Chapter 5: **Radiological Environmental Monitoring Program**

The purpose of the Savannah River Site (SRS) Radiological Environmental Monitoring Program is twofold in that it monitors any effects SRS has on the environment, and it demonstrates the Site is complying with applicable U.S. Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and U.S. Department of Energy (DOE) regulations and standards. Monitoring substantiates that SRS operations pose no risk to the surrounding population. As part of this program, the Site collects thousands of samples throughout the year and analyzes them for radionuclides that could be present from releases due to SRS operations. The Site collects samples both onsite and in the communities surrounding SRS. State and federal regulations drive some of the monitoring SRS conducts. DOE Orders 231.1B, Environment, Safety and Health Reporting, and 458.1, Radiation Protection of the Public and the Environment, also address environmental monitoring requirements.

2018 Highlights

Air Pathway—All air contaminants SRS released were below applicable permit and regulation limits. Radiological results for surveillance media associated with the airborne pathway were within historical levels.

Water Pathway—Water contaminants SRS released were all below applicable standards. Radiological results for surveillance media associated with the liquid pathway were within historical levels.

Wildlife Surveillance—All harvested animals SRS monitored during the annual onsite hunts were below the applicable standard. SRS monitored the deer, feral hogs, turkeys, and coyotes harvested during the hunts and released 382 animals.

Chapter 5—Key Terms

Actinides *are a group of radioactive metallic elements with an atomic number between 89 and 103. Within this chapter, laboratory analysis of actinides generally refers to the elements uranium, plutonium, americium, and curium.*

Derived concentration standard (DCS) *is the concentration of a radionuclide, measured at the discharge point, in air or water effluents that—under conditions of continuous exposure for one year (annual ingestion of water, submersion in air, or inhalation)—would result in a dose of 100 mrem. This assumption of direct exposure to discharge point effluents is extremely unlikely and ensures that the DCSs are highly conservative.*

Dose *is a general term for the quantity of radiation (energy) absorbed.*

Effluent monitoring *collects samples or data from the point a facility discharges liquids or releases gases.*

Environmental monitoring *encompasses both effluent monitoring and environmental surveillance.*

Environmental surveillance *collects samples beyond the effluent discharge points and from the surrounding environment.*

Exposure pathway *is the way that releases of radionuclides into the water and air could impact a person.*

5.1 INTRODUCTION

Environmental monitoring at SRS examines both radiological and nonradiological constituents that the Site could release to the environment. This chapter discusses radiological monitoring at SRS; Chapter 4, *Nonradiological Environmental Monitoring Program*, presents the nonradiological monitoring.

The SRS Radiological Environmental Monitoring Program monitors radiological contaminants from both air and liquid sources, as well as collects and analyzes environmental samples from numerous locations throughout the Site and the surrounding area. SRS measures tritium in most sample media as it is a significant contributor to potential dose to the public. The Radiological Environmental Monitoring Program has two focus areas: 1) effluent monitoring, and 2) environmental surveillance. SRS determines sampling frequency and analyses based on permit-mandated monitoring requirements, federal regulations, and DOE Orders.

In accordance with DOE Order 458.1, SRS evaluates the effluent monitoring program by comparing the annual average concentrations to the DOE derived concentration standards (DCSs). DOE's *Derived Concentration Technical Standard* (DOE 2011) establishes numerical standards for DCSs to support implementing DOE Order 458.1. SRS demonstrates DCS compliance when the sum of the ratios of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. This sum is referred to as the "sum of fractions." The DCSs are applicable at the point of discharge, and SRS uses them to screen existing effluent treatment systems to determine if they are appropriate and effective. SRS uses the same DCSs as reference concentrations to conduct environmental protection programs. All DOE sites use these DCSs.

The SRS surveillance program samples the types of media that Site releases, as measured in the effluent monitoring program, may impact. Figure 5-1 shows the liquid and airborne pathways, as well as the types of media sampled through those pathways.

SRS conducts environmental monitoring of the following:

- Air (stack emissions and ambient air)

- Rainwater
- Vegetation
- Soil
- Surface water (stream, river, and stormwater basins)
- Drinking water
- Stream, basin, and river sediment
- Aquatic food products
- Wildlife
- Food products (milk, meat, fruit, nuts, and vegetables)

Sampling results provide the data needed to assess the exposure pathways for the people living near SRS, as documented in Chapter 6, *Radiological Dose Assessment*.

Appendix Table B-2 of this document summarizes the radiological surveillance sampling media and frequencies.

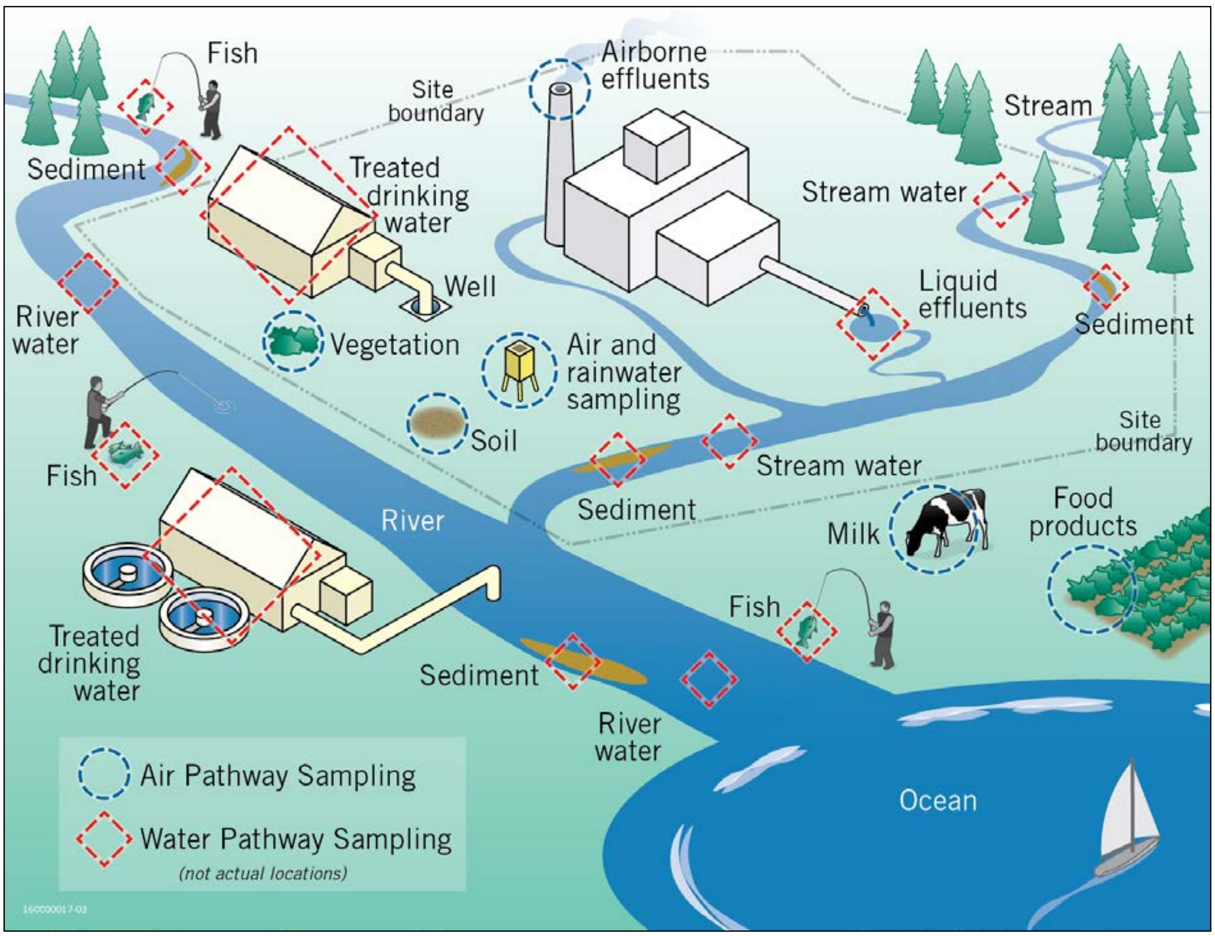


Figure 5-1 Types and Typical Locations of Radiological Sampling

5.2 SRS OFFSITE MONITORING

Offsite monitoring involves collecting and analyzing samples of air, river water, soil, sediment, vegetation, milk, food products, fish, and other media from many locations. SRS analyzes these samples for radioactive contaminants to monitor any effects the Site has on the environment and to assess long-term trends of the contaminants in the environment. SRS collects samples beyond the Site perimeter in Georgia and in South Carolina at 25 and 100 miles from the Site. Additionally, SRS collects samples at several population centers in Georgia and in South Carolina.

SRS monitors the Savannah River at River Mile (RM) 141.5, locations downriver of each SRS stream entry point, and above the Site at RM 161 as a control location. In 2018, SRS changed the control location at RM 160 to RM 161 as a program improvement described in Section 8.4, *Environmental Monitoring Program QA Activities*. Media-specific chapter figures and Environmental Maps show offsite environmental sampling locations. Chapter 7, *Groundwater Management Program,* provides information on SRS groundwater monitoring. Table 5-1 summarizes SRS offsite radiological sampling performed in Georgia and South Carolina, excluding samples collected in the Savannah River.

Table 5-1 SRS Offsite Radiological Sample Distribution by State

Environmental Sampling Media	Approximate Number of Samples (Number of Locations)	
	South Carolina	Georgia
Air Filters	26 (1)	52 (2)
Silica Gel	26 (1)	52 (2)
Ambient Gamma Radiation Monitoring	28 (7)	16 (4)
Rainwater	12 (1)	24 (2)
Food Products	20 (20)	5 (5)
Milk	16 (5)	15 (4)
Soil	5 (5)	2 (2)
Grassy Vegetation	1 (1)	2 (2)
Drinking Water	24 (2)	0 (0)
Total	**158 (43)**	**168 (23)**

Note:
This table excludes groundwater monitoring locations and samples that Chapter 7, *Groundwater Management Program*, discusses, as well as samples collected from the Savannah River.

5.3 AIR PATHWAY

The media in this section support the air pathway dose assessment discussed in Chapter 6, *Radiological Dose Assessment*.

5.3.1 Air Monitoring

SRS monitors the air to determine whether airborne radionuclides from SRS emissions have reached the environment in measurable quantities and to ensure that radiation exposure to the public remains below regulatory limits. SRS performs effluent monitoring of airborne radionuclides at the point of discharge from operating SRS facilities. This monitoring complies with radiation dose limits that the EPA and DOE established to protect the public. SRS conducts additional air sampling at surveillance stations onsite, along the SRS perimeter, and within communities surrounding SRS. Radionuclides in and around the SRS environment are from both SRS operations and from events not related to the Site. The events not associated with SRS include 1) natural sources, 2) past atmospheric testing of nuclear weapons, and 3) offsite nuclear power plant operations. Tritium in the elemental (hydrogen gas) and oxide (water vapor) forms make up most of the radionuclide emissions from SRS to the air. The amount of tritium released from SRS varies yearly, based on mission activities and on the annual production schedules of the tritium-processing facilities.

5.3.2 Airborne Emissions

EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) program establishes the limits for radionuclide emissions, detailing the methods for estimating and reporting radioactive emissions from DOE-owned or operated sources. SCDHEC issues Clean Air Act Part 70 Air Quality Permits to regulate radioactive airborne pollutant emissions for each major source of airborne emissions on SRS. Each permit has specific limitations and monitoring requirements.

SRS quantifies the total amount of radioactive material released to the environment by the following methods:

- Data obtained from monitored air effluent release points (stacks or vents)
- Calculated releases of unmonitored radioisotopes from the dissolution of spent fuel
- Estimates for unmonitored sources based on approved EPA calculation methods

SRS monitors the emissions from process area stacks at facilities that release, or have the potential to release, airborne radioactive materials. SRS typically uses laboratory analyses of samples to determine concentrations of radionuclides in airborne emissions. The Site collects airborne effluent samples on filter papers for particulates, on charcoal sampling media for gaseous iodine, and in a bubbler solution for airborne tritium. Depending on the processes involved, SRS may also use real-time instrumentation to monitor instantaneous and cumulative releases (of tritium, for example) to the air.

