 141.5 wtd avg conc	1.55E-01

Cs-137	Measured Ci Released	LADTAP BAF	RM 118.8 Flow, cfs	Calc Fish Conc,pCi/g	Meas Fish Conc,pCi/g	Ratio meas/calc
RM141.5-Max Ind	2.37E-02	3000	8,456	9.42E-03	1.55E-01	16.44

Ratios (right column) are multipliers for measured releases in order for LADTAP to calculate the appropriate dose using the built in BAF factors. Calculated release values used in LADTAP calculations are shown below:

Cs-137	Multiplier (ratio)	Measured Ci Release	Calc Ci Release	
RM141.5-Max Ind	16.44	2.37E-02	3.90E-01	(see note below)

Cs-137 direct+migration releases:	2.37E-02	Ci
2021 total effective flow RM 141.5:	7.55E+15	ml
Calc Cs-137 conc =	3.14E-06	pCi/ml

Ratios of Measured/Calculated Conc. of Cs-137 in fish

Year	Ratio	Year	Ratio
1985	5.2	2006	0.39
1986	8.4	2007	0.6
1987	3.0	2008	0.56
1988	1.4	2009	0.45
1989	1.2	2010	1.3
1990	6.8	2011	0.34
1991	25.3	2012	0.5
1992	1.2	2013	2.36
1993	1.1	2014	0.77
1994	1.4	2015	4.33
1995	3.1	2016	2.69
1996	1.3	2017	24.9
1997	2.6	2018	13.26
1998	1.2	2019	25.45
1999	2.3	2020	2.49
2000	1.1	2021	16.44
2001	0.8		
2002	2.1		
2003	0.54		
2004	0.27		
2005	0.42		

NOTE: FOR 2021, THE CALCULATED CS-137 EFFLUENT RELEASE VALUE OF 0.390 CURIE WAS USED IN THE DOSE CALCULATIONS INSTEAD OF THE MEASURED EFFLUENT RELEASE VALUE OF 0.0237 CURIE.

Data Table A-10 – *Support.* Adjustment of Cs-137 Liquid Releases Based on Fish Concentrations

Adjustment of Cs-137 Liquid Release Based on Fish Concentrations

Cesium-137 Measured Mean Concentrations in Steel Creek Fish

Location	Species	Number of Composites	Cs-137, pCi/g Average	# comp X avg. conc. pCi/g
Near River Mile 141.5	bass	3	3.61E-01	1.08E+00
	catfish	3	1.06E-01	3.18E-01
	panfish	3	1.59E-01	4.77E-01
	flathead	4	3.35E-02	1.34E-01
	Total Composites	13	Sum =	2.01E+00
			Overall weighted average----->	1.55E-01

Data Table A-11. Representative Person Dose – All Liquid Pathways Including Irrigation

Data Table A-11, Representative Person Dose - All Liquid Pathways Including Irrigation

By Pathway

Pathway	Representative Person Dose, mrem [a]	Percent of Total Dose
Vegetable	6.7E-02	23.9%
Milk	1.2E-02	4.2%
Meat	6.7E-03	2.4%
Fish Consumption	1.8E-01	65.5%
Water Consumption	1.0E-02	3.7%
Shoreline	1.0E-03	0.4%
Swimming and Boating	3.8E-06	0.0%
Total	**2.8E-01**	

By Radionuclide

Radionuclide	Representative Person Dose, mrem [a]	Percent of Total Dose
H-3 (oxide)	7.4E-03	2.6%
C-14	6.7E-06	0.0%
Mn-54	4.0E-08	0.0%
Co-58	3.8E-07	0.0%
Sr-90	4.4E-03	1.6%
Tc-99	3.6E-02	12.8%
I-129	1.0E-02	3.7%
Cs-137	2.0E-01	71.1%
U-234	4.5E-03	1.6%
U-235	5.0E-05	0.0%
U-238	4.1E-03	1.5%
Np-237	3.2E-05	0.0%
Pu-238	2.1E-04	0.1%
Pu-239	1.2E-05	0.0%
Am-241	3.4E-05	0.0%
Cm-244	4.4E-05	0.0%
Alpha	3.6E-03	1.3%
Nonvolatile Beta	1.1E-02	3.8%
Total	**2.8E-01**	

a) Committed effective dose

Data Table A-11 – *Support.* Representative Person Dose – All Liquid Pathways

Representative Person Dose - Liquid Pathways Except Irrigation

Irrigation Pathway Doses from IRRIDOSE

By Pathway

Pathway	LADTAPXL Representative Person Dose, mrem [a]	Food Type	IRRIDOSE (Irrigation Pathway) Representative Person, mrem
Fish Consumption	1.8E-01	Vegetable	6.7E-02
Water Consumption	1.0E-02	Milk	1.2E-02
Shoreline	1.0E-03	Meat	6.7E-03
Swimming and Boating	3.8E-06		
Total	**2.0E-01**	**Total**	**8.6E-02**

By Radionuclide

Radionuclide	LADTAPXL Representative Person Dose, mrem [a]	Radionuclide	IRRIDOSE (Irrigation Pathway) Representative Person Dose, mrem
H-3 (oxide)	4.1E-03	H-3 (oxide)	3.3E-03
C-14	1.6E-07	C-14	6.6E-06
Mn-54	2.9E-08	Mn-54	1.1E-08
Co-58	2.1E-07	Co-58	1.7E-07
Sr-90	3.5E-04	Sr-90	4.0E-03
Tc-99	2.0E-05	Tc-99	3.6E-02
I-129	2.0E-03	I-129	8.4E-03
Cs-137	1.9E-01	Cs-137	1.5E-02
U-234	7.7E-04	U-234	3.7E-03
U-235	9.0E-06	U-235	4.1E-05
U-238	7.6E-04	U-238	3.4E-03
Np-237	9.6E-06	Np-237	2.2E-05
Pu-238	7.8E-05	Pu-238	1.3E-04
Pu-239	4.3E-06	Pu-239	7.3E-06
Am-241	2.4E-05	Am-241	9.6E-06
Cm-244	1.6E-05	Cm-244	2.8E-05
Alpha	1.3E-03	Alpha	2.3E-03
Nonvolatile Beta	8.6E-04	Nonvolatile Beta	9.9E-03
Total	**2.0E-01**	**Total**	**8.6E-02**

a) Committed effective dose

Data Table A-12. Comparisons of 2017 – 2021 Offsite Doses

Data Table A-12, Comparison of 2017-2021 Offsite Doses

	2017	2018	2019	2020	2021	2021 vs 2020 %
Atmospheric Releases						
Representative Person, mrem [a]						
All Pathways	2.7E-02	8.2E-02	1.8E-02	1.2E-02	1.7E-02	**37.5%**
Population, person-rem						
50-mile (80-km) Population	9.7E-01	2.6E+00	7.0E-01	5.4E-01	7.3E-01	**35.2%**
Liquid Releases						
Representative Person, mrem [a]						
All Pathways Except Irrigation	1.3E-01	9.2E-02	1.1E-01	2.5E-01	2.0E-01	**-21.3%**
Irrigation Pathway	8.9E-02	9.9E-02	5.0E-02	1.0E-01	8.6E-02	**-13.8%**
	2.2E-01	1.9E-01	1.6E-01	3.5E-01	2.8E-01	**-19.2%**
Population, person-rem						
Down River Population	1.4E+00	1.1E+00	9.5E-01	1.4E+00	1.4E+00	**-2.2%**
Irrigation Pathway at RM 141.5	2.0E+00	2.3E+00	1.1E+00	2.3E+00	1.9E+00	**-14.3%**
	3.4E+00	3.4E+00	2.1E+00	3.7E+00	3.3E+00	**-9.6%**
Total Representative Person (Air + Liquid + Irrigation) (mrem)	**0.19**	**0.25**	**0.27**	**0.36**	**0.30**	**-17.3%**
Total Population (Air + Liquid + Irrigation) (person-rem)	**4.9**	**4.4**	**6.0**	**4.2**	**4.0**	**-3.9%**

a. In 2012, SRS changed from the MEI to the Representative Person concept for dose compliance.

Data Table A-13. Representative Person Drink Water Dose

Data Table A-13, Representative Person Drinking Water Dose

Radionuclide	Representative Person Dose, mrem [a]	Percent of Total Dose	Representative Person Dose, mrem [b]	Percent of Total Dose
H-3 (oxide)	1.6E-02	71%	4.0E-03	39%
C-14	1.4E-07	0%	1.4E-07	0%
Mn-54	3.4E-09	0%	3.4E-09	0%
Co-58	6.3E-08	0%	6.3E-08	0%
Sr-90	3.0E-04	1%	3.0E-04	3%
Tc-99	1.2E-05	0%	1.2E-05	0%
I-129	1.0E-03	5%	1.0E-03	10%
Cs-137	2.0E-03	9%	2.0E-03	20%
U-234	7.5E-04	3%	7.5E-04	7%
U-235	8.3E-06	0%	8.3E-06	0%
U-238	6.8E-04	3%	6.8E-04	7%
Np-237	5.7E-06	0%	5.7E-06	0%
Pu-238	4.1E-05	0%	4.1E-05	0%
Pu-239	2.3E-06	0%	2.3E-06	0%
Am-241	3.0E-06	0%	3.0E-06	0%
Cm-244	8.6E-06	0%	8.6E-06	0%
Alpha	7.0E-04	3%	7.0E-04	7%
Nonvolatile Beta	7.4E-04	3%	7.4E-04	7%
Total	**2.2E-02**		**1.0E-02**	

a) Based on Tritium Measurements from the BJSWA Purrysburg Treatment Plant. This includes Plant Vogtle and BLLWF releases

b) Based on SRS-Only releases of tritium

Data Table A-14. Collective Drinking Water Doses (person-rem) from SRS Only

Data Table A-14, Collective Drinking Water Doses (person-rem) from SRS Only

For the Beaufort Jasper Water and Sewer Authority Chelsea and Purrysburg Water Treatment Plants and the Savannah Industrial and Domestic Water Treatment Plant

Radionuclide	BJWSA Chelsea[a]	BJWSA Purrysburg[b]	Savannah I&D[c]
Total	**3.6E-01**	**2.9E-01**	**1.3E-01**

a) 102,000 people served (2/9/22 email from Tricia Kilgore to Brooke Stagich)

b) 81,000 people served (2/9/22 email from Tricia Kilgore to Brooke Stagich)

c) 36,677 people served (Based on production value (http://savannahwaterquality.com/reports/2020/i-and-d) and ratio of total production to population served for Chelsea & Purrysburg)

Data Table A-15. Collective Dose – All Liquid Pathways Including Irrigation

Data Table A-15, Collective Dose - All Liquid Pathways Including Irrigation

By Pathway

Pathway	Collective Dose (person-rem)[a]	Percent of Total Dose
Sport fish	6.3E-02	2%
Commercial fish	4.4E-01	13%
Saltwater invertebrates	5.2E-02	2%
Shoreline Exposure	4.3E-02	1%
Swimming	6.2E-05	0%
Boating	5.8E-05	0%
Beaufort-Jasper (Chelsea)	3.6E-01	11%
Beaufort-Jasper (Purrysburg)	2.9E-01	9%
Savannah I&D	1.3E-01	4%
Vegetable consumption	1.9E+00	56%
Milk consumption	6.2E-02	2%
Meat consumption	3.4E-03	0%
Total	**3.3E+00**	

By Radionuclide

Radionuclide	Collective Dose (person-rem)[a]	Percent of Total Dose
H-3	3.5E-01	11%
C-14	5.3E-04	0%
Mn-54	1.0E-06	0%
Co-58	2.6E-05	0%
Sr-90	1.3E-01	4%
Tc-99	9.0E-01	27%
I-129	2.5E-01	8%
Cs-137	9.3E-01	28%
U-234	1.5E-01	4%
U-235	1.7E-03	0%
U-238	1.4E-01	4%
Np-237	1.1E-03	0%
Pu-238	8.6E-03	0%
Pu-239	4.8E-04	0%
Am-241	7.0E-04	0%
Cm-244	2.0E-03	0%
Alpha	1.5E-01	4%
Nonvolatile Beta	3.1E-01	9%
Total	**3.3E+00**	

a) Committed effective dose

Data Table A-15 – *Support.* Collective Dose – All Liquid Pathways

Irrigation Pathway Doses from Irridose output

Radionuclide	Population (person-rem)
H-3 (oxide)	5.1E-02
C-14	1.0E-04
Mn-54	3.0E-07
Co-58	4.5E-06
Sr-90	1.0E-01
Tc-99	8.9E-01
I-129	1.6E-01
Cs-137	2.3E-01
U-234	9.0E-02
U-235	9.9E-04
U-238	8.2E-02
Np-237	6.0E-04
Pu-238	3.7E-03
Pu-239	2.0E-04
Am-241	2.6E-04
Cm-244	7.7E-04
Alpha	6.3E-02
Nonvolatile Beta	2.5E-01
Total	**1.9E+00**