The dissolution of spent nuclear fuel in the H-Canyon facility releases krypton-85, carbon-14, and tritium. SRS calculates these emissions and includes them with the monitored releases.

Each year, SRS calculates radionuclide release estimates (in curies [Ci]) from unmonitored diffuse and point sources. Point sources include stacks or other exhaust points, such as vents. In contrast, emissions from diffuse sources are not actively ventilated or exhausted. Diffuse emissions may originate from a larger area and not from a single location. SRS diffuse sources include research laboratories, disposal sites and storage tanks, and deactivation and decommissioning activities. The emissions calculated from unmonitored releases use the methods contained in Appendix D of EPA's NESHAP regulations (EPA 2002). Because these methods employ conservative assumptions, they generally overestimate actual emissions. Although SRS does not monitor these releases at their source, it uses onsite and offsite environmental surveillance to assess the impact, if any, of unmonitored releases.

5.3.2.1 Airborne Emissions Results Summary

Appendix Table D-1 presents SRS radioactive release totals from monitored and unmonitored (calculated) sources, while Table 5-2 provides a summary. During the past 10 years, the total annual tritium release has ranged from about 15,200 to 40,400 Ci per year, with an annual average tritium release of 26,900 Ci (Figure 5-2). The 2018 SRS tritium releases totaled 39,300 Ci. The increase in tritium releases from 2017 to 2018 is mainly attributed to releases associated with both monitored and unmonitored releases from the Tritium Facilities. The increase in monitored releases is due to short-term maintenance activities in the Tritium Facilities. The increase in unmonitored releases from the Tritium Facilities is due to 1) an increase of material stored in waste containers and 2) a more conservative emission factor being used in the calculation.

To understand the potential environmental impact of the short-term maintenance activities, additional air sampling, as well as sampling of media that would potentially be affected, was conducted in conjunction with these activities. The media sampled were rainwater, surface water, vegetation, and foodstuffs. The sample results, while above the 10-year average values for each media, had little impact to the offsite representative person dose, which was 0.27 mrem in 2018 and 0.25 mrem in 2017, as compared to the 100 mrem DOE dose standard. Chapter 6, *Radiological Dose Assessment,* discusses the dose calculation.

Tritium is released as part of routine SRS operations. The amount of tritium released from SRS fluctuates due to changes in SRS missions and in the annual production schedules of the tritium-processing facilities.

Table 5-2 SRS Radiological Atmospheric Releases for CY 2018 (measured in curies)

Release Type	Totals (in curies)
Tritium	3.93E+04
Krypton-85 (^{85}Kr)	1.03E+04
Noble Gases ($T_{1/2}$ < 40 days)[a,b]	0.00E+00
Short-Lived Fission and Activation Products ($T_{1/2}$ < 3 hr)[b,c]	2.00E-08
Fission and Activation Products ($T_{1/2}$ > 3 hr)[b,c]	6.65E-02
Total Radio-iodine	3.76E-03
Total Radio-strontium[d]	5.17E-03
Total Uranium	1.05E-04
Plutonium[e]	5.90E-04
Other Actinides	2.36E-04
Other	2.00E-02

[a] SRS did not release any radioactive noble gases in CY 2018, other than Kr-85 (considered in krypton-85)
[b] ICRP 107 Half-life data, *Nuclear Decay Data for Dosimetric Calculations (2008)*
[c] IAEA Common Fission and Activation Products
[d] Includes unidentified beta releases
[e] Includes unidentified alpha releases

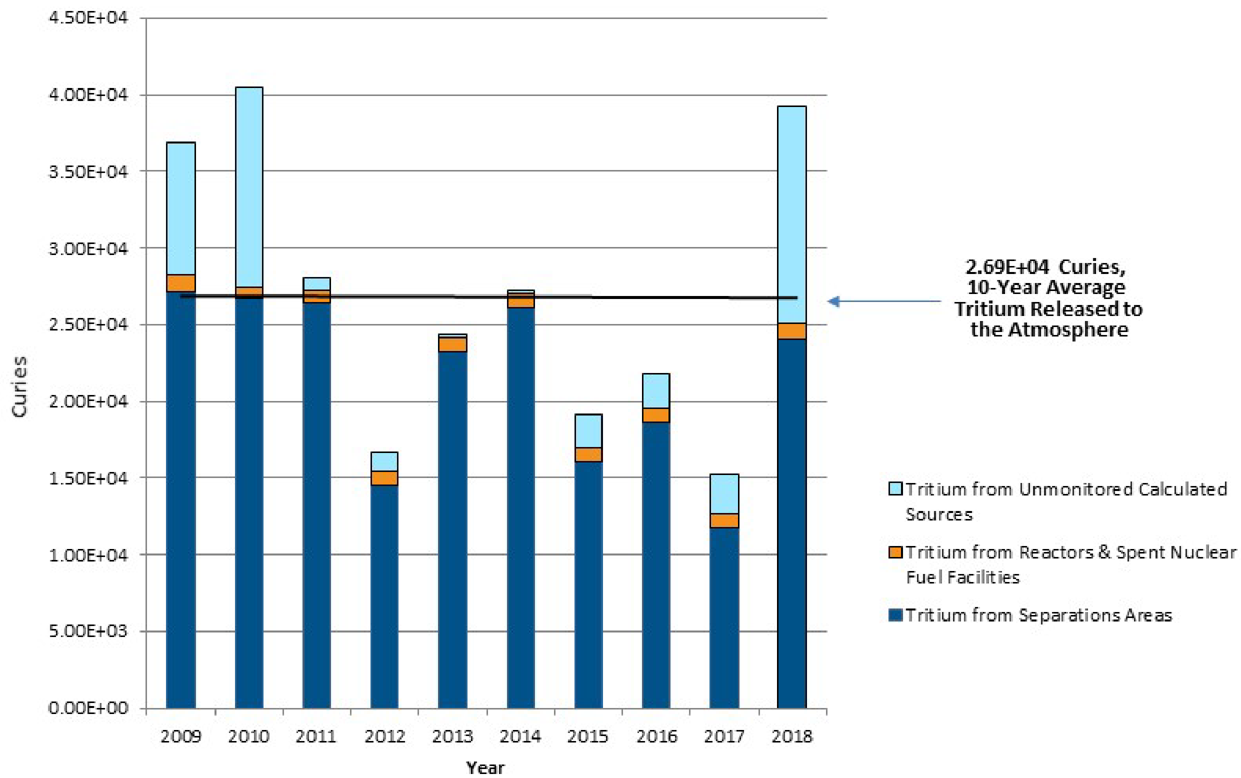


Figure 5-2 10-Year History of SRS Annual Tritium Releases to the Air

In 2018, tritium accounted for a majority of the total radiation SRS operations released to the air. Tritium-processing facilities are responsible for most of the SRS tritium releases. Tritium releases from the separations areas comprise the combination of releases from the tritium-processing facilities and the dissolution in H Canyon. Appendix Table D-1 and Figures 5-2 and 5-3 show the tritium releases from the separations areas, reactors and spent nuclear fuel facilities, and unmonitored sources.

Appendix Table D-2 summarizes the 2018 air effluent-derived concentration standards (DCSs) sum of the fractions. The raw data includes the specific radionuclide average concentrations and associated DOE DCSs for each monitored discharge point within the facilities. The raw data also contains calculated concentrations for tritium from the reactor areas and the tritium-processing facilities, and for krypton-85, carbon-14 and tritium from the H-Canyon facility during the dissolving process. These calculated concentrations are based on the annual releases in curies and the annual stack release volume.

Most SRS stacks and facilities release small quantities of radionuclides at concentrations below the DOE DCSs. As in 2017, F-Canyon stack had elevated analytical results in 2018. The elevated results led to a DCS exceedance with plutonium-239 as the primary contributing radionuclide. The DCS sum of fractions exceedance in 2018 is 3.19, which is down from 5.80 in 2017. SRS continues to monitor the decreasing levels of emissions. Dose limits from the levels are well below the 10 mrem EPA standard. SRS will continue to monitor and evaluate emissions to determine if the Site needs to take any action to reduce releases.

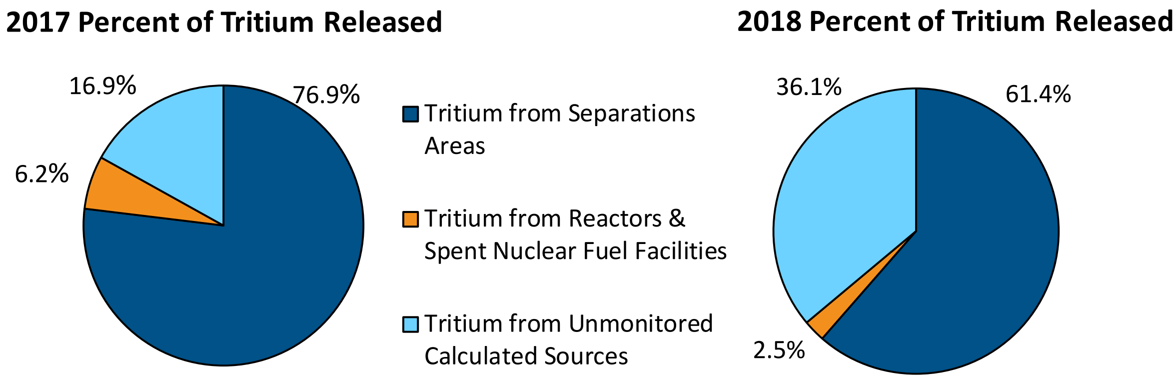


Figure 5-3 Percent of Tritium Released to the Air for 2017 and 2018

Because of the nature of several SRS facilities operations, tritium oxide releases exceeded DOE's tritium air DCS. However, DOE recognizes that tritium oxide, which is essentially water vapor, cannot be filtered or removed from the effluent. Therefore, DOE Order 458.1 specifically exempts tritium from Best Available Technology considerations but not from environmental As Low As Reasonably Achievable (ALARA) requirements, that Site procedures implement. The facilities that exceeded the tritium oxide air DCS are C Area, K Area, L Area, and the tritium-processing facilities. However, tritium releases are maintained as low as reasonably achievable to comply with DOE Order 458.1.

5.3.3 Air Surveillance

Beyond the operational facilities, SRS maintains a network of 14 air sampling stations (Figure 5-4 and Environmental Maps, *Radiological Air Surveillance Sampling Locations*) in and around SRS to monitor concentrations of tritium and radioactive particulate matter in the air and rainwater. The air contains radionuclides in various forms (gaseous, particulate matter, water vapor). Rainwater can redeposit particulate matter from the air onto the ground, and vegetation or soil can eventually absorb the radionuclides.

The sampling stations are at locations on and off the Site. Onsite stations are at the center of the Site and around the perimeter. Offsite sampling stations are 25 miles from the Site in population centers and at a control location, the U.S. Highway 301 Bridge at the Georgia Welcome Center in Screven County. SRS operations are not likely to affect the control location. SRS placed air-sampling stations near the Site boundary and beyond to be representative of the atmospheric distribution of airborne releases into the environment. Each air sampling station is set up to collect the media included in Table 5-3.