Other Liquid Pathway Doses from Ladtap output

Radionuclide	Collective Dose (person-rem)[a]
H-3	3.0E-01
C-14	4.3E-04
Mn-54	7.5E-07
Co-58	2.1E-05
Sr-90	2.4E-02
Tc-99	9.9E-04
I-129	8.9E-02
Cs-137	7.0E-01
U-234	5.8E-02
U-235	6.6E-04
U-238	5.6E-02
Np-237	4.6E-04
Pu-238	5.0E-03
Pu-239	2.8E-04
Am-241	4.4E-04
Cm-244	1.2E-03
Alpha	8.5E-02
Nonvolatile Beta	5.9E-02
Total	**1.4E+00**

Data Table A-16. 2021 Radioactive Atmospheric Releases by Source (Curies)

Data Table A-16, Radioactive Atmospheric Releases by Source (Curies)[a] **2 Pages**

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Gases and Vapors							
H-3 (oxide)	12.3	y	1.54E+02	7.43E+02	6.61E+03		**7.51E+03**
H-3 (elemental)	12.3	y			1.60E+03		**1.60E+03**
H-3 Total	12.3	y	1.54E+02	7.43E+02	8.21E+03		**9.11E+03**
C-14	5700	y	1.04E-05		6.20E-02		**6.20E-02**
Hg-203	46.6	d	5.26E-10				**5.26E-10**
Kr-85	10.8	y			1.68E+04		**1.68E+04**
I-129	1.57E+07	y	1.58E-05		5.56E-03	6.19E-07	**5.57E-03**
I-131	8.02	d	7.10E-10				**7.10E-10**
Particles							
Ag-110m	250	d	1.48E-11				**1.48E-11**
Am-241	432	y	1.67E-05	0.00E+00	7.00E-06		**2.37E-05**
Am-243	7370	y	3.61E-07				**3.61E-07**
Ba-133	10.5	y	6.55E-07				**6.55E-07**
Cd-109	461	d	1.36E-08				**1.36E-08**
Ce-139	138	d	5.18E-10				**5.18E-10**
Ce-141	32.5	d	4.94E-11				**4.94E-11**
Ce-144	285	d	2.00E-08				**2.00E-08**
Cm-243	29.1	y	0.00E+00				**0.00E+00**
Cm-244	18.1	y	2.98E-07	0.00E+00	1.90E-08		**3.17E-07**
Co-57	272	d	4.95E-10				**4.95E-10**
Co-60	5.27	y	3.39E-06	0.00E+00	0.00E+00	0.00E+00	**3.39E-06**
Cs-134	2.06	y	4.31E-07				**4.31E-07**
Cs-137	30.2	y	3.51E-03	0.00E+00	4.72E-03	0.00E+00	**8.23E-03**
Eu-152	13.5	y	9.21E-09				**9.21E-09**
Eu-154	8.59	y	7.11E-07				**7.11E-07**
Eu-155	4.76	y	1.18E-07				**1.18E-07**
F-18	1.83	h	1.00E-02				**1.00E-02**
Fe-55	2.74	y	3.76E-08				**3.76E-08**
Mn-54	312	d	4.55E-10				**4.55E-10**
Nb-94	2.03E+04	y	2.42E-07				**2.42E-07**
Nb-95	35.0	d	3.63E-07				**3.63E-07**
Ni-59	1.01E+05	y	3.67E-07				**3.67E-07**
Ni-63	100	y	4.55E-05				**4.55E-05**
Np-237	2.14E+06	y	1.54E-06	0.00E+00	1.30E-07		**1.68E-06**
Pa-233	27.0	d	1.42E-06				**1.42E-06**
Pb-212	10.6	h	8.43E-07				**8.43E-07**
Pm-147	2.62	y	2.89E-06				**2.89E-06**
Pm-148m	41.3	d	1.90E-12				**1.90E-12**
Pr-144	17.3	m	2.00E-08				**2.00E-08**
Pu-236	2.86	y	4.56E-10				**4.56E-10**
Pu-238	87.7	y	3.19E-05	0.00E+00	3.65E-06		**3.56E-05**
Pu-239	2.41E+04	y	8.20E-05	0.00E+00	8.10E-05		**1.63E-04**
Pu-240	6560	y	2.54E-05				**2.54E-05**
Pu-241	14.4	y	2.37E-04				**2.37E-04**
Pu-242	3.75E+05	y	2.68E-05				**2.68E-05**
Ra-226	1600	y	4.04E-07				**4.04E-07**
Ra-228	5.75	y	4.07E-07				**4.07E-07**

Data Table A-16, Radioactive Atmospheric Releases by Source (Curies)[a] **2 Pages**

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Rh-106[e]	29.8	s	3.04E-06				**3.04E-06**
Ru-103	39.3	d	5.11E-10				**5.11E-10**
Ru-106	374	d	3.04E-06				**3.04E-06**
Sb-125	2.76	y	1.18E-06				**1.18E-06**
Sb-126[e]	12.4	d	1.70E-07				**1.70E-07**
Se-79	2.95E+05	y	4.90E-09				**4.90E-09**
Sm-151	90	y	2.89E-06				**2.89E-06**
Sn-113	115	d	6.30E-10				**6.30E-10**
Sn-123	129	d	6.66E-12				**6.66E-12**
Sn-126	2.30E+05	y	1.70E-07				**1.70E-07**
Sr-85	64.8	d	5.82E-10				**5.82E-10**
Sr-89	50.5	d	5.40E-10				**5.40E-10**
Sr-90	28.8	y	2.85E-03	0.00E+00	1.51E-05		**2.87E-03**
Tc-99	2.11E+05	y	5.08E-05				**5.08E-05**
Te-127	9.35	h	1.04E-11				**1.04E-11**
Te-129	69.6	m	1.05E-12				**1.05E-12**
Th-228	1.91	y	1.17E-08	3.35E-09			**1.51E-08**
Th-229	7340	y	1.23E-09				**1.23E-09**
Th-230	7.54E+04	y	7.87E-11	4.99E-09			**5.06E-09**
Th-231	25.5	h	2.12E-04				**2.12E-04**
Th-232	1.41E+10	y	4.29E-12	2.68E-09			**2.69E-09**
Tl-208	3.05	m	1.41E-06				**1.41E-06**
U-232	68.9	y	5.35E-09				**5.35E-09**
U-233	1.59E+05	y	2.89E-08				**2.89E-08**
U-234	2.46E+05	y	5.02E-07	3.68E-09	3.12E-05		**3.17E-05**
U-235	7.04E+08	y	2.73E-08	0.00E+00	1.81E-06		**1.83E-06**
U-236	2.34E+07	y	3.01E-08				**3.01E-08**
U-238	4.47E+09	y	4.48E-07	3.41E-09	3.98E-05		**4.03E-05**
Y-88	107	d	5.18E-10				**5.18E-10**
Y-90[e]	64.1	h	2.85E-03	0.00E+00	1.51E-05		**2.87E-03**
Y-91	58.5	d	7.98E-10				**7.98E-10**
Zn-65	244	d	9.41E-10				**9.41E-10**
Zr-95	64.0	d	1.22E-07				**1.22E-07**
Unidentified alpha	N/A		3.00E-05	4.34E-06	1.90E-06	2.55E-06	**3.88E-05**
Unidentified beta	N/A		8.56E-04	4.13E-05	1.16E-04	4.91E-06	**1.02E-03**
TOTAL	N/A		1.54E+02	7.43E+02	2.50E+04	8.08E-06	**2.59E+04**

a. One curie equals 3.7E+10 Becquerels

b. ICRP 107, *Nuclear Decay Data for Dosimetric Calculations (2008)*

c. Estimated releases from unmonitored sources. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.

d. Includes separations, waste management, and tritium facilities

e. Daughter products (Sb-126, Rh-106 & Y-90) in secular equilibrium with source terms (Sn-126, Ru-106 & Sr-90, respectively). In MAXDOSE/POPDOSE, they are included in the source term and their ingrowth is included in their parents' source term.

Data Table A-17. 2017 - 2021 Atmospheric Releases (Curies)

Data Table A-17, 2017-2021 Atmospheric Releases (Curies) **2 Pages**

Radionuclide	2017[a]	2018	2019	2020	2021	2020-2021 %Change
Gases and Vapors						
H-3 (oxide)	1.99E+04	1.38E+04	7.94E+03	5.82E+03	7.51E+03	29%
H-3 (elemental)	1.88E+03	1.38E+03	1.31E+03	1.21E+03	1.60E+03	32%
H-3 Total	2.17E+04	1.52E+04	9.25E+03	7.03E+03	9.11E+03	30%
C-14	1.64E-02	3.00E-02	5.00E-02	5.00E-02	6.20E-02	24%
Hg-203	5.22E-10	5.07E-10	6.51E-10	5.42E-10	5.26E-10	-3%
Kr-85	3.96E+03	5.45E+03	1.07E+04	7.37E+03	1.68E+04	128%
I-129	2.09E-03	3.06E-03	9.99E-03	4.16E-03	5.57E-03	34%
I-131	6.75E-10	5.64E-10	7.01E-10	5.49E-10	7.10E-10	29%
Particles						
Ag-110m	1.48E-11	1.48E-11	1.48E-11	1.48E-11	1.48E-11	0%
Am-241	3.73E-05	3.28E-05	1.73E-05	1.95E-05	2.37E-05	22%
Am-243	4.50E-09	3.76E-09	3.97E-09	4.24E-09	3.61E-07	8412%
Ba-133	7.01E-10	1.40E-06	7.74E-07	6.90E-07	6.55E-07	-5%
Cd-109	1.34E-08	1.20E-08	1.68E-08	1.05E-08	1.36E-08	30%
Ce-139	5.20E-10	5.15E-10	6.71E-10	4.73E-10	5.18E-10	10%
Ce-141	4.94E-11	4.94E-11	4.94E-11	4.94E-11	4.94E-11	0%
Ce-144	2.00E-08	2.00E-08	2.00E-08	2.00E-08	2.00E-08	0%
Cm-243		1.56E-09	2.90E-09	1.76E-09		-100%
Cm-244	1.14E-06	6.02E-07	2.99E-07	3.02E-07	3.17E-07	5%
Co-57	4.96E-10	4.81E-10	6.41E-10	4.24E-10	4.95E-10	17%
Co-60	4.96E-07	5.37E-07	6.30E-07	6.37E-07	3.39E-06	431%
Cs-134	4.31E-07	4.31E-07	4.32E-07	4.31E-07	4.31E-07	0%
Cs-137	9.05E-03	1.13E-03	3.88E-03	4.67E-03	8.23E-03	76%
Eu-152	1.47E-09	1.43E-09	1.90E-09	8.96E-09	9.21E-09	3%
Eu-154	3.56E-07	3.56E-07	3.56E-07	3.56E-07	7.11E-07	100%
Eu-155	1.18E-07	1.18E-07	1.18E-07	1.18E-07	1.18E-07	0%
F-18	4.00E-02	4.00E-02	4.00E-02	0.00E+00	1.00E-02	#DIV/0!
Fe-55	1.17E-08	6.54E-09	8.04E-09	3.64E-09	3.76E-08	933%
Mn-54	3.78E-10	4.82E-10	6.01E-10	4.24E-10	4.55E-10	7%
Nb-94	2.42E-07	2.42E-07	2.42E-07	2.42E-07	2.42E-07	0%
Nb-95	3.63E-07	3.63E-07	3.63E-07	3.63E-07	3.63E-07	0%
Ni-59	5.76E-11	5.76E-11	5.76E-11	5.76E-11	3.67E-07	637153%
Ni-63	5.46E-09	4.73E-09	7.41E-09	7.26E-09	4.55E-05	626708%
Np-237	1.71E-06	2.11E-06	1.61E-06	1.69E-06	1.68E-06	-1%
Pa-233	1.42E-06	1.42E-06	1.42E-06	1.42E-06	1.42E-06	0%
Pb-212	8.43E-07	8.43E-07	8.43E-07	8.43E-07	8.43E-07	0%
Pm-147	2.89E-06	2.89E-06	2.89E-06	2.89E-06	2.89E-06	0%
Pm-148m	1.90E-12	1.90E-12	1.90E-12	1.90E-12	1.90E-12	0%
Pr-144	2.00E-08	2.00E-08	2.00E-08	2.00E-08	2.00E-08	0%
Pu-236	5.55E-10	4.21E-10	5.52E-10	5.30E-10	4.56E-10	-14%
Pu-238	3.94E-05	3.86E-05	3.57E-05	3.51E-05	3.56E-05	1%
Pu-239	1.04E-04	2.58E-04	1.38E-04	1.60E-04	1.63E-04	2%
Pu-240	7.73E-06	7.68E-06	7.68E-06	7.69E-06	2.54E-05	230%
Pu-241	2.07E-04	2.07E-04	2.07E-04	2.07E-04	2.37E-04	14%
Pu-242	2.16E-06	2.88E-06	3.28E-06	5.29E-06	2.68E-05	407%
Ra-226	2.48E-07	5.03E-07	5.97E-07	2.95E-07	4.04E-07	37%
Ra-228	2.29E-07	4.92E-07	5.93E-07	3.12E-07	4.07E-07	30%
Rh-106	1.19E-08	1.19E-08	3.05E-06	2.82E-05	3.04E-06	-89%