Table 5-3 Air Sampling Media

Media	Purpose	Radionuclides
Glass-Fiber Filter	Airborne particulate matter	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides, actinides, strontium-89,90
Charcoal Canister	Gaseous states of radioiodine	Iodine-129, gamma-emitting radionuclides
Silica Gel	Tritiated water vapor	Tritium
Rainwater	Tritium in rainwater	Tritium

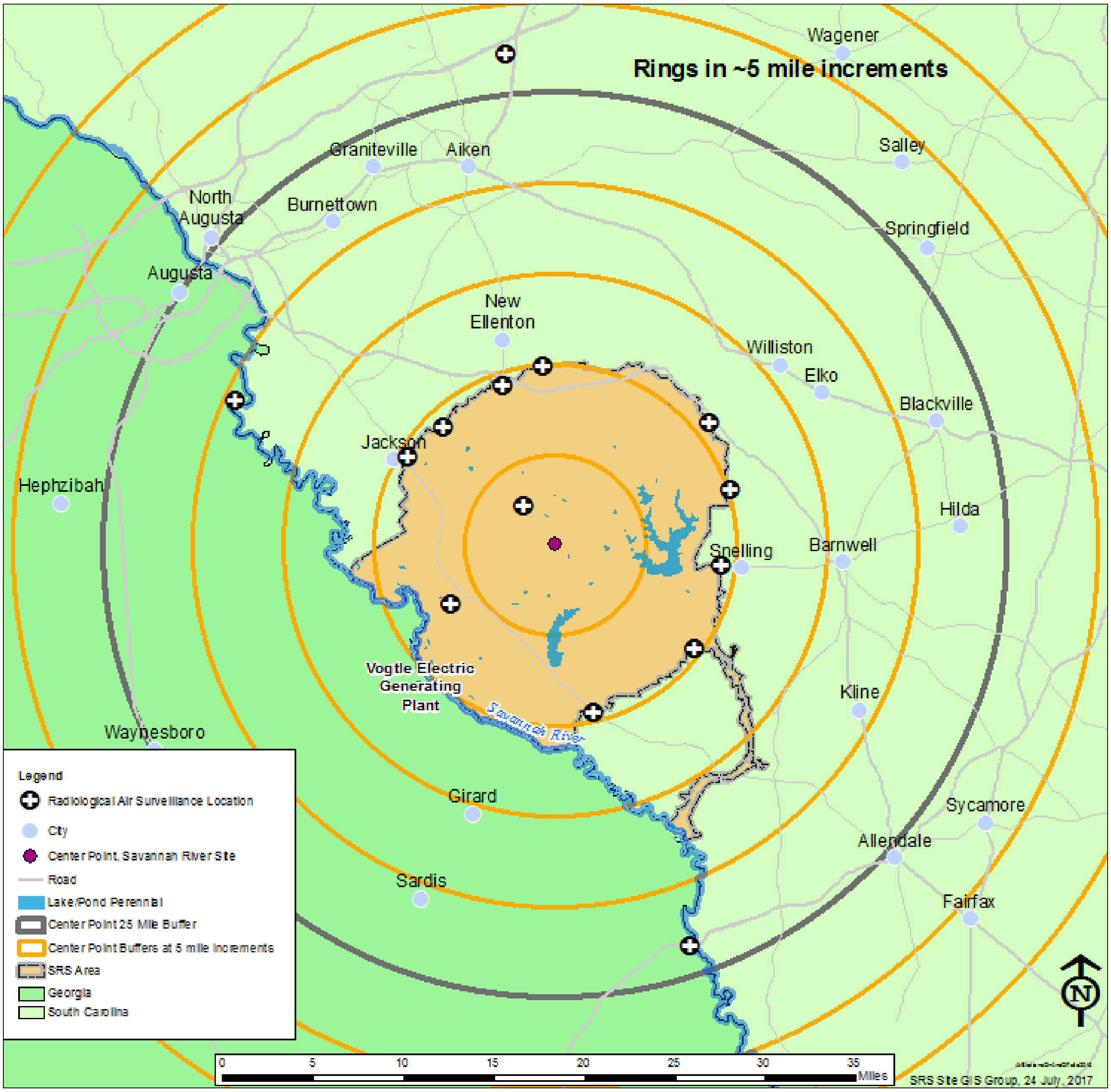


Figure 5-4 Air Sampling Locations Surrounding SRS up to 25 Miles

SRS selected the radionuclides presented in Table 5-3 based on known SRS airborne emission sources. Background levels in the air consist of naturally occurring radionuclides (for example, uranium, thorium, and radon) and radionuclides from global fallout due to historical nuclear weapons testing related to the Cold War (for example, strontium-89,90, and cesium-137 [a manmade gamma-emitting radionuclide]).

5.3.3.1 Results Summary

Due to releases at the F-Canyon stack, SRS analyzed existing samples taken from the nearby Burial Ground North air surveillance station for actinides. Results of the additional analyses showed a detectable amount of some actinides, but not at levels that provide any significant dose to the public.

All charcoal canisters analyzed annually for radioiodines and gamma-emitting radionuclides showed no detections of iodine-129 or cobalt-60. However, analyses detected low levels of cesium-137 in 12 out of 29 samples tested but did not detect cesium on the glass fiber filters associated with these samples. Air passes through the glass fiber filter before passing through the charcoal canisters. SRS investigated the cause of the detections and determined that specific lots of vendor-sealed charcoal canisters contain levels of cesium-137 consistent with those observed in canisters deployed in the field.

Technician Verifying Equipment Readings at Air Monitoring Station

For tritium in air (water vapor) and tritium in rainwater, Appendix Tables D-3 and D-4 summarize results and the comparison to the background control location at the U.S. Highway 301 Bridge. The 2018 results for tritium in air showed detectable levels in 96 of the 378 samples (25%), as compared to 2017 results with detectable levels in 11 % of the samples.

The 2018 results for tritium in rainwater showed detectable levels in 27 of the 180 rainwater samples (15%), as compared to 2017 results with detectable levels in 8 % of the samples. As in previous years, the 2018 values were highest near the center of SRS and decreased with distance from the Site.

Tritium results for both air and rainwater were above the 5-year average due to the SRS maintenance activities described in section 5.3.2.1. However, these results had little impact to the offsite representative person dose, which was 0.27 mrem in 2018, as compared to the 100 mrem DOE dose standard. Chapter 6, *Radiological Dose Assessment,* discusses the dose calculation.

The results for radionuclides measured from the charcoal canisters and the glass-fiber filters were within the trends levels for the previous 10 years. All offsite location results were near the levels observed at the control location at the U.S. Highway 301 bridge.

5.3.4 Ambient Gamma Surveillance

Since 1965, SRS has been monitoring ambient (surrounding) environmental gamma exposure rates with thermoluminescent dosimeters (TLDs), which are passive devices that measure the exposure from ionizing radiation. The Site uses data from the TLDs to determine the impact of Site operations on the gamma exposure to the public and the environment and to evaluate trends in exposure levels. Other uses include support of routine and emergency response dose calculations.

TLDs are Placed in the Environment for Three Months to Measure Environmental Gamma Exposure Rates

An extensive TLD network in and around SRS monitors external ambient gamma exposure rates (Environmental Maps, SRS Thermoluminescent Dosimeter [TLD] Sampling Locations). The SRS ambient gamma radiation-monitoring program has four subprograms: 1) Site perimeter stations, 2) population centers, 3) air surveillance stations, and 4) onsite perimeter stations co-located with Georgia Power's Vogtle Electric Generating Plant's stations. SRS conducts most gamma exposure monitoring onsite and at the SRS perimeter.

SRS monitors offsite in population centers located near the Site boundary, with limited monitoring beyond this distance at the three 25-mile air surveillance stations.

5.3.4.1 Ambient Gamma Results Summary

Appendix Table D-5 summarizes the gamma results. Ambient gamma exposure rates at all TLD monitoring locations show some variation based on location and natural levels of background radiation in the environment. In 2018, ambient gamma exposure rates onsite varied between 84.5 mR/yr at location NRC2 (onsite southwest) and 159 mR/yr at the BGN (onsite center of the Site). Rates at population centers ranged from 114 mR/yr at the Jackson, South Carolina, location to 149 mR/yr at the Girard, Georgia, location.

Consistent with the previous five-year trends, ambient gamma results indicate that no significant difference in average annual dose rates exists between monitoring networks. Ambient dose rates in population centers are slightly elevated compared to the other monitoring networks, as expected, because materials present in buildings and roadways contribute to the natural background radiation.

5.3.5 Soil Surveillance

SRS conducts soil surveillance to provide the following:

- Data for long-term trending of radioactivity deposited from atmospheric fallout (both wet and dry deposition)
- Information on the concentrations of radioactive materials in the environment

In 2018, SRS collected soil samples from 5 onsite locations, 10 Site perimeter locations, and 7 offsite locations (Environmental Maps, *Radiological Soil Sampling Locations*). Radionuclide concentrations in soil vary greatly among locations because of differences in the patterns, retention, and transport of rainfall in different types of soils. Therefore, a direct comparison of year-to-year data could be misleading. However, SRS evaluates the data for long-term trends.

Sampling technicians use hand augers, shovels, or other similar devices to collect soil to a depth of 6 inches. The technicians mix the soil samples to ensure they are homogeneous when the laboratory analyzes them for gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and actinides (including neptunium).

5.3.5.1 Soil Results Summary

Technician Collecting Soil Sample

In 2018, SRS detected radionuclides in soil samples from all 22 sampling locations. Analyses detect uranium isotopes (U-234, U-235, and U-238) in the soil samples each year. Uranium is naturally occurring in soil and expected to be present in the environment. The concentration range for naturally occurring uranium in soil is typically about 1-5 pCi/g, with an average concentration of 2 pCi/g in soils in the United States. Uranium results both onsite and at the Site perimeter were below the levels observed at the control location (Highway 301) and are consistent with naturally occurring uranium levels. These levels are within the typical range for soils and are at or below the average concentration in U.S. soils. Many factors affect the uranium concentration in soil over time. These include the pH of the soil, the type of soil, and deposits from the air transferred through rainfall. Organic matter and clay minerals provide exchange sites in soil, which can increase the uranium sorption.

The concentrations of other radionuclides at these locations are consistent with historical results, with maximum cesium-137 concentrations of 27.3 pCi/g at the Creek Plantation Trail 1 (1805 ft) location and 0.152 pCi/g at the control location (Highway 301). Appendix Table D-6 summarizes the results.

5.3.6 Grassy Vegetation Surveillance

SRS collects and analyzes grassy vegetation samples annually at locations onsite and offsite (Environmental Maps, *Radiological Vegetation Sampling Locations*). This information complements the soil and sediment sample results that the Site uses to evaluate the accumulation of radionuclides in the environment and to validate SRS dose models. Vegetation can receive radioactive contamination either externally, when radioactive particles from the air settle on the plant, or internally, when the plant absorbs contaminants in soil and water through its roots. The Site prefers Bermuda grass for surveillance because of its importance as a pasture grass for dairy herds. SRS collects vegetation samples from the following:

Technicians Collecting Grassy Vegetation Sample

- All air sampling locations
- When applicable, locations where SRS expects soil radionuclide concentrations to be higher than normal background levels and
- When applicable, locations receiving potentially contaminated water

Vegetation sample analyses consist of tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, technetium-99, and actinides (including neptunium).

5.3.6.1 Grassy Vegetation Results Summary

SRS collected all annual samples plus additional samples, as discussed in section 5.3.2.1. SRS detected various radionuclides in the grassy vegetation samples collected during 2018 at all air sampling locations (1 onsite, 10 at the perimeter, and 3 offsite). Appendix Table D-7 summarizes the results. Results for all radionuclides are within the trends of the previous 10 years for all locations except for tritium at the East Talatha, Aiken Airport, and Talatha Gate locations. The sample results from these three locations, while above the 10-year average value for each location, had little impact to the offsite representative person dose, which was 0.27 mrem in 2018, as compared to the 100 mrem DOE dose standard. Chapter 6, *Radiological Dose Assessment,* discusses the dose calculation.

5.3.7 Terrestrial Food Surveillance

Pecan Sample to be Prepared for Laboratory Analysis

SRS personnel collect terrestrial food products grown and consumed in the communities surrounding the Site, as well as fish and shellfish caught from the Savannah River. They analyze these samples for radionuclides. The results reveal whether radionuclides are present in the environment. Tritium releases from SRS and non-SRS sources are the primary contributors to tritium in food products.

Agricultural products, livestock, and game animals that humans eat may contain radionuclides. Livestock and game animals may be exposed if the radionuclides are in the air. Radionuclides in the air can settle on grass, which animals can eat. If humans consume the meat of these exposed animals, they become exposed to radiation. Dairy cows are also livestock of concern to SRS because they produce milk that humans consume, leading to a potential radiation exposure. SRS samples milk, meat, fruit, nuts, and vegetables based on the potential to transport radionuclides to humans through the food chain.

Local gardens, farms, and dairies are the source of the terrestrial food products. SRS collects beef, watermelon, and greens annually. Site personnel also collect two specific crops a year, rotating through a variety of vegetables, grains, and nuts. Once a quarter, the Site collects milk samples. In 2018, SRS began sampling goat milk, in addition to cow milk. Section 8.4, *Environmental Monitoring Program QA Activities,* provides more information. Food product samples come from each of the four quadrants surrounding SRS, which extend up to 10 miles from the Site boundary. Additionally, SRS collects a control sample to the southeast at a distance between 10 miles and 25 miles from the Site boundary.

Laboratory analysis of the food samples include gamma-emitting radionuclides, tritium, strontium-89,90, technetium-99, gross alpha, gross beta, and actinides (including neptunium). Laboratory analysis of the dairy samples include gamma-emitting radionuclides, tritium, and strontium-89,90.

5.3.7.1 Terrestrial Food Results Summary

In 2018, SRS sampled the milk and the following terrestrial foodstuffs: greens, watermelons, beef, pecans, and corn. SRS collected all food types from all four quadrants and the control area. Appendix Tables D-8 and D-9 summarize the foodstuffs and dairy results. The analytical results of the routine terrestrial foodstuffs and milk are consistent with 10-year trends. Results for most foodstuffs (85% for terrestrial foodstuffs and 92% for dairy) did not detect radionuclides. The tritium results from the samples collected to evaluate environmental impacts of the maintenance activities in the Tritium Facilities, as discussed in section 5.3.2.1, while above the 10-year average value for tritium in milk, had little impact to the offsite representative person dose, which was 0.27 mrem in 2018, as compared to the 100 mrem DOE dose standard. Chapter 6, *Radiological Dose Assessment* discusses the dose calculation.

5.4 WATER PATHWAY

The media presented in this section support the water pathway dose assessment discussed in Chapter 6, *Radiological Dose Assessment.* The Environmental Maps, *Stream Systems,* identifies SRS stream systems included in the pathway.

5.4.1 Liquid Effluents Monitoring Program

SRS routinely samples, analyzes for radionuclides, and monitors flow at each liquid effluent discharge point that releases, or has potential to release, radioactive materials. Figure 5-5 shows the effluent sampling points near SRS facilities.

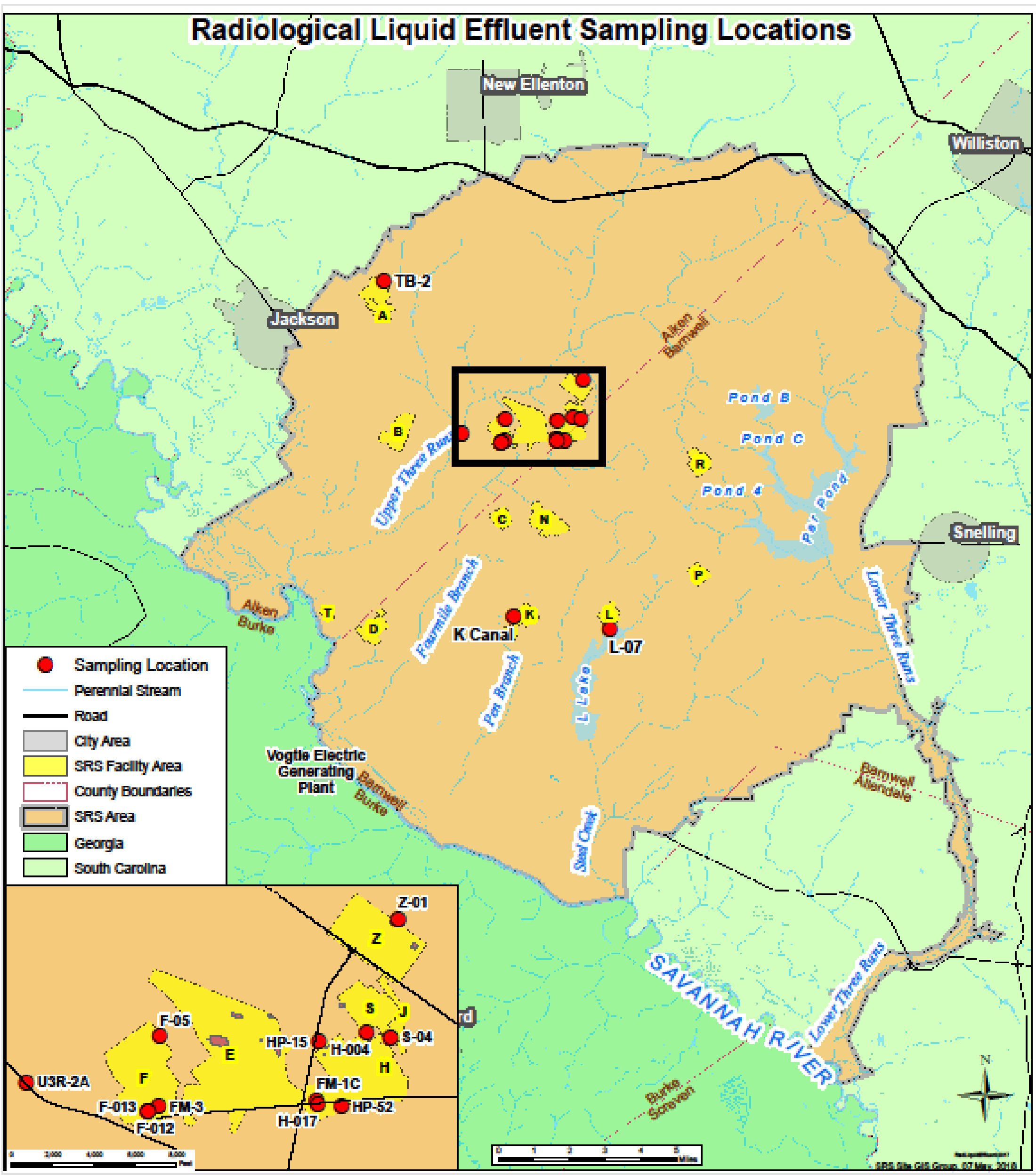


Figure 5-5 Radiological Liquid Effluent Sampling Locations

5.4.1.1 Liquid Effluent Results Summary

Appendix Table D-10 provides SRS liquid radionuclide releases for 2018 to include direct releases plus the shallow groundwater migration of radioactivity from SRS seepage basins and the Solid Waste Disposal Facility (SWDF). Table 5-4 summarizes the liquid effluent releases of radioactive materials. The direct releases (including migration) of tritium increased by 7.5% (from 494 Ci in 2017 to 531 Ci).

The total amount of tritium released directly from process areas to SRS streams (not including shallow groundwater migration) during 2018 was 91.9 Ci. This is an increase from the 64.9 Ci released in 2017. Figure 5-6 presents the tritium released by potential source area and shows that the total direct release of tritium has had a general decreasing trend over the last 10 years.

The DCS sum of the fractions for all locations was less than 1.00. Appendix Table D-11 summarizes the 2018 liquid effluent sum of the fractions and radionuclides monitored for each outfall or facility.

Table 5-4 SRS Radiological Liquid Effluent Releases of Radioactive Material for CY 2018 (measured in curies)

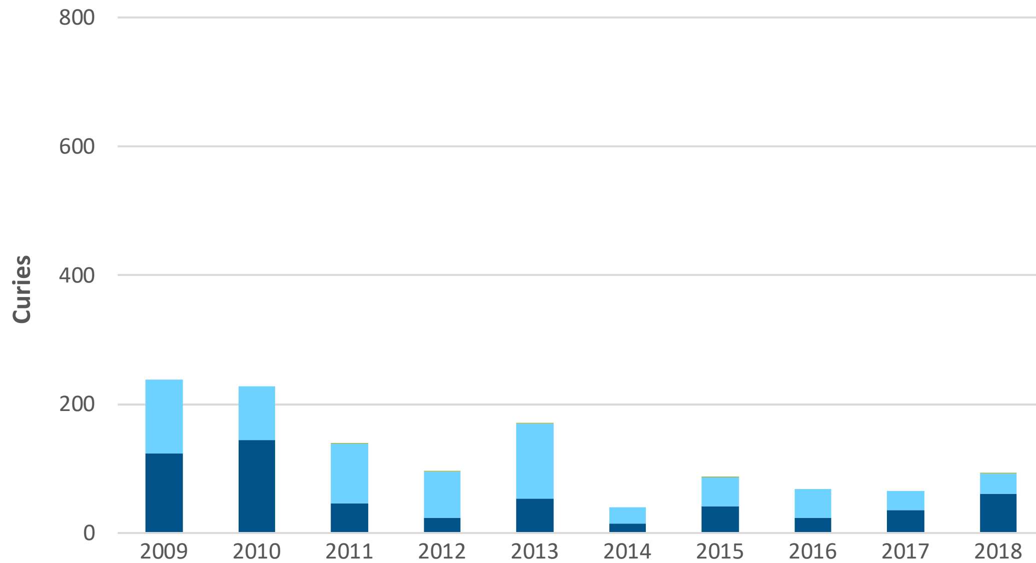
Release Type	Totals (in Curies)
Tritium	5.31E+02
Fission and Activation Products ($T_{1/2}$ > 3 hr)[a,b]	3.71E-02
Total Radioiodine[c]	1.66E-02
Total Radio-strontium[c]	7.69E-02
Total Uranium	6.23E-02
Plutonium[d]	3.27E-03
Other Actinides	2.06E-04
Other	1.03E-03

[a] International Commission on Radiological Protection (ICRP) 107 Half-life data, *Nuclear Decay Data for Dosimetric Calculations (2008)*

[b] International Atomic Energy Agency (IAEA) Common Fission and Activation Products

[d] Includes unidentified beta releases

[e] Includes unidentified alpha releases



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SRNL	0	0	0.28	0.21	0.12	0	0	0	0.0	0.05
Reactor Areas	114	83	91.5	71.6	116.8	26.1	43.8	45.2	29.9	31.7
Separations Areas	124	144	46.5	24.1	53.3	14.5	41.8	22.9	35	60.1

Notes:

1. The SRNL contribution to direct releases is minimal; thus, it is not visible on this figure.
2. Tritium releases from the separations areas comprise the combination of releases from the separations, waste management, and tritium processing facilities.

Figure 5-6 10-Year History of Direct Releases of Tritium to SRS Streams

5.4.2 Stormwater Basin Surveillance

SRS monitors the accumulated stormwater in the Site's stormwater basins (Figure 5-7) for gross alpha, gross beta, tritium, strontium, technetium, gamma-emitting radionuclides, and carbon. Additional analytes may include actinides (including neptunium). With no active processes discharging to SRS's stormwater basins, the accumulations in these basins are mainly stormwater runoff. SRS selects the specific radionuclides for monitoring based on the operational history of each basin. The E-Area basins receive stormwater from the SWDF, E-Area Vault, and stormwater from the controlled clean-soil pit on the east side of E Area. F-Area Pond 400 receives stormwater from F Area and the Mixed Oxide Fuel Fabrication Facility. Z-Area Stormwater Basin receives stormwater from Z Area (Saltstone processing and disposal facilities). Stormwater basins release to monitored outfalls during heavy rainfall.