Data Table A-17, 2017-2021 Atmospheric Releases (Curies) **2 Pages**

Radionuclide	2017[a]	2018	2019	2020	2021	2020-2021 %Change
Ru-103	5.11E-10	9.23E-09	5.11E-10	5.11E-10	5.11E-10	0%
Ru-106	3.04E-06	3.04E-06	3.05E-06	2.82E-05	3.04E-06	-89%
Sb-125	1.18E-06	1.18E-06	1.18E-06	1.18E-06	1.18E-06	0%
Sb-126	1.70E-07	1.70E-07	1.70E-07	1.70E-07	1.70E-07	0%
Se-75	1.94E-07					
Se-79	4.90E-09	4.90E-09	4.90E-09	4.90E-09	4.90E-09	0%
Sm-151	2.89E-06	2.89E-06	2.89E-06	2.89E-06	2.89E-06	0%
Sn-113	6.27E-10	6.43E-10	8.31E-10	6.05E-10	6.30E-10	4%
Sn-123	6.66E-12	6.66E-12	6.66E-12	6.66E-12	6.66E-12	0%
Sn-126	1.70E-07	1.70E-07	1.70E-07	1.70E-07	1.70E-07	0%
Sr-85	6.00E-10	5.80E-10	7.61E-10	5.63E-10	5.82E-10	3%
Sr-89	5.99E-10	6.66E-10	5.99E-10	5.67E-10	5.40E-10	-5%
Sr-89,90	1.87E-04	8.53E-05	3.35E-03	3.02E-03	2.87E-03	-5%
Tc-99	1.06E-06	2.08E-05	5.08E-05	5.09E-05	5.08E-05	0%
Te-127	1.04E-11	1.04E-11	1.04E-11	1.04E-11	1.04E-11	0%
Te-129	1.05E-12	1.05E-12	1.05E-12	1.05E-12	1.05E-12	0%
Th-228	9.55E-10	1.49E-08	1.61E-08	1.68E-08	1.51E-08	-10%
Th-229	1.60E-09	1.38E-09	1.34E-09	1.23E-09	1.23E-09	-1%
Th-230	7.82E-09	3.68E-09	6.61E-09	4.75E-09	5.06E-09	7%
Th-231	2.12E-04	2.12E-04	2.12E-04	2.12E-04	2.12E-04	0%
Th-232	2.18E-09	1.92E-09	3.14E-09	3.22E-09	2.69E-09	-17%
Tl-208	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	0%
U-232	6.04E-09	5.25E-09	5.50E-09	5.57E-09	5.35E-09	-4%
U-233	4.21E-10	3.90E-09	3.42E-09	3.74E-10	2.89E-08	7618%
U-234	1.03E-04	1.19E-04	2.72E-05	3.54E-05	3.17E-05	-11%
U-235	6.34E-06	1.01E-05	1.37E-06	2.22E-06	1.83E-06	-17%
U-236	3.01E-08	3.39E-08	3.01E-08	3.01E-08	3.01E-08	0%
U-238	1.48E-04	1.66E-04	3.55E-05	4.67E-05	4.03E-05	-14%
Y-88	4.58E-10	4.67E-10	5.81E-10	4.38E-10	5.18E-10	18%
Y-90	1.87E-04	8.53E-05	3.35E-03	3.02E-03	2.87E-03	-5%
Y-91	7.98E-10	7.98E-10	2.14E-09	7.98E-10	7.98E-10	0%
Zn-65	9.56E-10	9.42E-10	5.82E-10	8.62E-10	9.41E-10	9%
Zr-95	1.22E-07	1.22E-07	1.22E-07	1.22E-07	1.22E-07	0%
Unidentified Alpha	5.15E-05	5.44E-04	4.19E-05	5.19E-05	3.88E-05	-25%
Unidentified Beta	3.13E-03	1.16E-03	1.19E-03	9.51E-04	1.02E-03	7%

a. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) will no longer be reported in this table.

Data Table A-18. Comparison of Measured vs. Calculated Tritium in Air Concentrations

Data Table 6-18, Comparison of Measured vs. Calculated Tritium in Air Concentrations

Source of Data	Average Concentration at Site Boundary (pCi/m³)	Concentration in the North Sector[a] (pCi/m³)
Measured:	4.4	3.4
Calculated:		
MAXDOSE-SR	3.9	7.2
CAP88-PC	4.3	7.5

CAP88 HTO Concentration Calculated from Chi/Q based on Total (HTO & Elemental Tritium) Curies Released (Ci/y):

1.55E+02	at 0 m
2.09E+03	at 15 m
1.10E+01	at 21 m
1.96E+03	at 31 m
1.79E+03	at 56 m
3.11E+03	at 59 m
9.11E+03	Total

2014-2018 Chi/Q

Toward Sector	Distance m	0-m sec/m³	Concentration pCi/m³	15m sec/m3	Concentration pCi/m³	21-m sec/m³	Concentration pCi/m³	31-m sec/m3	Concentration pCi/m³	56-m sec/m³	Concentration pCi/m³	59-m sec/m³	Concentration pCi/m³	HTO Conc. pCi/m³
N	12378	3.208E-08	1.579E-01	3.122E-08	2.065E+00	3.043E-08	1.06E-02	2.869E-08	1.78E+00	2.318E-08	1.31E+00	2.250E-08	2.216E+00	7.5
NNW	12280	2.517E-08	1.239E-01	2.433E-08	1.609E+00	2.357E-08	8.22E-03	2.190E-08	1.36E+00	1.679E-08	9.52E-01	1.619E-08	1.595E+00	5.6
NW	11871	2.000E-08	9.846E-02	1.948E-08	1.289E+00	1.901E-08	6.63E-03	1.796E-08	1.12E+00	1.465E-08	8.31E-01	1.424E-08	1.403E+00	4.7
WNW	13009	1.694E-08	8.340E-02	1.656E-08	1.095E+00	1.622E-08	5.66E-03	1.546E-08	9.61E-01	1.297E-08	7.35E-01	1.265E-08	1.246E+00	4.1
W	13179	1.735E-08	8.541E-02	1.707E-08	1.129E+00	1.680E-08	5.86E-03	1.620E-08	1.01E+00	1.416E-08	8.03E-01	1.389E-08	1.368E+00	4.4
WSW	17817	1.453E-08	7.153E-02	1.433E-08	9.479E-01	1.414E-08	4.93E-03	1.372E-08	8.53E-01	1.223E-08	6.93E-01	1.203E-08	1.185E+00	3.8
SW	17089	1.828E-08	8.999E-02	1.786E-08	1.181E+00	1.746E-08	6.09E-03	1.660E-08	1.03E+00	1.384E-08	7.85E-01	1.350E-08	1.330E+00	4.4
SSW	19649	1.154E-08	5.681E-02	1.117E-08	7.389E-01	1.084E-08	3.78E-03	1.009E-08	6.27E-01	7.818E-09	4.43E-01	7.550E-09	7.437E-01	2.6
S	19763	8.502E-09	4.186E-02	8.208E-09	5.429E-01	7.941E-09	2.77E-03	7.353E-09	4.57E-01	5.547E-09	3.14E-01	5.335E-09	5.255E-01	1.9
SSE	18726	8.791E-09	4.328E-02	8.472E-09	5.604E-01	8.183E-09	2.85E-03	7.545E-09	4.69E-01	5.592E-09	3.17E-01	5.364E-09	5.283E-01	1.9
SE	18125	1.086E-08	5.346E-02	1.050E-08	6.945E-01	1.018E-08	3.55E-03	9.466E-09	5.88E-01	7.264E-09	4.12E-01	7.004E-09	6.899E-01	2.4
ESE	13728	1.964E-08	9.669E-02	1.907E-08	1.261E+00	1.855E-08	6.47E-03	1.741E-08	1.08E+00	1.389E-08	7.88E-01	1.348E-08	1.328E+00	4.6
E	16220	1.667E-08	8.207E-02	1.628E-08	1.077E+00	1.591E-08	5.55E-03	1.511E-08	9.39E-01	1.253E-08	7.10E-01	1.221E-08	1.203E+00	4.0
ENE	15788	2.110E-08	1.039E-01	2.060E-08	1.363E+00	2.015E-08	7.03E-03	1.913E-08	1.19E+00	1.586E-08	8.99E-01	1.546E-08	1.523E+00	5.1
NE	14701	2.266E-08	1.116E-01	2.199E-08	1.455E+00	2.139E-08	7.46E-03	2.005E-08	1.25E+00	1.589E-08	9.01E-01	1.539E-08	1.516E+00	5.2
NNE	13482	2.946E-08	1.450E-01	2.851E-08	1.886E+00	2.765E-08	9.64E-03	2.574E-08	1.60E+00	1.986E-08	1.13E+00	1.916E-08	1.887E+00	6.7
Maximum		3.208E-08	1.579E-01	3.122E-08	2.065E+00	3.043E-08	1.061E-02	2.869E-08	1.783E+00	2.318E-08	1.314E+00	2.250E-08	2.216E+00	7.547E+00
Minimum		8.502E-09	4.186E-02	8.208E-09	5.429E-01	7.941E-09	2.770E-03	7.353E-09	4.569E-01	5.547E-09	3.145E-01	5.335E-09	5.255E-01	1.884E+00
Mean		1.835E-08	9.033E-02	1.785E-08	1.181E+00	1.740E-08	6.070E-03	1.640E-08	1.019E+00	1.325E-08	7.515E-01	1.287E-08	1.268E+00	4.316E+00

Measured Averages of HTO Concentration in Air at Site Perimeter

Location	pCi/m³ of Air
Allendale Gate	4.2
Barnwell Gate	2.3
Barricade 8	5.3
D Area	6.5
Darkhorse	3.9
East Talatha[a]	3.4
Greenpond	4.7
Highways 21 & 167	3.7
Jackson	5.0
Patterson Mill Road	3.0
Talatha Gate	6.4
Maximum	**6.5**
Minimum	**2.3**
Mean	**4.4**

(a) Since the Site MEI and Reference Person are located in the North sector for air dose calculations, the East Talatha (located in the North sector) measured concentration and CAP88 North sector calculated concentration are used for comparison.

Data Table A-19a. MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway

Data Table A-19a, MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway

2021 MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway

Pathway	Representative Person Dose (mrem)[a]	Percent of Total Dose
Plume	9.1E-04	3.26%
Ground	6.7E-04	3.68%
Inhalation	5.4E-03	33.62%
Vegetation	5.8E-03	36.22%
Cow Milk	3.5E-03	21.36%
Meat	3.1E-04	1.86%
Total	**1.7E-02**	**100.0%**

Radionuclide	Maximally Exposed Individual Dose (mrem)[a]	Percent of Total Dose [b]
Gases and Vapors		
H-3	1.2E-02	71.52%
C-14	4.9E-05	0.30%
K-85	9.1E-04	5.54%
I-129	2.2E-03	13.33%
Particulates		
Am-241	2.9E-05	0.18%
Cs-137	6.4E-04	3.89%
Pu-238	5.0E-05	0.30%
Pu-239	2.3E-04	1.36%
Pu-240	4.0E-05	0.24%
Pu-241	6.6E-06	0.04%
Pu-242	4.0E-05	0.24%
Sr-90	2.6E-04	1.57%
Tc-99	1.3E-05	0.08%
U-234	3.6E-06	0.02%
U-238	5.1E-06	0.03%
Unidentified Alpha	5.6E-05	0.34%
Unidentified Beta	1.1E-04	0.65%
Other	6.1E-05	0.37%
Total	**1.7E-02**	**100.0%**

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

Data Table A-19b. MAXDOSE-SR Potential Dose to TRL Industrial Worker

Data Table A-19b, Potential Dose to an Adult Worker at Three Rivers Landfill

2000 h/y exposure via inhalation and shine.