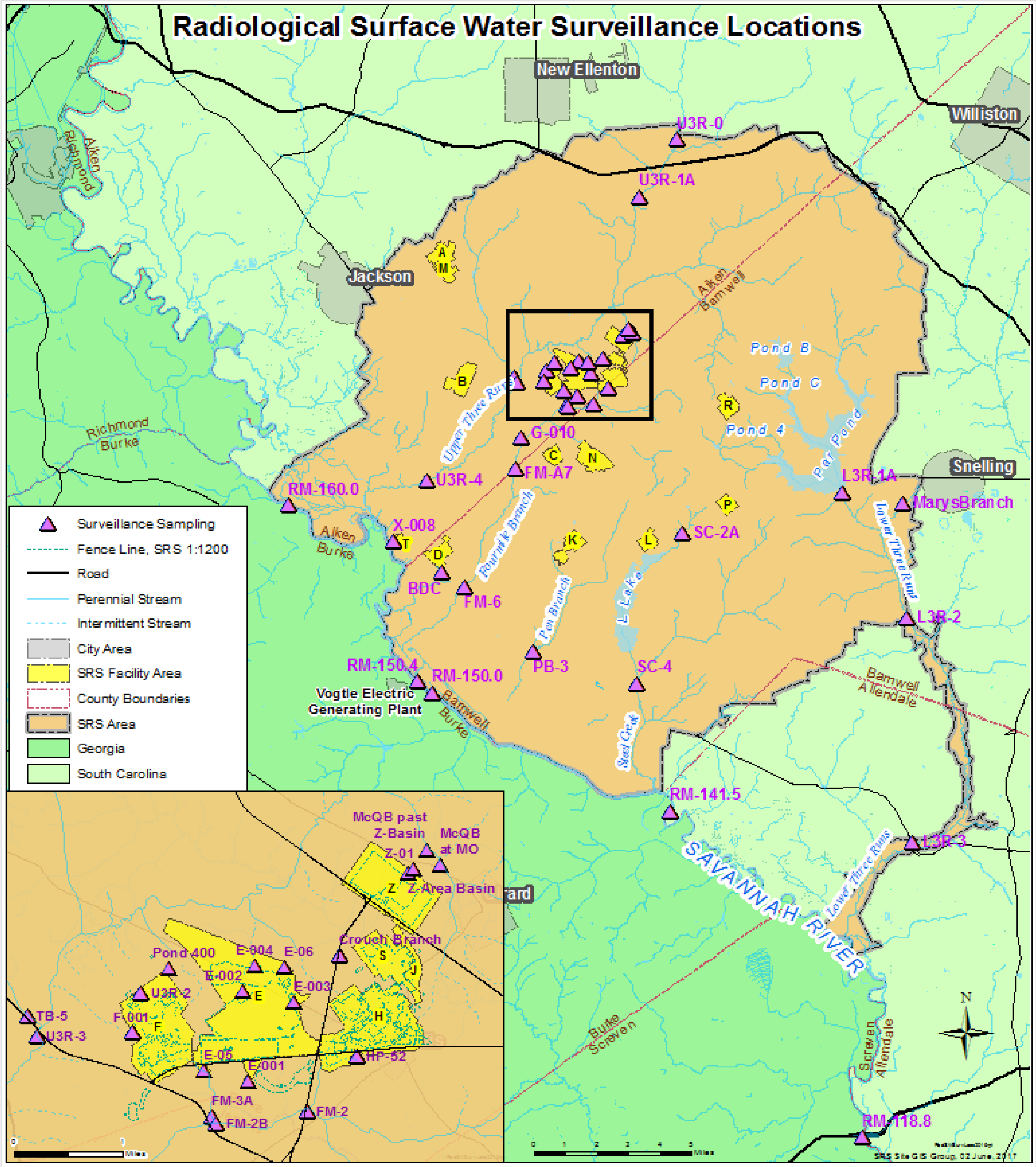


Figure 5-7 Radiological Surface Water Sampling Locations

5.4.2.1 Stormwater Basin Results Summary

In 2018, SRS sampled at five E-Area basins, as well as at the Z-Area Stormwater Basin and F-Area Pond 400. Table 5-5 summarizes gross alpha, beta, and tritium results for stormwater basins, which SRS sampled in the following locations: E-001, E-002, E-003, E-004, E-005, Pond 400, and Z Basin. E-003 Basin had the highest tritium concentration (59,500 pCi/L). The tritium results from the samples collected to evaluate environmental impacts of the SRS maintenance activities as discussed in section 5.3.2.1, while higher than the previous five years, had little impact to the offsite representative person dose, which was 0.27 mrem, in 2018 as compared to the 100 mrem DOE dose standard. Chapter 6, *Radiological Dose Assessment,* discusses the dose calculation.

Table 5-5 Radionuclide Concentrations Summary for Stormwater Basins (pCi/L) for CY 2018

Basin Location	Average Gross Alpha	Average Gross Beta	Average Tritium	Maximum Tritium
E-001	0.218	3.14	6,660	33,200
E-002	0.360	3.75	12,600	35,400
E-003	0.754	2.99	12,000	59,500
E-004	0.418	2.19	9,480	31,100
E-005	0.992	6.00	4,520	7,780
Pond 400	0.635	3.95	503	1,620
Z-Basin	0.294	194	2,830	19,900

5.4.3 SRS Stream Sampling and Monitoring

SRS continuously samples SRS streams downstream of several process areas to detect and quantify levels of radioactivity that effluents and shallow groundwater migration transport to the Savannah River. The five primary streams that deposit into the Savannah River are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. SRS monitors and quantifies radioactivity migration from SRS seepage basins and the SWDF as part of its stream surveillance program. Seepage basins include the General Separations Area (F and H Area) Seepage Basins and the K-Area Seepage Basin, which are closed. SRS closed the F-Area and H-Area Seepage Basins in 1991, and the K-Area Seepage Basin in 2002. Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF in E Area continues to migrate through the groundwater and enter Fourmile Branch (also known as Four Mile Creek) and Upper Three Runs. Groundwater migration from the F-Area Seepage Basins enters Fourmile Branch, where there are three monitoring locations (FM-3A, FM-2B, and FM-A7) along the stream. Groundwater migration from the H-Area Seepage Basins enters Fourmile Branch, where two monitoring stations (FM-2B and FM 3-A) are located, and from SWDF, the location of the FM 3-A monitoring station. Groundwater from K-Area Seepage Basin migrates into Pen Branch.

Field Personnel Measure Stream Flow Using River Surveyor

Figure 5-7 displays the radiological surface water sampling locations. The sampling frequency and types of analyses depend on the upstream discharges and groundwater migration history of radionuclides.

5.4.3.1 SRS Stream Results Summary

Table 5-6 presents the average 2018 concentrations of gross alpha, gross beta, and tritium, along with the maximum concentrations of tritium in SRS streams. These stream locations represent the last monitoring location for the respective tributary before discharging into the Savannah River. SRS found detectable concentrations of tritium at all major stream locations. The 10-year trend for the average tritium levels in the streams shows a decrease, which is due to decreases in Site releases and the natural decay of tritium. Figure 5-8 indicates that average tritium levels in Fourmile Branch are trending closer to the EPA drinking water standard of 20 pCi/mL (20,000 pCi/L), although onsite streams are not a direct source of drinking water.

Table 5-6 Radionuclide Concentrations in the Primary SRS Streams by Location for CY 2018

Location	Average Alpha (pCi/L)	Average Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
Onsite Stream Locations				
Lower Three Runs (L3R-3)	1.08	1.95	396	800
Steel Creek (SC-4)	0.325	1.13	1,490	2090
Pen Branch (PB-3)	0.505	1.01	10,900	15,100
Fourmile Branch (FM-6)	0.873	4.02	27,300	32,200
Upper Three Runs (U3R-4)	4.76	2.77	1,490	5,220
Onsite Control Locations (for comparison)				
Upper Three Runs (U3R-0)	3.87	2.30	107	473

The surveillance program uses the EPA standard as a benchmark for comparing stream surface water results. Tritium levels are higher in Fourmile Branch compared to the other streams due to shallow groundwater migration from the historical seepage basins and SWDF. SRS has taken active measures to reduce this migration. Section 7.3.3, *Remediating SRS Groundwater,* presents additional information on the groundwater remediation efforts to reduce tritium to Fourmile Branch.

Figure 5-9 presents a graphical representation of releases of tritium via migration to Site streams from 2009 through 2018. As seen in the figure, migration releases of tritium generally have declined over the past 10 years, with year-to-year variability caused mainly by the amount of annual rainfall. During 2018, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 439 Ci, compared to 429 Ci in 2017, which represents a 2.5% increase. The 10-year trend displays a decrease in tritium migration.

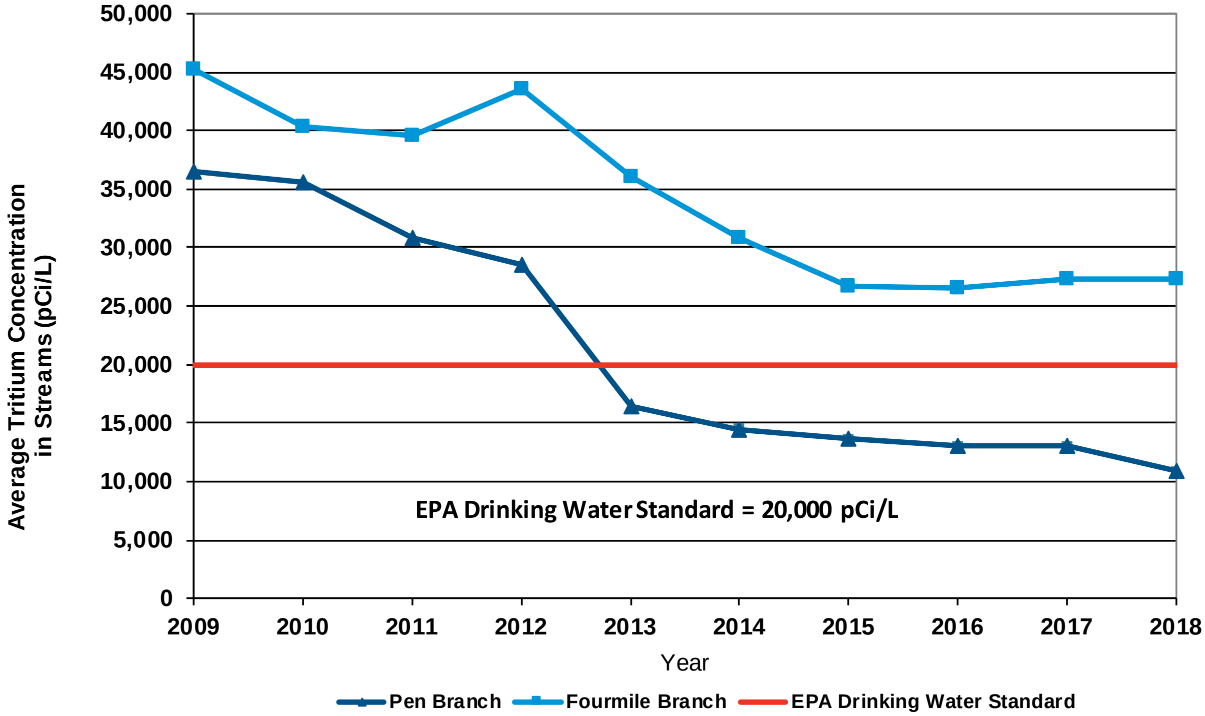


Figure 5-8 10-Year Trend of Tritium in Pen Branch and Fourmile Branch (pCi/L)

Of the 439 Ci of tritium migrating into SRS streams, 228 Ci (52%) was measured in Fourmile Branch. Migration releases of other radionuclides vary from year-to-year but have remained below 0.4 Ci the past 10 years. Sampling in Pen Branch measures the tritium migration from the K-Area Seepage Basin and the percolation field below the K-Area Retention Basin. An estimated 143 Ci migrated in 2018, which represents a 3.6% increase compared to 138 Ci in 2017. Stream transport also accounts for tritium migration releases from C-Area, L-Area, and P-Area Disassembly Basins (see Section 5.4.5, *Tritium Transport in Streams and Savannah River Surveillance,* in this chapter).