Pathway	Industrial Worker Dose at TRL (mrem)[a]	Percent of Total Dose
Shine Dose[b]	5.57E-03	47.81%
Inhalation	6.08E-03	52.19%
Total	**1.17E-02**	**100.0%**

NOTE: (a) Committed effective dose

NOTE: (b) Shine dose is the total of both plume shine and ground shine output from MAXINE

Data Table A-20. Sector- Specific Representative Person Airborne Pathway Doses (Using Cow Milk Pathway)

Data Table A-20, Sector-Specific Representative Person Airborne Pathway Doses (Using Cow Milk Pathway)

2021 Representative Person Airborne Pathway Doses

N[(a)]	0.016
NNE	0.014
NE	0.012
ENE	0.011
E	0.012
ESE	0.009
SE	0.006
SSE	0.005
S	0.005
SSW	0.006
SW	0.011
WSW	0.013
W	0.011
WNW	0.011
NW	0.013
NNW	0.016

NOTE: (a) Maximum Location

Data Table A-21. MAXDOSE-SR Representative Person Dose Using Goat Milk Pathway

Data Table A-21, MAXDOSE-SR Representative Person Dose Using Goat Milk Pathway

2021 Representative Person Dose Using Goat Milk Pathway

Pathway	Maximally Exposed Individual Dose (mrem)[a]	Percent of Total Dose
Plume	9.1E-04	2.89%
Ground	6.7E-04	3.27%
Inhalation	5.4E-03	29.84%
Vegetation	5.8E-03	32.15%
Goat Milk	5.5E-03	30.20%
Meat	3.1E-04	1.65%
Total	**1.9E-02**	**100.0%**

Radionuclide	Maximally Exposed Individual Dose (mrem)[a]	Percent of Total Dose [b]
Gases and Vapors		
H-3	1.3E-02	72.04%
C-14	5.1E-05	0.27%
Kr-85	9.1E-04	4.91%
I-129	2.6E-03	13.87%
Particulates		
Am-241	2.9E-05	0.16%
Cs-137	8.0E-04	4.31%
Pu-238	5.0E-05	0.27%
Pu-239	2.3E-04	1.21%
Pu-240	4.0E-05	0.21%
Pu-241	6.6E-06	0.04%
Pu-242	4.0E-05	0.21%
Sr-90	2.7E-04	1.42%
Tc-99	1.2E-05	0.06%
U-234	3.5E-06	0.02%
U-238	5.0E-06	0.03%
Unidentified Alpha	5.6E-05	0.30%
Unidentified Beta	1.0E-04	0.56%
Total	**1.9E-02**	**100.0%**

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

Data Table A-22. POPDOSE-SR Population Doses from Airborne Releases

Data Table A-22, POPDOSE-SR Population Dose from Airborne Releases
2021 Population Dose from Airborne Releases

Pathway	Population Dose (person-rem)[a]	Percent of Total Dose
Plume	7.4E-02	6.04%
Ground	6.4E-02	7.50%
Inhalation	4.7E-01	68.4%
Vegetation	2.1E-02	3.01%
Cow Milk	1.0E-01	14.51%
Meat	4.2E-03	0.58%
Total	**7.3E-01**	**100.0%**

Radionuclide	Population Dose (person-rem)[a]	Percent of Total Dose[b]
Gases and Vapors		
H-3	5.4E-01	73.6%
C-14	5.5E-04	0.1%
Kr-85	7.4E-02	10.07%
I-129	2.8E-02	3.76%
Particulates		
Am-241	1.7E-03	0.22%
Cs-137	5.4E-02	7.28%
Pu-238	2.7E-03	0.37%
Pu-239	1.4E-02	1.84%
Pu-240	2.1E-03	0.29%
Pu-241	3.5E-04	0.05%
Pu-242	2.1E-03	0.29%
Sr-90	8.2E-03	1.12%
U-234	2.1E-04	0.03%
U-238	3.5E-04	0.05%
Unidentified Alpha	3.2E-03	0.44%
Unidentified Beta	3.5E-03	0.48%
Other	4.1E-04	0.06%
Total	**7.3E-01**	**100.0%**

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

Data Table A-23. Airborne Releases by Stack Height for NESHAP

Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies) **2 Pages**

Radionuclide	Total 0 m Stack	Total 15 m Stack	Total 21 m Stack	Total 31 m Stack	Total 56 m Stack	Total 59 m Stack	Total All Stacks
GASES AND VAPORS							
H-3 (oxide)	1.55E+02	8.85E+02	1.10E+01	1.89E+03	1.79E+03	2.78E+03	7.51E+03
H-3 (elemental)		1.20E+03		7.20E+01		3.22E+02	1.60E+03
H-3 Total	1.55E+02	2.09E+03	1.10E+01	1.96E+03	1.79E+03	3.11E+03	9.11E+03
C-14	1.04E-05					6.20E-02	6.20E-02
Hg-203	5.26E-10						5.26E-10
Kr-85						1.68E+04	1.68E+04
I-129	1.58E-05		6.19E-07			5.56E-03	5.57E-03
I-131	7.10E-10						7.10E-10
PARTICLES							
Ag-110m	1.48E-11						1.48E-11
Am-241	1.76E-05	6.76E-08		9.67E-07		5.10E-06	2.37E-05
Am-243	3.61E-07						3.61E-07
Ba-133	6.55E-07						6.55E-07
Cd-109	1.36E-08						1.36E-08
Ce-139	5.18E-10						5.18E-10
Ce-141	4.94E-11						4.94E-11
Ce-144	2.00E-08						2.00E-08
Cm-244	2.98E-07					1.90E-08	3.17E-07
Co-57	4.95E-10						4.95E-10
Co-60	3.39E-06						3.39E-06
Cs-134	4.31E-07						4.31E-07
Cs-137	3.51E-03	9.84E-05		4.62E-03		6.25E-06	8.23E-03
Eu-152	9.21E-09						9.21E-09
Eu-154	7.11E-07						7.11E-07
Eu-155	1.18E-07						1.18E-07
F-18	1.00E-02						1.00E-02
Fe-55	3.76E-08						3.76E-08
Mn-54	4.55E-10						4.55E-10
Nb-94	2.42E-07						2.42E-07
Nb-95	3.63E-07						3.63E-07
Ni-59	3.67E-07						3.67E-07
Ni-63	4.55E-05						4.55E-05
Np-237	1.54E-06					1.30E-07	1.68E-06
Pa-233	1.42E-06						1.42E-06
Pb-212	8.43E-07						8.43E-07
Pm-147	2.89E-06						2.89E-06
Pm-148m	1.90E-12						1.90E-12
Pr-144	2.00E-08						2.00E-08
Pu-236	4.56E-10						4.56E-10
Pu-238	3.19E-05	9.30E-08				3.56E-06	3.56E-05
Pu-239	8.22E-05	2.34E-08				8.08E-05	1.63E-04
Pu-240	2.54E-05						2.54E-05
Pu-241	2.37E-04						2.37E-04
Pu-242	2.68E-05						2.68E-05
Ra-226	4.04E-07						4.04E-07
Ra-228	4.07E-07						4.07E-07
Rh-106[(b)]	3.04E-06						3.04E-06
Ru-103	5.11E-10						5.11E-10

Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies) **2 Pages**

Radionuclide	Total 0 m Stack	Total 15 m Stack	Total 21 m Stack	Total 31 m Stack	Total 56 m Stack	Total 59 m Stack	Total All Stacks
Ru-106	3.04E-06						3.04E-06
Sb-125	1.18E-06						1.18E-06
Sb-126[(b)]	1.70E-07						1.70E-07
Se-79	4.90E-09						4.90E-09
Sm-151	2.89E-06						2.89E-06
Sn-113	6.30E-10						6.30E-10
Sn-123	6.66E-12						6.66E-12
Sn-126	1.70E-07						1.70E-07
Sr-85	5.82E-10						5.82E-10
Sr-89	5.40E-10						5.40E-10
Sr-90	2.85E-03	3.35E-07				1.46E-05	2.87E-03
Tc-99	5.08E-05						5.08E-05
Te-127	1.04E-11						1.04E-11
Te-129	1.05E-12						1.05E-12
Th-228	1.17E-08	3.35E-09					1.51E-08
Th-229	1.23E-09						1.23E-09
Th-230	7.87E-11	4.99E-09					5.06E-09
Th-231	2.12E-04						2.12E-04
Th-232	4.29E-12	2.68E-09					2.69E-09
Tl-208	1.41E-06						1.41E-06
U-232	5.35E-09						5.35E-09
U-233	2.89E-08						2.89E-08
U-234	2.70E-06	3.17E-07		2.32E-06		2.63E-05	3.17E-05
U-235	2.73E-08					1.81E-06	1.83E-06
U-236	3.01E-08						3.01E-08
U-238	2.30E-06	1.97E-07		2.36E-06		3.54E-05	4.03E-05
Y-88	5.18E-10						5.18E-10
Y-90[(b)]	2.85E-03	3.35E-07				1.46E-05	2.87E-03
Y-91	7.98E-10						7.98E-10
Zn-65	9.41E-10						9.41E-10
Zr-95	1.22E-07						1.22E-07
Unidentified alpha	3.18E-05		2.55E-06	4.45E-06			3.88E-05
Unidentified beta	8.89E-04	1.88E-05	1.94E-06	1.55E-05		9.36E-05	1.02E-03

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126, Rh-106 & Y-90) are assumed to be in secular equilibrium with their parent source terms (Sn-126, Ru-106 & Sr-90, respectively).

Data Table A-24. Site-Specific Parameters Used with CAP88 PC for NESHAP

Data Table A-24, Site-Specific Parameters Used with CAP88 PC for NESHAP

2021 Parameters Used with CAP88 PC for NESHAP

Parameter	Value	
Particle size, AMAD[a]		
Gases and Vapors	0	
Particles	1	
Meteorological data	2014-2018; H Area	
Plume rise	None	
Number of stacks	6	
Stack heights, m	0, 15, 21, 31, 56, and 59	
Height of lid, m	1328	
Rainfall rate, cm/yr	126.28	
Average air temperature, C	18.5	
Absolute humidity, g/m^3	12.32	
State	South Carolina	
MEI Specific Parameters		
Distance to MEI	12378 m in North Direction	
Food supply fractions:	Home Produced	From Assessment Area
Vegetable	1.00	0.00
Meat	1.00	0.00
Milk	1.00	0.00
EPA Food Source Scenario	Local	
TRL Worker MEI Specific Parameters		
Distance to MEI	9379 m in West Southwest Direction	
Food supply fractions:	Home Produced	From Assessment Area
Vegetable	0.00	1.00
Meat	0.00	1.00
Milk	0.00	1.00
EPA Food Source Scenario	Regional	
Population Specific Parameters		
Population size (around H-Area)	803,370	
Food supply fractions:[b]	Home Produced	From Assessment Area
Vegetable	0.70	0.30
Meat	0.44	0.56
Milk	0.40	0.60
EPA Food Source Scenario	Rural	

[a]Activity Medium Aerodynamic Diameter, micrometers

[b]CAP88-PC may recalculate the input food source fractions should the productivity of the local or assessment area be insufficient to produce enough food to meet the population times the consumption rates.