SRS measures gross alpha concentrations in Site streams. If the results for any of the major stream locations, shown in Table 5-6, are greater than the EPA screening level of 15 pCi/L gross alpha, then SRS measures for alpha-specific isotopes, such as the actinides. In addition to the monthly samples collected for tritium, gross alpha, gross beta, and gamma analyses, SRS collects samples annually for alpha-specific actinides analyses to provide a more comprehensive suite of radionuclides for annual shallow groundwater migration reporting. All radionuclide results for 2018 showed no elevated levels and are consistent with historical measurements.

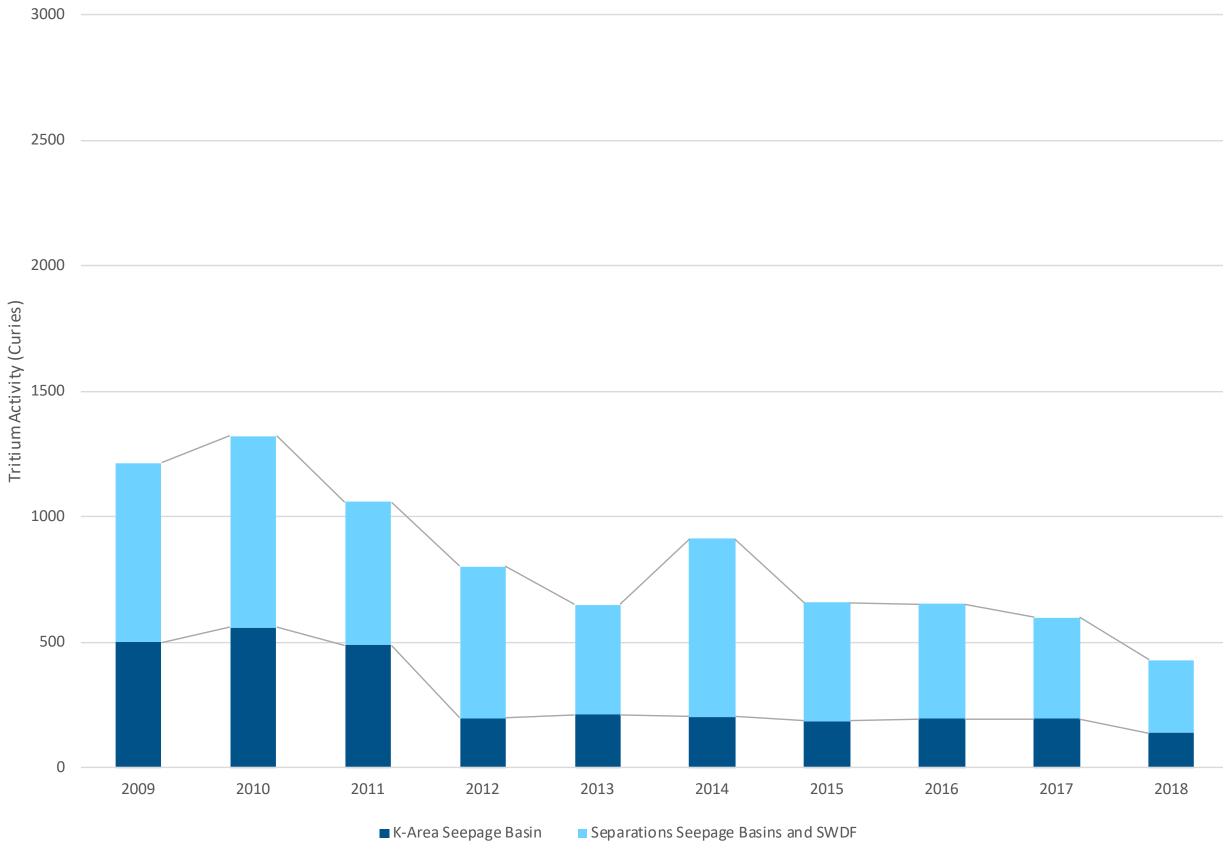


Figure 5-9 Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

5.4.4 Savannah River Sampling and Monitoring

SRS samples continuously along the Savannah River at locations above and below SRS streams, including at a location where liquid discharges from Vogtle Electric Generating Plant (VEGP) enter the river.

Five locations (Figure 5-7) along the river continued to serve as environmental surveillance points in 2018. SRS collects samples at these river locations and analyzes them for gross alpha, gross beta, tritium, strontium, technetium, actinides, and gamma-emitting radionuclides.

5.4.4.1 Savannah River Results Summary

Table 5-7 lists the average 2018 concentrations of gross alpha, gross beta, and tritium, and the maximum 2018 concentrations of tritium at river locations. The tritium concentration levels are well below the EPA drinking water standard of 20 pCi/mL (20,000 pCi/L).

Table 5-7 Radionuclide Concentrations in the Savannah River for CY 2018

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
CONTROL (RM-160 and RM-161)	0.121	1.98	154	449
RM-150.4 (VEGP)	0.154	2.03	828	7840
RM-150	0.146	1.98	307	632
RM-141.5	0.246	2.08	495	2970
RM-118.8	0.160	1.97	421	1600

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS, VEGP, and Barnwell Low-Level Disposal Facility (BLLDF) tritium estimates based on concentration results at Savannah River RM 141.5 and average flow rates at RM 118.8 were 2,500 Ci in 2018 compared to 2,893 Ci in 2017. This decrease was due to decreased releases from VEGP. Total releases from VEGP were 1,314 Ci in 2018 compared to 2,337 Ci in 2017, which represents a decrease of greater than 43%. In addition to the weekly samples collected for tritium, gross alpha, gross beta, and gamma analyses, SRS collects samples annually for strontium-89,90, technetium-99, and actinides analyses to provide a more comprehensive suite of radionuclides. Average radionuclide concentrations are consistent with the results from the previous 10 years.

5.4.5 Tritium Transport in Streams and Savannah River Surveillance

Due to the mobility of tritium in water and the amount released over the course of more than 60 years of SRS operations, the Site monitors and compares the amount of tritium measured at various onsite stream sampling locations to that found at the Savannah River sampling locations. The comparison uses the following methods of calculation:

- Direct releases measured at the source—Total direct tritium releases, including releases from facility effluent discharges and measured shallow groundwater migration of tritium from SRS seepage basins and SWDF
- Stream transport, which measures the amount of tritium leaving the Site—Tritium transport in SRS streams, measured at the last sampling point before entry into the Savannah River
- River transport—Tritium transport in the Savannah River, measured downriver of SRS (near RM 141.5) after subtracting any measured contribution above SRS

SRS bases its methods for estimating releases on environmental data reporting guidance described in *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015). General agreement between the three calculation methods of annual tritium transport—measurements at the source plus any measured migration, stream transport, and river transport—validates both that SRS is sampling at the appropriate locations and the accuracy of analytical results.

5.4.5.1 Tritium Transport in Streams and Savannah River Results Summary

In 2018, tritium levels in streams showed an increase, while river transport showed a decrease, specifically as described below:

- The direct releases (including migration) of tritium increased by 7.5% (from 494 Ci in 2017 to 531 Ci).
- The stream transport of tritium increased by 18% (from 563 Ci in 2017 to 666 Ci).
- The river transport of tritium decreased by greater than 13% (from 2,893 Ci in 2017 to 2,500 Ci). VEGP, BLLDF, and SRS contributed to these values. 36 Ci is attributed to the BLLDF. 1,314 Ci is attributed to VEGP.

SRS tritium transport data from 1960–2018 (Figure 5-10), shows the history of direct releases, stream transport, and river transports. The general trend over time is attributable to the following:

- Variations in tritium production and processing at SRS
- Implementing effluent controls beginning in the early 1960s
- SRS tritium inventory continuing to deplete and decay

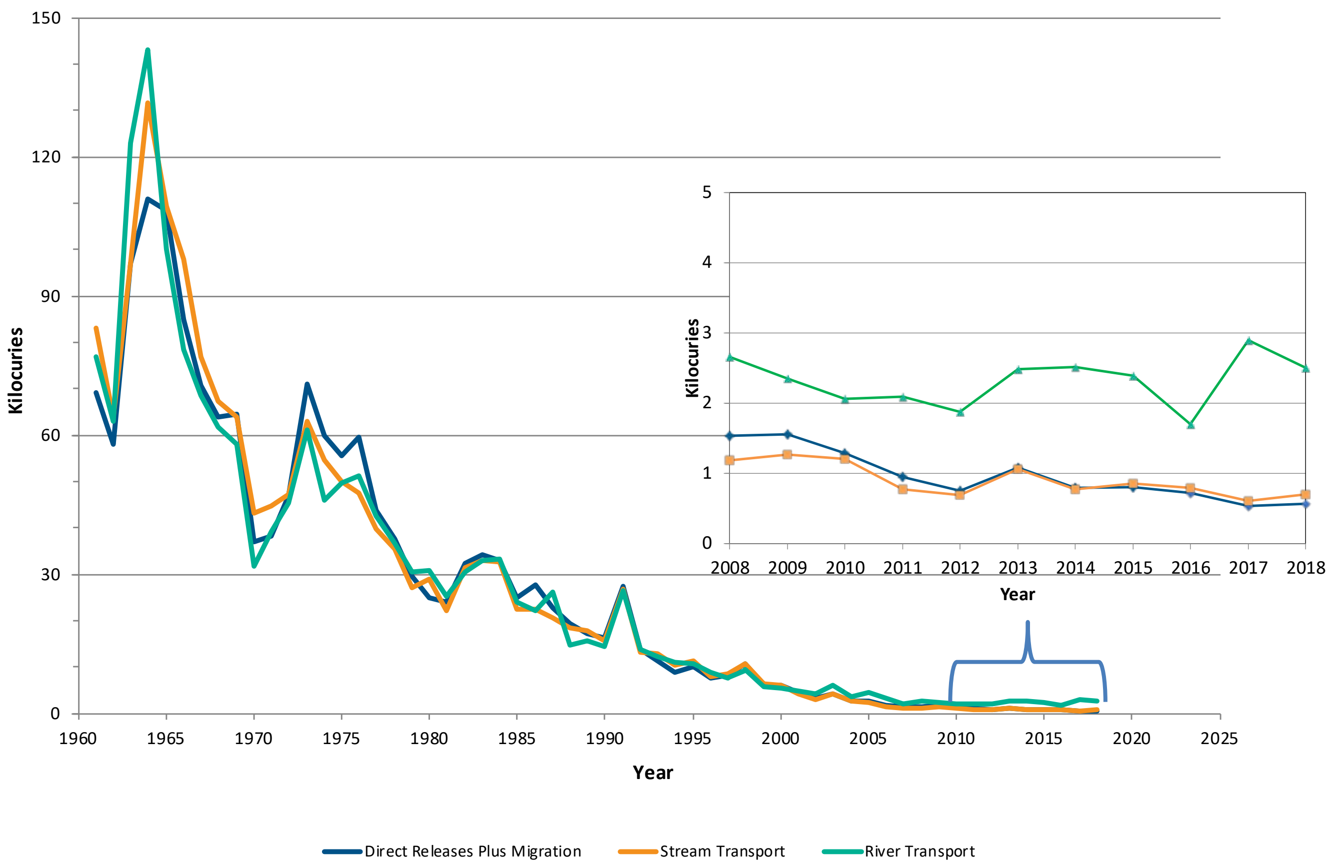


Figure 5-10 SRS Tritium Transport Summary

Within the past 10 years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the BLLDF, which Energy*Solutions*, LLC operates. The tritium continues to enter the SRS stream system at Marys Branch, which deposits into Lower Three Runs. The facility is privately owned and adjacent to SRS. The tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. In 2014, SRS started monitoring at Marys Branch, which is near BLLDF, to account for the tritium BLLDF contributes. SRS estimated the amount of tritium from BLLDF during 2018 to be 36 Ci, which SRS direct release or stream transport totals did not include.

For compliance dose calculations, the Site uses whichever value is higher: SRS direct releases or the stream transport measurements (see Chapter 6, *Radiological Dose Assessment*).

5.4.6 Settleable Solids Surveillance

Settleable solids are solids in water that are heavy enough to sink to the bottom of the collection container. SRS evaluates settleable solids in water, in conjunction with routine sediment monitoring, to determine whether a long-term buildup of radioactive materials occurs in stream systems.

The DOE limits for the radioactivity levels in settleable solids are 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides. Accurately measuring radioactivity levels in settleable solids is impractical in water samples with low total suspended solids (TSS). In 1995, DOE interpreted the radioactivity levels in settleable solids requirement. The interpretation indicated that TSS levels below 40 parts per million comply with the DOE limits.

To determine compliance with these limits, SRS uses TSS results gathered from radiological liquid effluent locations, National Pollutant Discharge Elimination System (NPDES) outfalls co-located at or near radiological liquid effluent locations, and water quality surveillance locations. If TSS results are regularly greater than 40 parts per million, SRS will investigate the cause and take additional water or sediment samples, or both, if necessary to ensure compliance.

5.4.6.1 Settleable Solids Results Summary

In 2018, all TSS averages were below the 40 parts per million limit. The TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

5.4.7 Sediment Sampling

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed. Year-to-year differences may be evident because sediment continuously moves and deposits at different locations in the stream and riverbeds (or because of slight variations in sampling locations), but the data obtained can be used to observe long-term environmental trends.

In 2018, SRS collected sediment samples at 11 Savannah River locations, 8 basin or pond locations, and 21 onsite streams or swamp discharge locations (Environmental Maps, *Radiological Sediment Sampling Locations*).

5.4.7.1 Sediment Results Summary

Appendix Table D-12 shows the maximum of each radionuclide compared to the applicable SRS control location. The Z-Area Stormwater Basin, a posted soil contamination area, had the maximum cesium-137 concentration of 2,640 pCi/g. Soil contamination areas at SRS are locations where the contamination levels exceed 150 pCi/g for beta and gamma radionuclides. The lowest levels of cesium-137 in river, stream, and basin sediments were below detection. Table 5-8 shows the maximum sediment concentrations.

Table 5-8 Maximum Cesium-137 Concentration in Sediments Collected in 2018

Location	Maximum Location	Maximum Concentration (pCi/g)
Savannah River Sediment	Steel Creek River Mouth	9.63E-01
SRS Stream Sediment	R-Area (Downstream of R-1)	1.51E+01
SRS Basin Sediment	Z Basin	2.64E+03

The levels in SRS streams and the Savannah River show a decreasing trend, which is due to decreases in Site releases and the natural decay of radionuclides. The levels in the basins show no increases, with concentrations being within historical trends. Results indicate the radioactive materials from effluent release points are not building up in the sediment at the sampling locations.

5.4.8 Drinking Water Monitoring

SRS collects drinking water samples from 10 locations at SRS and at 2 water treatment facilities that use water from the Savannah River as a source of drinking water (Environmental Maps, *Domestic Water Systems*).

Onsite drinking water sampling consists of samples from the large treatment plant in A Area and samples at four wells and five small systems.

SRS monitors potable water at offsite treatment facilities to ensure that SRS operations do not adversely affect the water supply and to assure that drinking water does not exceed EPA drinking water standards for radionuclides. SRS collects samples offsite from the following two South Carolina locations (Figure 5-11):

- Beaufort-Jasper Water and Sewer Authority's (BJWSA) Purrysburg Water Treatment Plant (WTP)
- North Augusta WTP

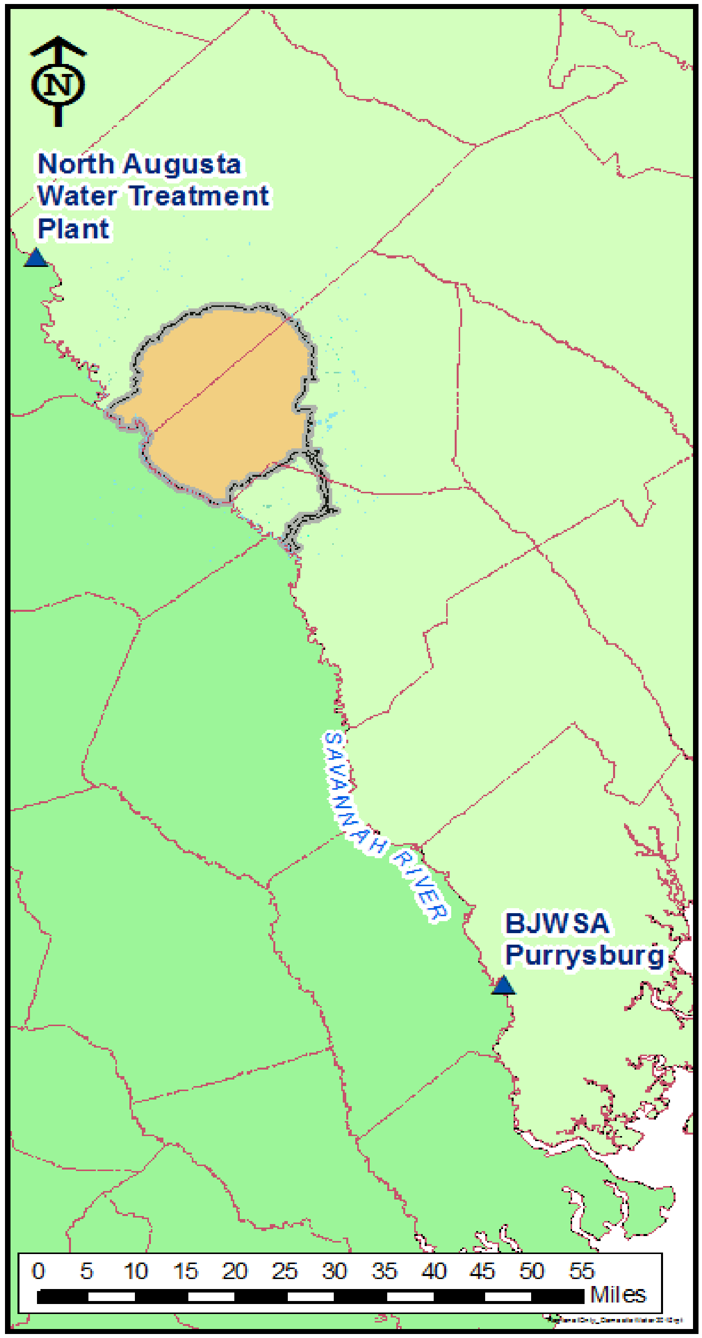


Figure 5-11 Offsite Drinking Water Sampling Locations

SRS collects treated water from these two WTPs, which supply water to the public. The North Augusta WTP samples determine concentrations in drinking water upstream of SRS. The BJWSA Purrysburg WTP is the furthest downriver sampling location. SRS compares these locations to evaluate potential impacts from upstream sources that include SRS.

5.4.8.1 Drinking Water Results Summary

In 2018, SRS performed gross alpha and gross beta screening on all onsite and offsite drinking water samples. No results exceeded the EPA's 15 pCi/L alpha concentration limit or 50 pCi/L beta concentration limit. In addition, no onsite or offsite drinking water samples exceeded the 20 pCi/mL (20,000 pCi/L) EPA standard for tritium or the 8 pCi/L strontium-89,90 maximum contaminant level.

Figure 5-12 presents the average drinking water tritium concentrations for the local water treatment plants upstream and downstream from SRS compared to the average of weekly river water samples collected at RM 141.5. The average tritium concentration at RM 141.5 is approximately 2.5% of the EPA standard for tritium and decreases further at the downstream sampling location.

Sample results did not detect tritium, cobalt-60, cesium-137, strontium 89,90, uranium-235, plutonium-238, plutonium-239, and curium-244 in onsite drinking water test locations. Sample results indicated detectable levels of americium-241 in 4 onsite samples, uranium-234 in 8 onsite samples, and uranium-238 in 10 onsite samples. Appendix Table D-13 summarizes the results. Americium-241 concentrations are near the method detection limit, and the uranium is natural. All analytical results are well below the EPA standard.

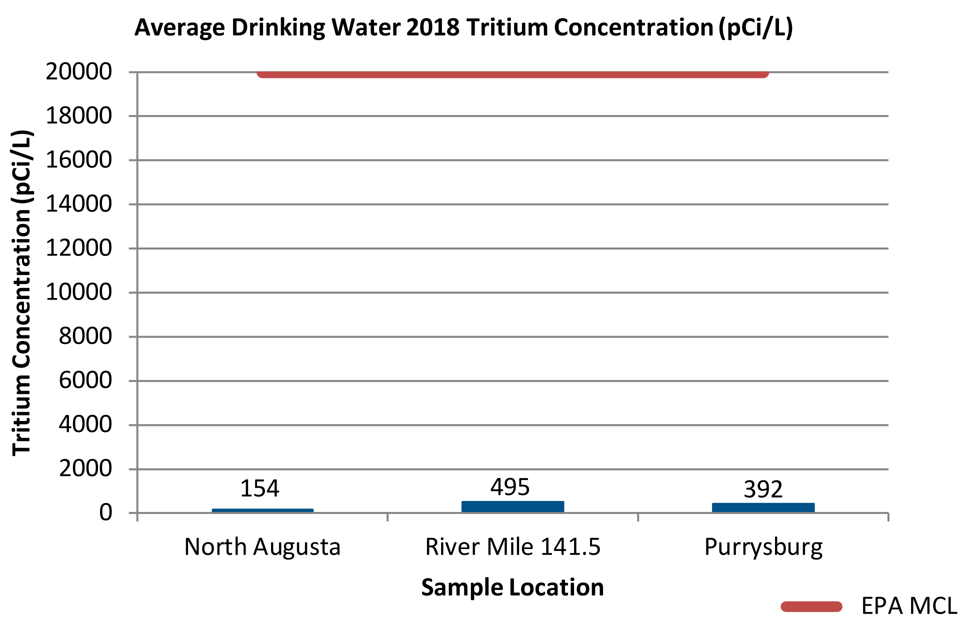


Figure 5-12 Tritium in Offsite Drinking Water and River Mile 141.5

5.5 AQUATIC FOOD PRODUCTS

5.5.1 Fish Collection in the Savannah River

SRS collects aquatic food from the Savannah River. Freshwater fish come from six locations on the Savannah River from above SRS at Augusta, Georgia, to the Highway 301 bridge (Environmental Maps, *Fish Sampling Locations*). Onsite, SRS collects freshwater fish at the mouth of the streams that traverse the Site. Saltwater fish come from the Savannah River mouth near Savannah, Georgia. Additionally, shellfish come from the Savannah River mouth near Savannah or SRS purchases them from vendors in the Savannah area that harvest from local saltwater that waters of the Savannah River potentially influence. Table 5-9 identifies the aquatic products collected in 2018.

Table 5-9 Aquatic Products Collected by SRS in 2018 for the Radiological Environmental Monitoring Program

Freshwater Fish	Saltwater Fish	Shellfish
Bass	Mullet	Crab
Catfish		Shrimp
Panfish		

SRS analyzes both edible (meat and skin only) and nonedible (bone) samples of freshwater and saltwater fish. SRS analyzes only the edible portion of shellfish. Analyses of edible samples of all aquatic species collected include gross alpha, gross beta, gamma-emitting radionuclides (that is, cesium-137 and cobalt-60), strontium-89,90, technetium-99, and iodine-129. Strontium-89,90 is the only analysis SRS conducts on the nonedible samples.