Data Table A-25a. Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI

Data Table A-25a Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI

2021 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose (mrem)	Fraction of Dose
	0 m	15m	21m	31m	56m	59m		
H-3 (oxide)	1.55E+02	8.85E+02	1.10E+01	1.89E+03	1.79E+03	2.78E+03	1.40E-02	0.73
H-3 (elemental)		1.20E+03		7.20E+01		3.22E+02	2.90E-03	0.151
Cs-137	3.51E-03	9.84E-05		4.62E-03		6.25E-06	6.37E-04	0.033
Ba-137m							6.02E-04	0.031
Kr-85						1.68E+04	3.37E-04	0.018
Sr-90	2.85E-03	3.35E-07				1.46E-05	3.01E-04	0.016
Pu-239	8.22E-05	2.34E-08				8.08E-05	1.24E-04	0.006
Unidentified Beta	8.89E-04	1.88E-05	1.94E-06	1.55E-05		9.36E-05	1.21E-04	0.006
Y-90							4.12E-05	0.002
Unidentified Alpha	3.18E-05		2.55E-06	4.45E-06			3.30E-05	0.002
Pu-238	3.19E-05	9.30E-08				3.56E-06	2.72E-05	0.0014
Pu-240	2.54E-05						2.17E-05	0.0011
Pu-242	2.68E-05						2.17E-05	0.0011
C-14	1.04E-05					6.20E-02	1.61E-05	0.0008
Am-241	1.76E-05	6.76E-08		9.67E-07		5.10E-06	1.60E-05	0.0008
Bi-214							1.07E-05	0.0006
I-129	1.58E-05		6.19E-07			5.56E-03	7.61E-06	0.0004
Th-230	7.87E-11	4.99E-09					6.78E-06	0.0004
Ra-226	4.04E-07						5.86E-06	0.0003
Pu-241	2.37E-04						3.69E-06	0.0002
Pb-214							1.83E-06	0.0001
U-238	2.30E-06	1.97E-07		2.36E-06		3.54E-05	1.58E-06	0.00008
U-234	2.70E-06	3.17E-07		2.32E-06		2.63E-05	1.49E-06	0.00008
Tc-99	5.08E-05						1.12E-06	0.00006
Pa-234m							1.06E-06	0.00006
Np-237	1.54E-06					1.30E-07	6.61E-07	0.00003
Co-60	3.39E-06						3.26E-07	0.00002
Am-243	3.61E-07						2.56E-07	0.00001
Bi-210							1.46E-07	0.00001
U-235	2.73E-08					1.81E-06	1.39E-07	0.00001
Cm-244	2.98E-07					1.90E-08	1.38E-07	0.00001
Ra-228	4.07E-07						1.04E-07	0.00001
Th-234							9.13E-08	0.000005
Nb-94	2.42E-07						9.03E-08	0.000005
Pa-233	1.42E-06						8.50E-08	0.000004
Sb-126m							6.64E-08	0.000003
Eu-154	7.11E-07						4.97E-08	0.000003
F-18	1.00E-02						4.74E-08	0.000002
Th-229	1.23E-09						3.75E-08	0.000002
Cs-134	4.31E-07						2.97E-08	0.000002
Pa-234							2.09E-08	0.000001
Tl-208	1.41E-06						1.91E-08	0.000001
Ni-63	4.55E-05						1.72E-08	0.000001
Ba-133	6.55E-07						1.68E-08	0.0000009
Sb-126							1.60E-08	0.0000008
Ac-228							1.48E-08	0.0000008
Np-239							1.47E-08	0.0000008
Th-228	1.17E-08	3.35E-09					1.17E-08	0.0000006
Sb-125	1.18E-06						1.09E-08	0.0000006
Pb-210							9.04E-09	0.0000005

Data Table A-25a Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI
2021 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose (mrem)	Fraction of Dose
	0 m	15m	21m	31m	56m	59m		
Rh-106							8.80E-09	0.0000005
Th-231	2.12E-04						7.42E-09	0.0000004
Ru-106	3.04E-06						6.16E-09	0.0000003
Sn-126	1.70E-07						4.95E-09	0.0000003
Tl-210							4.19E-09	0.0000002
Pb-212	8.43E-07						3.98E-09	0.0000002
Bi-212							3.06E-09	0.0000002
Ac-225							2.85E-09	0.0000001
Rn-222							2.81E-09	0.00000015
Ra-225							2.60E-09	0.00000013
U-233	2.89E-08						1.67E-09	0.00000009
U-236	3.01E-08						1.56E-09	0.00000008
Bi-213							1.25E-09	0.00000007
Th-232	4.29E-12	2.68E-09					1.24E-09	0.00000006
U-232	5.35E-09						9.98E-10	0.00000005
Ra-224							9.08E-10	0.00000005
Eu-152	9.21E-09						8.37E-10	0.00000004
Po-214							5.95E-10	0.000000031
Pm-147	2.89E-06						4.74E-10	0.000000025
Sm-151	2.89E-06						4.73E-10	0.000000025
Te-125m							4.60E-10	0.000000024
Nb-95	3.63E-07						4.60E-10	0.000000024
Tl-209							3.20E-10	0.000000017
Eu-155	1.18E-07						2.55E-10	0.000000013
Fr-221							2.04E-10	0.000000011
Pu-236	4.56E-10						1.48E-10	0.000000008
Zr-95	1.22E-07						1.48E-10	0.000000008
Se-79	4.90E-09						1.29E-10	0.000000007
Ni-59	3.67E-07						6.62E-11	0.000000003
U-237							6.09E-11	0.000000003
Po-210							3.78E-11	0.000000002
Ce-144	2.00E-08						3.04E-11	0.0000000016
Pb-209							2.42E-11	0.0000000013
Pr-144	2.00E-08						2.07E-11	0.0000000011
Ra-223							1.96E-11	0.0000000010
Th-227							1.75E-11	0.0000000009
Pb-211							1.67E-11	0.0000000009
Fe-55	3.76E-08						1.45E-11	0.0000000008
Zn-65	9.41E-10						1.42E-11	0.0000000007
Cd-109	1.36E-08						1.37E-11	0.0000000007
Pa-231							1.17E-11	0.0000000006
Rn-220							1.08E-11	0.0000000006
Tl-207							8.64E-12	0.0000000004
Rn-219							8.50E-12	0.00000000044
Bi-211							6.87E-12	0.00000000036
Y-88	5.18E-10						3.21E-12	0.00000000017
Mn-54	4.55E-10						2.63E-12	0.00000000014
Nb-95m							2.27E-12	0.00000000012
At-217							1.72E-12	0.00000000009
Sr-85	5.82E-10						5.07E-13	0.00000000003
Co-57	4.95E-10						4.50E-13	0.00000000002
Sr-89	5.40E-10						4.25E-13	0.00000000002
In-113m							4.08E-13	<0.00000000001
Y-91	7.98E-10						3.91E-13	<0.00000000001
Tl-206							3.41E-13	<0.00000000001

Data Table A-25a Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI
2021 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose	Fraction of Dose
	0 m	15m	21m	31m	56m	59m	(mrem)	
I-131	7.10E-10						2.79E-13	<0.00000000001
Ru-103	5.11E-10						2.79E-13	<0.00000000001
Po-213							2.66E-13	<0.00000000001
Ce-139	5.18E-10						2.65E-13	<0.00000000001
Po-216							2.59E-13	<0.00000000001
Ag-110m	1.48E-11						2.32E-13	<0.00000000001
Sn-113	6.30E-10						2.06E-13	<0.00000000001
At-218							1.89E-13	<0.00000000001
Fr-223							1.66E-13	<0.00000000001
Hg-203	5.26E-10						7.38E-14	<0.00000000001
Po-218							5.03E-14	<0.00000000001
Ac-227							3.67E-14	<0.00000000001
Po-215							2.59E-14	<0.00000000001
Pr-144m							1.37E-14	<0.00000000001
Hg-206							1.18E-14	<0.00000000001
Ce-141	4.94E-11						8.07E-15	<0.00000000001
Sn-123	6.66E-12						8.06E-15	<0.00000000001
Pm-148m	1.90E-12						3.98E-15	<0.00000000001
Po-211							3.31E-15	<0.00000000001
U-235m							1.40E-15	<0.00000000001
Rn-218							1.09E-15	<0.00000000001
Rh-103m							3.91E-16	<0.00000000001
Pm-148							3.00E-16	<0.00000000001
Ag-110							1.85E-16	<0.00000000001
Bi-215							3.83E-17	<0.00000000001
Te-127	1.04E-11						1.68E-17	<0.00000000001
Te-129	1.05E-12						5.33E-19	<0.00000000001
Xe-131m							8.06E-22	<0.00000000001
Sm-147							3.42E-22	<0.00000000001
Gd-152							2.46E-28	<0.00000000001
Nd-144							1.20E-28	<0.00000000001
At-219								<0.00000000001
Po-212								<0.00000000001
Sm-148								<0.00000000001
Grand Total	**1.55E+02**	**2.09E+03**	**1.10E+01**	**1.96E+03**	**1.79E+03**	**1.99E+04**	**1.92E-02**	

Data Table A-25b. Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

2020 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose (mrem)	Fraction of Dose
	0 m	15m	21m	31m	56m	59m		
H-3 (oxide)	1.55E+02	8.85E+02	1.10E+01	1.89E+03	1.79E+03	2.78E+03	1.43E-02	0.72
H-3 (elemental)		1.20E+03		7.20E+01		3.22E+02	2.93E-03	0.147
Ba-137m							7.29E-04	0.037
Cs-137	3.51E-03	9.84E-05		4.62E-03		6.25E-06	6.71E-04	0.034
Kr-85						1.68E+04	4.04E-04	0.020
Sr-90	2.85E-03	3.35E-07				1.46E-05	3.18E-04	0.016
Pu-239	8.22E-05	2.34E-08				8.08E-05	1.40E-04	0.007
Unidentified Beta	8.89E-04	1.88E-05	1.94E-06	1.55E-05		9.36E-05	1.30E-04	0.007
Y-90							4.96E-05	0.002
Unidentified Alpha	3.18E-05		2.55E-06	4.45E-06			3.57E-05	0.002
Pu-238	3.19E-05	9.30E-08				3.56E-06	2.96E-05	0.0015
Pu-240	2.54E-05						2.34E-05	0.0012
Pu-242	2.68E-05						2.34E-05	0.0012
Am-241	1.76E-05	6.76E-08		9.67E-07		5.10E-06	1.77E-05	0.0009
C-14	1.04E-05					6.20E-02	1.57E-05	0.0008
Bi-214							1.35E-05	0.0007
I-129	1.58E-05		6.19E-07			5.56E-03	9.13E-06	0.0005
Th-230	7.87E-11	4.99E-09					7.86E-06	0.0004
Ra-226	4.04E-07						6.31E-06	0.0003
Pu-241	2.37E-04						3.97E-06	0.0002
Pb-214							2.31E-06	0.0001
U-238	2.30E-06	1.97E-07		2.36E-06		3.54E-05	1.83E-06	0.00009
U-234	2.70E-06	3.17E-07		2.32E-06		2.63E-05	1.72E-06	0.00009
Pa-234m							1.33E-06	0.00007
Tc-99	5.08E-05						1.19E-06	0.00006
Np-237	1.54E-06					1.30E-07	7.18E-07	0.00004
Co-60	3.39E-06						3.88E-07	0.00002
Am-243	3.61E-07						2.76E-07	0.00001
Bi-210							1.83E-07	0.00001
U-235	2.73E-08					1.81E-06	1.68E-07	0.00001
Cm-244	2.98E-07					1.90E-08	1.49E-07	0.00001
Th-234							1.13E-07	0.00001
Ra-228	4.07E-07						1.10E-07	0.000006
Nb-94	2.42E-07						1.09E-07	0.000005
Pa-233	1.42E-06						1.03E-07	0.000005
Sb-126m							7.99E-08	0.000004
Eu-154	7.11E-07						5.96E-08	0.000003
F-18	1.00E-02						5.46E-08	0.000003
Th-229	1.23E-09						4.05E-08	0.000002
Cs-134	4.31E-07						3.30E-08	0.000002
Pa-234							2.63E-08	0.000001
Tl-208	1.41E-06						2.30E-08	0.000001
Ba-133	6.55E-07						2.02E-08	0.000001
Sb-126							1.93E-08	0.0000010
Ni-63	4.55E-05						1.81E-08	0.0000009
Ac-228							1.78E-08	0.0000009
Np-239							1.77E-08	0.0000009

Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

2020 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose (mrem)	Fraction of Dose
	0 m	15m	21m	31m	56m	59m		
Sb-125	1.18E-06						1.30E-08	0.0000007
Th-228	1.17E-08	3.35E-09					1.26E-08	0.0000006
Pb-210							1.13E-08	0.0000006
Rh-106							1.06E-08	0.0000005
Th-231	2.12E-04						9.23E-09	0.0000005
Ru-106	3.04E-06						6.54E-09	0.0000003
Sn-126	1.70E-07						5.54E-09	0.0000003
Tl-210							5.26E-09	0.0000003
Pb-212	8.43E-07						4.59E-09	0.0000002
Bi-212							3.65E-09	0.0000002
Rn-222							3.53E-09	0.0000002
Ac-225							3.08E-09	0.00000015
Ra-225							2.82E-09	0.00000014
U-233	2.89E-08						1.80E-09	0.00000009
U-236	3.01E-08						1.68E-09	0.00000008
Bi-213							1.50E-09	0.00000008
Th-232	4.29E-12	2.68E-09					1.33E-09	0.00000007
U-232	5.35E-09						1.07E-09	0.00000005
Eu-152	9.21E-09						1.01E-09	0.00000005
Ra-224							1.00E-09	0.00000005
Po-214							7.47E-10	0.000000038
Nb-95	3.63E-07						5.48E-10	0.000000028
Te-125m							5.17E-10	0.000000026
Sm-151	2.89E-06						5.09E-10	0.000000026
Pm-147	2.89E-06						5.08E-10	0.000000026
Tl-209							3.86E-10	0.000000019
Eu-155	1.18E-07						3.03E-10	0.000000015
Fr-221							2.46E-10	0.000000012
Zr-95	1.22E-07						1.75E-10	0.000000009
Pu-236	4.56E-10						1.60E-10	0.000000008
Se-79	4.90E-09						1.36E-10	0.000000007
U-237							7.33E-11	0.000000004
Ni-59	3.67E-07						7.02E-11	0.000000004
Po-210							4.75E-11	0.000000002
Ce-144	2.00E-08						3.27E-11	0.0000000016
Pb-209							2.92E-11	0.0000000015
Pr-144	2.00E-08						2.49E-11	0.0000000013
Ra-223							2.48E-11	0.0000000012
Th-227							2.22E-11	0.0000000011
Pb-211							2.10E-11	0.0000000011
Zn-65	9.41E-10						1.55E-11	0.0000000008
Fe-55	3.76E-08						1.53E-11	0.0000000008
Cd-109	1.36E-08						1.49E-11	0.0000000007
Pa-231							1.45E-11	0.0000000007
Rn-220							1.29E-11	0.0000000006
Tl-207							1.09E-11	0.0000000005
Rn-219							1.08E-11	0.00000000054
Bi-211							8.68E-12	0.00000000044
Y-88	5.18E-10						3.84E-12	0.00000000019
Mn-54	4.55E-10						3.15E-12	0.00000000016
Nb-95m							2.54E-12	0.00000000013
At-217							2.07E-12	0.00000000010
Sr-85	5.82E-10						5.95E-13	0.00000000003
Co-57	4.95E-10						5.25E-13	0.00000000003

Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

2020 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose (mrem)	Fraction of Dose
	0 m	15m	21m	31m	56m	59m		
In-113m							4.91E-13	0.00000000002
Sr-89	5.40E-10						4.56E-13	0.000000000023
Tl-206							4.29E-13	0.000000000022
Y-91	7.98E-10						4.25E-13	0.000000000021
Ru-103	5.11E-10						3.27E-13	0.000000000016
Po-213							3.19E-13	0.000000000016
Ce-139	5.18E-10						3.15E-13	0.000000000016
Po-216							3.12E-13	0.000000000016
I-131	7.10E-10						2.93E-13	0.000000000015
Ag-110m	1.48E-11						2.77E-13	0.000000000014
At-218							2.37E-13	0.000000000012
Sn-113	6.30E-10						2.22E-13	0.000000000011
Fr-223							2.09E-13	0.000000000011
Hg-203	5.26E-10						7.76E-14	<0.00000000001
Po-218							6.31E-14	<0.00000000001
Ac-227							4.65E-14	<0.00000000001
Po-215							3.28E-14	<0.00000000001
Pr-144m							1.65E-14	<0.00000000001
Hg-206							1.48E-14	<0.00000000001
Ce-141	4.94E-11						8.96E-15	<0.00000000001
Sn-123	6.66E-12						8.73E-15	<0.00000000001
Pm-148m	1.90E-12						4.72E-15	<0.00000000001
Po-211							4.18E-15	<0.00000000001
U-235m							1.59E-15	<0.00000000001
Rn-218							1.38E-15	<0.00000000001
Rh-103m							4.69E-16	<0.00000000001
Pm-148							3.47E-16	<0.00000000001
Ag-110							2.23E-16	<0.00000000001
Bi-215							4.83E-17	<0.00000000001
Te-127	1.04E-11						1.84E-17	<0.00000000001
Te-129	1.05E-12						6.21E-19	<0.00000000001
Xe-131m							7.54E-22	<0.00000000001
Sm-147							3.27E-22	<0.00000000001
Gd-152							2.37E-28	<0.00000000001
Nd-144							1.12E-28	<0.00000000001
At-219								<0.00000000001
Po-212								<0.00000000001
Sm-148								<0.00000000001
Grand Total	**1.55E+02**	**2.09E+03**	**1.10E+01**	**1.96E+03**	**1.79E+03**	**1.99E+04**	**1.99E-02**	

a. Daughter products are calculated to have the same release rate as their parent source terms

Data Table A-26a. Diffuse and Fugitive Releases and MEI Doses for NESHAP at Site Boundary MEI

Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2021 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Cs-137	3.51E-03	5.27E-04	0.330
H-3 (oxide)	1.55E+02	3.65E-04	0.229
Sr-90	2.85E-03	3.00E-04	0.188
Pu-239	8.22E-05	1.40E-04	0.088
Unidentified Beta	8.89E-04	1.06E-04	0.067
Y-90		4.10E-05	0.026
Unidentified Alpha	3.18E-05	2.71E-05	0.017
Pu-238	3.19E-05	2.49E-05	0.016
Pu-240	2.54E-05	2.17E-05	0.014
Pu-242	2.68E-05	2.17E-05	0.014
Am-241	1.76E-05	1.25E-05	0.0078
Pu-241	2.37E-04	3.69E-06	0.0023
Tc-99	5.08E-05	1.12E-06	0.0007
Bi-214		1.11E-06	0.0007
Th-230	7.87E-11	6.99E-07	0.0004
Ra-226	4.04E-07	6.25E-07	0.0004
Np-237	1.54E-06	6.19E-07	0.0004
Co-60	3.39E-06	3.26E-07	0.0002
Am-243	3.61E-07	2.56E-07	0.0002
Pb-214		1.90E-07	0.0001
U-234	2.70E-06	1.53E-07	0.0001
Cm-244	2.98E-07	1.31E-07	0.00008
U-238	2.30E-06	1.09E-07	0.00007
Ra-228	4.07E-07	1.03E-07	0.00006
Nb-94	2.42E-07	9.03E-08	0.00006
Pa-233	1.42E-06	7.89E-08	0.00005
Sb-126m		6.64E-08	0.00004
Pa-234m		6.49E-08	0.00004
Eu-154	7.11E-07	4.97E-08	0.00003
F-18	1.00E-02	4.74E-08	0.00003
Th-229	1.23E-09	3.75E-08	0.00002
I-129	1.58E-05	3.07E-08	0.00002
Cs-134	4.31E-07	2.97E-08	0.000019
Tl-208	1.41E-06	1.83E-08	0.000011
Ni-63	4.55E-05	1.72E-08	0.000011
Ba-133	6.55E-07	1.68E-08	0.000011
Sb-126		1.60E-08	0.000010
Bi-210		1.50E-08	0.000009
Np-239		1.47E-08	0.000009
Ac-228		1.42E-08	0.000009
Sb-125	1.18E-06	1.09E-08	0.000007
Th-228	1.17E-08	9.77E-09	0.000006
Rh-106		8.80E-09	0.000006
Ru-106	3.04E-06	6.16E-09	0.0000039
Th-234		5.64E-09	0.0000035
Sn-126	1.70E-07	4.95E-09	0.0000031
Pb-212	8.43E-07	3.88E-09	0.0000024
C-14	1.04E-05	3.84E-09	0.0000024

Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2021 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Bi-212		2.95E-09	0.0000018
Ac-225		2.85E-09	0.0000018
Ra-225		2.60E-09	0.0000016
U-235	2.73E-08	2.41E-09	0.0000015
U-233	2.89E-08	1.67E-09	0.0000010
U-236	3.01E-08	1.56E-09	0.0000010
Pa-234		1.28E-09	0.0000008
Bi-213		1.25E-09	0.0000008
Th-231	2.12E-04	1.03E-09	0.0000006
U-232	5.35E-09	1.00E-09	0.0000006
Pb-210		9.34E-10	0.00000058
Eu-152	9.21E-09	8.37E-10	0.00000052
Ra-224		7.80E-10	0.00000049
Pm-147	2.89E-06	4.74E-10	0.00000030
Sm-151	2.89E-06	4.73E-10	0.00000030
Nb-95	3.63E-07	4.60E-10	0.00000029
Te-125m		4.60E-10	0.00000029
Tl-210		4.33E-10	0.00000027
Tl-209		3.20E-10	0.00000020
Rn-222		2.9E-10	0.000000182
Eu-155	1.18E-07	2.6E-10	0.000000160
Fr-221		2.0E-10	0.000000128
Pu-236	4.56E-10	1.5E-10	0.000000093
Zr-95	1.22E-07	1.5E-10	0.000000093
Se-79	4.90E-09	1.3E-10	0.000000081
Ni-59	3.67E-07	6.6E-11	0.000000041
Po-214		6.1E-11	0.000000038
U-237		6.1E-11	0.000000038
Ce-144	2.00E-08	3.04E-11	0.000000019
Pb-209		2.42E-11	0.000000015
Pr-144	2.00E-08	2.07E-11	0.000000013
Fe-55	3.76E-08	1.45E-11	0.000000009
Zn-65	9.41E-10	1.42E-11	0.000000009
Cd-109	1.36E-08	1.4E-11	0.0000000086
Rn-220		1.0E-11	0.0000000065
Po-210		3.9E-12	0.0000000024
Y-88	5.18E-10	3.21E-12	0.0000000020
Mn-54	4.55E-10	2.63E-12	0.0000000016
Nb-95m		2.27E-12	0.0000000014
Th-232	4.29E-12	1.93E-12	0.0000000012
At-217		1.72E-12	0.0000000011
Pa-231		1.1E-12	0.0000000007
Ra-223		6.4E-13	0.0000000004
Th-227		5.8E-13	0.0000000004
Pb-211		5.48E-13	0.0000000003
Sr-85	5.82E-10	5.07E-13	0.00000000032
Co-57	4.95E-10	4.50E-13	0.00000000028
Sr-89	5.40E-10	4.25E-13	0.00000000027
In-113m		4.08E-13	0.00000000026
Y-91	7.98E-10	3.91E-13	0.00000000024
Tl-207		2.84E-13	0.00000000018

Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2021 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
I-131	7.10E-10	2.79E-13	0.00000000017
Rn-219		2.79E-13	0.00000000017
Ru-103	5.11E-10	2.79E-13	0.00000000017
Po-213		2.66E-13	0.000000000166
Ce-139	5.18E-10	2.65E-13	0.000000000166
Po-216		2.50E-13	0.000000000156
Ag-110m	1.48E-11	2.32E-13	0.000000000145
Bi-211		2.26E-13	0.000000000141
Sn-113	6.30E-10	2.06E-13	0.000000000129
Hg-203	5.26E-10	7.38E-14	0.000000000046
Tl-206		3.52E-14	0.000000000022
At-218		1.95E-14	0.000000000012
Pr-144m		1.37E-14	0.000000000009
Ce-141	4.94E-11	8.07E-15	0.000000000005
Sn-123	6.66E-12	8.06E-15	0.000000000005
Fr-223		5.43E-15	0.000000000003
Po-218		5.19E-15	0.000000000003
Pm-148m	1.90E-12	3.98E-15	0.000000000002
U-235m		1.59E-15	0.000000000001
Hg-206		1.22E-15	0.000000000001
Ac-227		1.21E-15	0.000000000001
Po-215		8.53E-16	0.000000000001
Rh-103m		3.91E-16	0.0000000000002
Pm-148		3.00E-16	0.0000000000002
Ag-110		1.85E-16	0.0000000000001
Rn-218		1.13E-16	0.0000000000001
Po-211		1.09E-16	0.0000000000001
Te-127	1.04E-11	1.68E-17	0.0000000000000
Bi-215		1.26E-18	0.00000000000000
Te-129	1.05E-12	5.33E-19	0.00000000000000
Xe-131m		8.06E-22	0.00000000000000
Sm-147		3.42E-22	0.000000000000000
Gd-152		2.46E-28	0.000000000000000
Nd-144		1.20E-28	0.000000000000000
At-219			0.000000000000000
Po-212			0.000000000000000
Sm-148			0.000000000000000
Grand Total	**1.55E+02**	**1.60E-03**	**100.00%**

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126 & Y-90) in secular equilibrium with source terms (Sn-126 & Sr-90, respectively). In CAP88, they are included in their parents' source term and are not run separately.
c. Radionuclides with no release values are daughter products with no original source term of their own.