5.5.1.1 Fish in Savannah River Results Summary

In 2018, SRS collected freshwater fish from the six locations, saltwater fish and shrimp from the Savannah River mouth, and obtained crabs in the Savannah area from a supplier that harvests from saltwater potentially influenced by Savannah River water. SRS analyzed 54 freshwater fish composites, 3 saltwater fish composites, and 2 shellfish composites. The freshwater and saltwater composites consisted of three to eight fish each. The two shellfish composites consisted of one bushel of crab and one bushel of shrimp, respectively. The analytical results of the freshwater and saltwater fish, and shellfish collected are consistent with results for the previous 10 years. The majority of the results for the specific radionuclides associated with SRS operations were nondetectable (61% for freshwater fish, 78% for saltwater fish, and 90% for shellfish). Table 5-10 lists the maximum concentration for those radionuclides detected in the flesh of all fish types sampled. The table also identifies the fish type and the collection location associated with the maximum concentration for each detected radionuclide. SRS did not detect cobalt-60 and iodine-129 in any fish flesh samples. Appendix Tables D-14, D-15, and D-16 for freshwater fish, saltwater fish and shellfish, respectively, summarize results for all fish and shellfish.

Gross alpha results were below the minimum detectable concentration for all saltwater and freshwater fish. One gross alpha result was above the minimum detectable concentration but less than the trigger value, thus the Site did not analyze for actinides. Gross beta activity was detectable in all freshwater and saltwater fish, as well as shellfish. The concentrations are consistent with results from the previous 10 years and are likely attributed to the naturally occurring radionuclide potassium-40.

Table 5-10 Location and Fish Type for the Maximum Detected Concentration of Specific Radionuclides Measured in Flesh Samples Collected in 2018

Radionuclide	Maximum Concentration	Location	Fish Type
Cesium-137	0.792 pCi/g	Upper Three Runs Creek river mouth	Bass
Strontium-89,90	0.00711 pCi/g	Steel Creek river mouth	Panfish
Technetium-99	0.104 pCi/g	Steel Creek river mouth	Catfish

Determining the potential dose and risk to the public, as reported in Chapter 6, *Radiological Dose Assessment*, includes data from the fish monitoring.

5.6 WILDLIFE SURVEILLANCE

The wildlife surveillance program monitors wildlife harvested from SRS and subsequently released to the public. Monitoring assesses any impact of Site operations on the wildlife populations and ensures that no individual exceeds the SRS Annual Administrative Game Animal Release Limit of 22 mrem/yr. Annual game animal hunts for deer, coyote, and feral hogs are open to the public. During 2018, SRS held one turkey hunt for Wounded Warriors and residents with mobility impairments in the spring and 13 game animal hunts in the fall. The Site holds the annual hunts to reduce animal-vehicle collisions and control Site deer, coyote, and feral hog populations.

SRS monitors all animals harvested during the annual hunts to ensure the total dose to any hunter is below the SRS 22 mrem/yr limit. SRS uses portable sodium iodide detectors to perform field analyses for cesium-137.

SRS uses the cesium-137 concentration detected in the edible flesh of the animal to calculate dose. A dose is assigned to each hunter for every animal harvested if the cesium-137 concentration is above the background concentration of 1.97 picocuries per gram (pCi/g) for hogs (Morrison et al., 2019) and 2.59 pCi/g for the deer and coyote (Aucott et al., 2017). In addition to the field monitoring, SRS collects samples of muscle for laboratory analysis of cesium-137 concentrations in both deer and hogs based on the following: 1) a set frequency, 2) the field measured cesium-137 levels, or 3) exposure limit considerations. These laboratory-analyzed data provide a quality-control check on the field monitoring results.

Cesium-137 is chemically similar to and behaves like potassium in the environment. Cesium-137 has a half-life of about 30 years and tends to persist in soil, where it can readily enter the food chain through plants. It is widely distributed throughout the world from nuclear weapons detonations from 1945 to 1980 and is present at low levels in all environmental media. Flesh sample laboratory analyses also include cobalt-60, strontium-89,90, gross alpha, and gross beta. SRS collects bone samples at the same frequency as the flesh samples and analyzes them in the laboratory for strontium-89,90.

5.6.1 Wildlife Results Summary

During the hunts in 2018, SRS monitored a total of 275 deer, 66 feral hogs, 14 coyotes, and 27 turkeys. SRS did not assign a dose to any hunter during 2 of the 13 game animals hunts, as well as the turkey hunt. This indicates that all animals harvested during those hunts were at or below the background cesium-137 concentration of 1.97 pCi/g for the hogs and 2.59 pCi/g for all others. All animals harvested during the 2018 hunts were below the administrative game animal release limit of 22 mrem. SRS released all animals to the hunters; however, hunters chose not to keep 14 coyotes and 6 hogs.

Appendix Table D-17 summarizes the muscle and bone sample results from a subset of the monitored deer and hogs. As seen in previous years, laboratory analysis detected cesium-137 in muscle tissue. Laboratory analysis detected strontium-89,90, a beta-emitting radionuclide, in bone and in some muscle tissue.

Generally, the cesium-137 concentration field detectors measure is similar to that of laboratory methods. Figure 5-13 compares the 2018 field versus laboratory measurement for each deer muscle sample collected. Table 5-11 summarizes all field and laboratory measurements. Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past 50 years, with relatively little change in the last 10 years. Figure 5-14 shows the historical trend analysis.

Because its chemistry is similar to that of calcium, strontium exists at higher concentration in bone than in muscle tissue. In 2018, all 45 deer bone and all 4 hog bone samples had detectable levels of strontium-89,90. Strontium-89,90 was detected in deer bone with an average of 3.35 pCi/g and a maximum of 8.86 pCi/g. Strontium-89,90 was detected in hog bone with an average of 2.53 pCi/g and a maximum of 3.05 pCi/g.

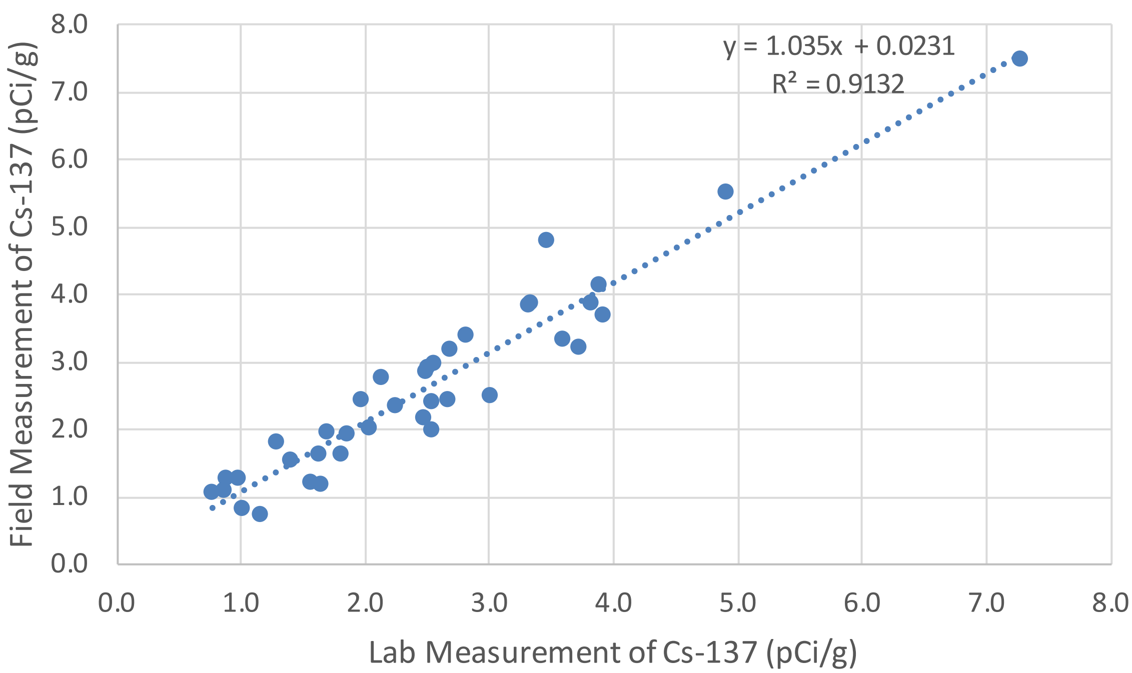


Figure 5-13 Comparison of 2018 Cesium-137 Field Measurements to Laboratory Analyses for Deer Muscle Samples

For the deer muscle tissue samples, 3 out of the 45 muscle tissue samples had levels greater than the minimum detectable concentration for strontium-89,90, with a maximum concentration of 0.014 pCi/g. These average results are similar to those of previous years. All cobalt-60 results were not detectable. One of 45 gross alpha results had levels greater than the minimum detectable concentration, with a maximum concentration of 0.152 pCi/g. Gross beta activity, detected in all samples, is consistent with 2008 through 2017 results.

Chapter 6, *Radiological Dose Assessment,* presents the calculation of dose from consuming wildlife harvested on SRS.

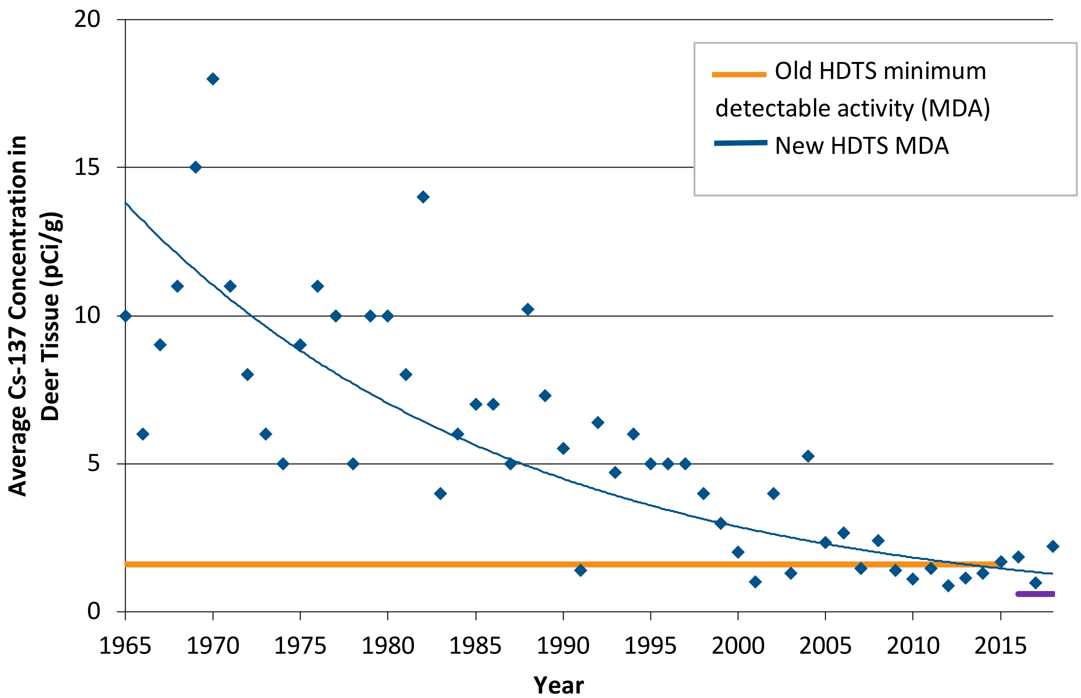


Figure 5-14 Historical Trend of Average Cesium-137 Concentration in Deer Tissue (1965-2018)

Table 5-11 Cesium-137 Results for Laboratory and Field Measurements in Wildlife for CY 2018

	Number of Animals Field Monitored	Field Gross Average Cs-137 Conc. (pCi/g)	Field Maximum Cs-137 Conc. (pCi/g)	Number of Samples Collected for Laboratory Analysis	Number of Detected Results	Lab Average Cs-137 Conc. (pCi/g)	Lab Maximum Cs-137 Conc. (pCi/g)
Deer	275	2.22	7.79	45	44	2.21	7.27
Hog	66	1.58	6.01	4	4	2.35	6.35
Coyote	14	2.92	6.41	-----	-----	-----	-----
Turkey	27	1.14	1.27	-----	-----	-----	-----