Data Table A-26b. Diffuse and Fugitive Releases and MEI Doses for NESHAP at TRL Worker Location

Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2021 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Cs-137	3.51E-03	5.94E-04	0.344
H-3 (oxide)	1.55E+02	3.73E-04	0.216
Sr-90	2.85E-03	3.17E-04	0.184
Pu-239	8.22E-05	1.51E-04	0.088
Unidentified Beta	8.89E-04	1.14E-04	0.066
Y-90		4.94E-05	0.029
Unidentified Alpha	3.18E-05	2.92E-05	0.017
Pu-238	3.19E-05	2.69E-05	0.016
Pu-240	2.54E-05	2.34E-05	0.014
Pu-242	2.68E-05	2.34E-05	0.014
Am-241	1.76E-05	1.35E-05	0.0078
Pu-241	2.37E-04	3.97E-06	0.0023
Bi-214		1.33E-06	0.0008
Tc-99	5.08E-05	1.19E-06	0.0007
Th-230	7.87E-11	7.52E-07	0.0004
Np-237	1.54E-06	6.69E-07	0.0004
Ra-226	4.04E-07	6.65E-07	0.0004
Co-60	3.39E-06	3.88E-07	0.0002
Am-243	3.61E-07	2.76E-07	0.0002
Pb-214		2.28E-07	0.0001
U-234	2.70E-06	1.64E-07	0.0001
Cm-244	2.98E-07	1.42E-07	0.00008
U-238	2.30E-06	1.17E-07	0.00007
Ra-228	4.07E-07	1.09E-07	0.00006
Nb-94	2.42E-07	1.09E-07	0.00006
Pa-233	1.42E-06	9.49E-08	0.00005
Sb-126m		7.99E-08	0.00005
Pa-234m		7.81E-08	0.00005
Eu-154	7.11E-07	5.96E-08	0.00003
F-18	1.00E-02	5.46E-08	0.00003
Th-229	1.23E-09	4.05E-08	0.00002
Cs-134	4.31E-07	3.30E-08	0.00002
I-129	1.58E-05	3.23E-08	0.000019
Tl-208	1.41E-06	2.20E-08	0.000013
Ba-133	6.55E-07	2.02E-08	0.000012
Sb-126		1.93E-08	0.000011
Bi-210		1.81E-08	0.000011
Ni-63	4.55E-05	1.81E-08	0.000010
Np-239		1.77E-08	0.000010
Ac-228		1.71E-08	0.000010
Sb-125	1.18E-06	1.30E-08	0.000008
Rh-106		1.06E-08	0.000006
Th-228	1.17E-08	1.05E-08	0.000006
Th-234		6.66E-09	0.0000039
Ru-106	3.04E-06	6.54E-09	0.0000038
Sn-126	1.70E-07	5.54E-09	0.0000032
Pb-212	8.43E-07	4.48E-09	0.0000026
C-14	1.04E-05	3.89E-09	0.0000023

Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2021 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Bi-212		3.52E-09	0.0000020
Ac-225		3.08E-09	0.0000018
Ra-225		2.82E-09	0.0000016
U-235	2.73E-08	2.72E-09	0.0000016
U-233	2.89E-08	1.80E-09	0.0000010
U-236	3.01E-08	1.68E-09	0.0000010
Pa-234		1.54E-09	0.0000009
Bi-213		1.50E-09	0.0000009
Th-231	2.12E-04	1.14E-09	0.0000007
Pb-210		1.12E-09	0.0000007
U-232	5.35E-09	1.08E-09	0.00000063
Eu-152	9.21E-09	1.01E-09	0.00000059
Ra-224		8.62E-10	0.00000050
Nb-95	3.63E-07	5.48E-10	0.00000032
Tl-210		5.21E-10	0.00000030
Te-125m		5.17E-10	0.00000030
Sm-151	2.89E-06	5.09E-10	0.00000029
Pm-147	2.89E-06	5.08E-10	0.00000029
Tl-209		3.86E-10	0.00000022
Rn-222		3.5E-10	0.000000203
Eu-155	1.18E-07	3.0E-10	0.000000176
Fr-221		2.5E-10	0.000000143
Zr-95	1.22E-07	1.8E-10	0.000000101
Pu-236	4.56E-10	1.6E-10	0.000000093
Se-79	4.90E-09	1.4E-10	0.000000079
Po-214		7.4E-11	0.000000043
U-237		7.3E-11	0.000000042
Ni-59	3.67E-07	7.0E-11	0.000000041
Ce-144	2.00E-08	3.27E-11	0.000000019
Pb-209		2.92E-11	0.000000017
Pr-144	2.00E-08	2.49E-11	0.000000014
Zn-65	9.41E-10	1.55E-11	0.000000009
Fe-55	3.76E-08	1.53E-11	0.000000009
Cd-109	1.36E-08	1.5E-11	0.0000000086
Rn-220		1.2E-11	0.0000000072
Po-210		4.7E-12	0.0000000027
Y-88	5.18E-10	3.84E-12	0.0000000022
Mn-54	4.55E-10	3.15E-12	0.0000000018
Nb-95m		2.54E-12	0.0000000015
Th-232	4.29E-12	2.08E-12	0.0000000012
At-217		2.07E-12	0.0000000012
Pa-231		1.1E-12	0.0000000007
Ra-223		7.8E-13	0.0000000004
Th-227		6.9E-13	0.0000000004
Pb-211		6.60E-13	0.0000000004
Sr-85	5.82E-10	5.95E-13	0.00000000034
Co-57	4.95E-10	5.25E-13	0.00000000030
In-113m		4.91E-13	0.00000000028
Sr-89	5.40E-10	4.56E-13	0.00000000026
Y-91	7.98E-10	4.25E-13	0.00000000025
Tl-207		3.42E-13	0.00000000020

Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2021 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Rn-219		3.36E-13	0.00000000019
Ru-103	5.11E-10	3.27E-13	0.00000000019
Po-213		3.19E-13	0.00000000018
Ce-139	5.18E-10	3.15E-13	0.000000000182
Po-216		3.00E-13	0.000000000174
I-131	7.10E-10	2.93E-13	0.000000000170
Ag-110m	1.48E-11	2.77E-13	0.000000000160
Bi-211		2.72E-13	0.000000000158
Sn-113	6.30E-10	2.22E-13	0.000000000129
Hg-203	5.26E-10	7.76E-14	0.000000000045
Tl-206		4.24E-14	0.000000000025
At-218		2.35E-14	0.000000000014
Pr-144m		1.65E-14	0.000000000010
Ce-141	4.94E-11	8.96E-15	0.000000000005
Sn-123	6.66E-12	8.73E-15	0.000000000005
Fr-223		6.53E-15	0.000000000004
Po-218		6.24E-15	0.000000000004
Pm-148m	1.90E-12	4.72E-15	0.000000000003
U-235m		1.72E-15	0.000000000001
Hg-206		1.47E-15	0.000000000001
Ac-227		1.45E-15	0.000000000001
Po-215		1.03E-15	0.000000000001
Rh-103m		4.69E-16	0.0000000000003
Pm-148		3.47E-16	0.0000000000002
Ag-110		2.23E-16	0.0000000000001
Rn-218		1.37E-16	0.0000000000001
Po-211		1.31E-16	0.0000000000001
Te-127	1.04E-11	1.84E-17	0.0000000000000
Bi-215		1.51E-18	0.00000000000000
Te-129	1.05E-12	6.21E-19	0.00000000000000
Xe-131m		7.54E-22	0.00000000000000
Sm-147		3.27E-22	0.000000000000000
Gd-152		2.37E-28	0.000000000000000
Nd-144		1.12E-28	0.000000000000000
At-219			0.000000000000000
Po-212			0.000000000000000
Sm-148			0.000000000000000
Grand Total	**1.55E+02**	**1.73E-03**	**100.00%**

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126 & Y-90) in secular equilibrium with source terms (Sn-126 & Sr-90, respectively). In CAP88, they are included in their parents' source term and are not run separately.
c. Radionuclides with no release values are daughter products with no original source term of their own.

Data Table A-27. CAP88 Offsite MEI Dose Compared to MAXDOSE-SR

Data Table A-27, CAP88 Offsite MEI Dose Compared to MAXDOSE-SR
2021 Maximally Exposed Individual Dose Commitment at Site Boundary from Atmospheric Releases

Pathway	CAP88 PC Maximally Exposed Individual		MAXDOSE-SR Representative Person	
	(Millirem)[a]	(Percent of Dose)	(Millirem)[a]	(Percent of Dose)[d]
Plume	3.37E-04	1.75%	9.14E-04	3.26%
Ground	6.77E-04	3.51%	6.68E-04	3.68%
Inhalation	2.41E-03	12.51%	5.36E-03	33.62%
Food[b]	1.59E-02	82.24%	9.55E-03	59.44%
Total	**1.93E-02**	**100.00%**	**1.65E-02**	**100.00%**

Radionuclide	CAP88 PC Maximally Exposed Individual		MAXDOSE-SR Representative Person	
	(Millirem)[a]	(Percent of Dose)	(Millirem)[a]	(Percent of Dose)[d]
Gases and Vapors				
H-3[c]	1.69E-02	87.83%	1.18E-02	71.52%
C-14	1.61E-05	0.08%	4.88E-05	0.30%
Kr-85	3.37E-04	1.75%	9.14E-04	5.54%
I-129	7.61E-06	0.04%	2.20E-03	13.33%
Particulates				
Am-241	1.60E-05	0.08%	2.89E-05	0.18%
Cs-137	1.24E-03	6.44%	6.42E-04	3.89%
Pu-238	2.72E-05	0.14%	5.00E-05	0.30%
Pu-239	1.24E-04	0.64%	2.25E-04	1.36%
Pu-240	2.17E-05	0.11%	3.96E-05	0.24%
Pu-241	3.69E-06	0.02%	6.58E-06	0.04%
Pu-242	2.17E-05	0.11%	3.98E-05	0.24%
Sr-90	3.01E-04	1.56%	2.59E-04	1.57%
Tc-99	1.12E-06	0.01%	1.27E-05	0.08%
U-234	1.49E-06	0.01%	3.59E-06	0.02%
U-238	1.58E-06	0.01%	5.09E-06	0.03%
Unidentified Alpha	3.30E-05	0.17%	5.58E-05	0.34%
Unidentified Beta	1.21E-04	0.63%	1.08E-04	0.65%
Others	7.00E-05	0.36%	6.11E-05	0.37%
Total	**1.92E-02**	**100.00%**	**1.65E-02**	**100.00%**

NOTE: (a) Committed effective dose.

NOTE: (b) Meat, milk, and vegetables.

NOTE: (c) Dose from tritium in foods calculated with absolute humidity of 12.9 g water/cubic meter of air.

NOTE: (d) Radionuclides contributing 0.01% or more from MAXDOSE-SR output.

Data Table A-28. CAP88 PC Population Dose Compared to POPDOSE-SR

Data Table A-28, CAP88 PC Population Dose Compared to POPDOSE-SR
2021 Collective Committed Dose from Atmospheric Releases

Pathway	CAP88 Code		POPDOSE-SR Code	
	Person-rem[(a)]	Percent of Dose	Person-rem[(a)]	Percent of Dose[(d)]
Plume	4.31E-02	2.23%	7.40E-02	6.04%
Ground	8.24E-02	4.27%	6.36E-02	7.50%
Inhalation	2.97E-01	15.38%	4.70E-01	68.36%
Food[(b)]	1.51E+00	78.12%	1.26E-01	18.10%
Total	**1.93E+00**	**100.00%**	**7.34E-01**	**100.00%**

Radionuclide	CAP88 Code		POPDOSE-SR Code	
	Person-rem(a)	Percent of Dose	Person-rem(a)	Percent of Dose(d)
Gases and Vapors				
H-3[(c)]	1.68E+00	86.37%	5.41E-01	73.61%
C-14	1.55E-03	0.08%	5.51E-04	0.07%
Kr-85	4.31E-02	2.33%	7.40E-02	10.07%
I-129	9.74E-04	0.05%	2.76E-02	3.76%
Particulates				
Am-241	1.52E-03	0.08%	1.65E-03	0.22%
Cs-137	1.36E-01	7.35%	5.35E-02	7.28%
Pu-238	2.54E-03	0.14%	2.73E-03	0.37%
Pu-239	1.20E-02	0.65%	1.35E-02	1.84%
Pu-240	2.01E-03	0.11%	2.11E-03	0.29%
Pu-241	3.41E-04	0.02%	3.50E-04	0.05%
Pu-242	2.01E-03	0.11%	2.11E-03	0.29%
Sr-90	2.73E-02	1.47%	8.20E-03	1.12%
U-234	1.42E-04	0.01%	2.08E-04	0.03%
U-238	1.50E-04	0.01%	3.53E-04	0.05%
Unidentified Alpha	3.07E-03	0.17%	3.22E-03	0.44%
Unidentified Beta	1.14E-02	0.62%	3.51E-03	0.48%
Others	8.04E-03	0.42%	4.08E-04	0.06%
Total	**1.93E+00**	**100.00%**	**7.35E-01**	**100.00%**

NOTE: (a) Committed effective dose equivalent

NOTE: (b) Meat, milk, and vegetables

NOTE: (c) Dose from tritium in foods calculated with absolute humidity of 12.9 g water/cubic meter of air

NOTE: (d) Radionuclides contributing 0.01% or more from POPDOSE-SR or CAP88 output.

Data Table A-29. Deer and Hog Hunter Doses

Data Table A-29 Deer and Hog Hunter Doses

2021 Deer and Hog Hunter Doses

Onsite Deer Hunter (Actual Hunter)				
Maximum Individual Dose determined by field measurements =			**0.00**	**mrem**
0 animal harvested				
Total gross (live) weight =	0	lbs	*0*	*kg*
Total edible weight =	0	lbs	*0*	*kg*
Offsite Deer Hunter Dose (Hypothetical Hunter)				
Mean of the gross cesium-137 concentration in onsite deer =			1.23	pCi/g
CSRA background concentration =			0.5	pCi/g
MEI meat consumption rate =			81	kg/y
Cesium-137 adult dose coefficient (from DOE-STD-1196-2011) =			5.03E-05	mrem/pCi
Dose =			**2.97**	**mrem**
Offsite Hog Hunter Dose (Hypothetical Hunter)				
Mean of the gross cesium-137 concentration in onsite hogs =			1.77	pCi/g
CSRA background concentration =			0.5	pCi/g
MEI meat consumption rate =			81	kg/y
Cesium-137 adult dose coefficient (from DOE-STD-1196-2011) =			5.03E-05	mrem/pCi
Dose =			**5.17**	**mrem**

Data in red are from the Environmental Monitoring Program Subject Matter Expert
Email from Brian Price to Brooke Stagich (03/22/2022)

Data Table A-30a. Average Concentration in Composites used in the Dose Calculations (pCi/g)

Data Table A-30a, Average Concentration in Composites used in the Dose Calculations (pCi/g)

Location	Species	Sr-89,90	Cs-137	I-129	Tc-99
Augusta	Bass	2.87E-03	1.44E-02	1.06E-02	
Lock + Dam	Catfish		3.59E-02		
	Flathead Catfish		5.32E-02		
U3R	Bass	4.34E-03	4.43E-02		
Mouth	Catfish		1.33E-02		
	Flathead Catfish		3.25E-02	7.19E-03	6.48E-02
	Panfish		5.56E-02		0.00E+00
Fourmile	Bass	2.09E-03	3.84E-02		
Branch Mouth	Catfish	2.39E-03	6.41E-02		
	Flathead Catfish	2.85E-03	4.58E-02		
	Panfish	3.06E-03	5.09E-02		
Steel Creek	Bass		3.61E-01		
Mouth	Catfish		1.06E-01		
	Flathead Catfish		3.35E-02		
	Panfish	4.93E-03	1.59E-01		
L3R	Bass	4.60E-03	3.92E-02		
Mouth	Catfish	1.48E-03	1.04E-01		
	Flathead Catfish		1.60E-01		
	Panfish		2.79E-02		
Hwy-301	Bass		2.23E-02		
Bridge Area	Catfish	3.98E-03	2.46E-02		
	Flathead Catfish		2.78E-02		
	Panfish		2.17E-02		

Note: Averages are based on three composites of up to five fish of each species from each location.
At least one of the three composite samples had to have a significant result for an average concentration to be reported.
Refer to Data Table 5-16 for the radioanalytical results.

Data Table A-30b. Total Dose from Consumption of 24 kg/y from Savannah River Fish (mrem)

Data Table A-30b, Total Dose from Consumption of 24 kg/y from Savannah River Fish (mrem) **Page 2 of 3**

Location	Species	Sr-90	Cs-137	I-129	Tc-99	Total
Augusta	Bass	9.17E-03	1.70E-02	1.14E-01		1.40E-01
Lock + Dam	Catfish		4.24E-02			4.24E-02
	Flathead Catfish		6.28E-02			6.28E-02
U3R	Bass	1.39E-02	5.23E-02			6.62E-02
Mouth	Catfish		1.57E-02			1.57E-02
	Flathead Catfish		3.84E-02	7.73E-02	5.18E-03	1.21E-01
	Panfish		6.57E-02			6.57E-02
Fourmile	Bass	6.68E-03	4.54E-02			5.20E-02
Branch Mouth	Catfish	7.64E-03	7.57E-02			8.33E-02
	Flathead Catfish	9.11E-03	5.41E-02			6.32E-02
	Panfish	9.78E-03	6.01E-02			6.99E-02
Steel Creek	Bass		4.26E-01			**4.26E-01**
Mouth	Catfish		1.25E-01			1.25E-01
	Flathead Catfish		3.96E-02			3.96E-02
	Panfish	1.58E-02	1.88E-01			2.04E-01
L3R	Bass	1.47E-02	4.63E-02			6.10E-02
Mouth	Catfish	4.73E-03	1.23E-01			1.28E-01
	Flathead Catfish		4.57E-02		7.98E-03	5.37E-02
	Panfish		3.30E-02			3.30E-02
Hwy-301	Bass		2.63E-02			2.63E-02
Bridge Area	Catfish	1.27E-02	2.91E-02			4.18E-02
	Flathead Catfish		4.57E-02		7.98E-03	5.37E-02
	Panfish		2.56E-02			2.56E-02

Note: Ingestion dose coefficients are from the DOE Derived Concentration Technical Standard (DOE-STD-1196-2011)

Data Table A-30c. Total Risk from Consumption of 24 kg/y from Savannah River Fish (risk/year)

Data Table A-30c, Total Risk from Consumption of 24 kg/y from Savannah River Fish (risk/year) **Page 3 of 3**

Location	Species	Sr-90	Cs-137	I-129	Tc-99	Total
Augusta	Bass	6.56E-09	1.29E-08	4.91E-08		6.86E-08
Lock + Dam	Catfish		3.22E-08			3.22E-08
	Flathead Catfish		4.78E-08			4.78E-08
U3R	Bass	9.93E-09	3.98E-08			4.97E-08
Mouth	Catfish		1.19E-08			1.19E-08
	Flathead Catfish		2.92E-08	3.33E-08	6.22E-09	6.87E-08
	Panfish		4.99E-08			4.99E-08
Fourmile	Bass	4.78E-09	3.45E-08			3.92E-08
Branch Mouth	Catfish	5.47E-09	5.75E-08			6.30E-08
	Flathead Catfish	6.52E-09	4.11E-08			4.76E-08
	Panfish	7.00E-09	4.57E-08			5.27E-08
Steel Creek	Bass		3.24E-07			**3.24E-07**
Mouth	Catfish		9.51E-08			9.51E-08
	Flathead Catfish		3.01E-08			3.01E-08
	Panfish	1.13E-08	1.43E-07			1.54E-07
L3R	Bass	1.05E-08	3.52E-08			4.57E-08
Mouth	Catfish	3.39E-09	9.34E-08			9.67E-08
	Flathead Catfish		1.44E-07			1.44E-07
	Panfish		2.50E-08			2.50E-08
Hwy-301	Bass		2.00E-08			2.00E-08
Bridge Area	Catfish	9.10E-09	2.21E-08			3.12E-08
	Flathead Catfish		2.50E-08			2.50E-08
	Panfish		1.95E-08			1.95E-08

Note: SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13.

Data Table A-31 . SRS Supplemental Release Criteria

Data Table A-31, SRS Supplemental Release Criteria

Radionuclide Groups (a)	Removable (b) dpm/100 cm2	Total (Fixed+Removable)(c) dpm/100 cm2	Volumetric (d) pCi/g
Group 1 Radium, Thorium, and Transuranics: 210Po, 210Pb, 226Ra, 228Ra, 228Th, 230Th, 232Th, 237Np, 239Pu, 240Pu, 241Am, 244Cm, and associated decay chains(e), and others(a)	20	500	3
Group 2 U-nat, 234U, 235U, 238U, and associated decay products(f): 14C, 22Na, 24Na, 32P, 35S, 36Cl, 45Ca, 51Cr, 54Mn, 55Fe, 59Fe, 58Co, 60Co, 63Ni, 65Zn, 89Sr, 90Sr, 94Nb, 99Tc, 106Ru, 110mAg, 109Cd, 111In, 124Sb, 125I, 129I, 131I, 134Cs, 137Cs, 144Ce, 147Pm, 152Eu, 154Eu, 192Ir, 198Au, 241Pu, and others(a)	1000	5000	30
Tritium and tritiated compounds(g)	10,000/100,000(h)	N/A	2000

(a) To determine the specific group for radionuclides not shown, a comparison of the effective dose factors, by exposure pathway, listed in Table A.1 of NCRP Report No. 123 for the radionuclides in question and the radionuclides in the general groups above shall be performed and a determination of the proper group made, based on similarity of the factors.
(b) The amount of removable radioactive material per 100 cm2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium). When removable contamination on objects of surface area less than 100 cm2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
(c) The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm2 is less than three times the value specified. For purpose of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) from measurements of a representative number of sections it is determined that the average contamination exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm2 area exceeds three times the applicable value.
(d) Volume criteria will only be applied for the purpose of release of materials for disposal in a state, DOE, permitted or approved on-site landfill.
(e) For decay chains, the screening levels represent the total activity (i.e., the activity of the parent plus the activity of all progeny) present.
(f) Alpha component of activity
(g) Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a "Total" value does not apply.
(h) The criterion of 10,000 dpm/100 cm2 will be used for release of material for unrestricted use (reuse or recycle). The criterion of 100,000 dpm/100 cm2 will be used for the controlled on-site landfill disposal of material. (Note - DOE Suspension (July 2000) for recycle of metals will apply until rescinded). However, WSRC will only implement this more relaxed tritium surface criterion if a future exemption to 10CFR835 is granted.

Data Table A-32. Biota Dose Assessment

Data Table A-32, Biota Dose Assessment

Initial Level 1 Aquatic Systems Screen using Maximum Radionuclide Concentrations in Water and Sediment[a,b]

Location	Sum-of-the-Fractions of BCGs
FM-2	0.1400
FM-2B	0.2490
FM-3A	0.1760
FM-6	0.1300
FM-A7	0.2470
L3R-1A	0.1160
L3R-3	0.1450
PB-3	0.1130
SC-2A	0.2740
SC-4	0.1180
TB-5	0.1020
U3R-3	0.0896
U3R-4	0.0902
Z-Area Basin	0.3140

Note: Values are provided in SRNL-L3200-2022-00054

Initial Level 1 Terrestrial Systems Screen using Maximum Radionuclide Concentrations in Soil[a,b]

Location	Sum-of-the-Fractions of BCGs
F-Area	0.0140
H-Area	0.0057
Z-Area	0.0030
643-26E	0.0012
Burial Ground-North	0.0043

Note: Values are provided in SRNL-L3200-2022-00053

a. Soils and sediment are sampled on an annual basis. Stream water is generally sampled monthly.
b. Negative concentrations were assumed to be 0.