# ESOP

## Environmental Surveillance and Oversight Program

## 2022 DATA REPORT

dhec
Healthy People. Healthy Communities.

Aiken Environmental Affairs Office
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CR-004111 12/23

# Acknowledgements

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# Acknowledgements

ESOP Team (left to right): Rhett Watson, Grace Anne Martin, Thomas Rolka, Jeffrey Joyner, Bethany Cameron, Tim Mettlen, Richard Burnett, Anita Brown, Bethany Johnson, Gregory Mason, and Gregg O'Quinn (not pictured: Krista McCuen)

# Purpose

**PURPOSE OF THIS REPORT**

**WHAT:** South Carolina's Department of Health and Environmental Control (DHEC) monitors the Department of Energy's Savannah River Site (SRS) for potential contaminants and produces a report of all its annual findings.

**WHY:** Due to nuclear material testing and lack of environmental regulations during the Cold War era, radioactive and non-radioactive constituents are present on SRS property. SRS personnel have been sampling multiple media for many years. However, to verify the data being collected on and around SRS, DHEC conducts independent monitoring associated with the site to provide a second set of results for comparison.

**HOW:** In order to have a verification system for SRS's annual data, the Department of Energy-Savannah River (DOE-SR) partnered with DHEC as part of a 1995 Agreement in Principle (AIP) to create the Environmental Surveillance and Oversight Program (ESOP). ESOP is a division of DHEC specific to the Midlands Aiken Environmental Affairs Office. There are 10 team members with varying expertise working in ESOP that collect and analyze samples of air, water, soil, sediment, vegetation, milk, fish, and game for radiological and non-radiological constituents.

**WHERE:** Samples are collected on site property, around its perimeter, and in background locations. Depending upon the media, some DHEC sample locations coincide with those of DOE-SR. These locations are compared in our report.

**WHEN:** Samples are collected weekly, quarterly, biannually, and annually and are dependent upon the type of media and can be affected by availability of the resource, accessibility, and weather.

**RADIATION** – Occurs when an unstable atom tries to become stable by releasing some of its energy in the form of an alpha or beta particle or gamma wave.

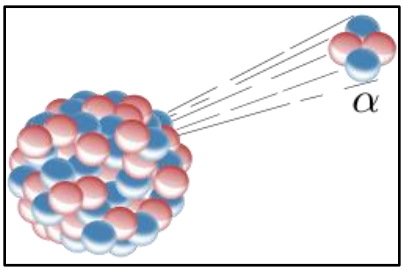
## TYPES OF RADIATION

**ALPHA** – results when the nucleus of an atom releases two protons and two neutrons. Due to this particle being heavier in mass, it can be stopped by the air, skin, or paper. External exposure is not dangerous, but if swallowed, breathed in, or enters a person through a cut, it can harm the human body.

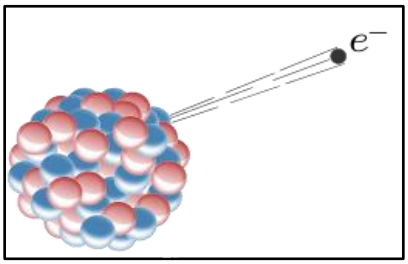
**BETA** – occurs when an atom releases an electron (negative charge). Since it is lighter in mass and faster moving, it can travel greater distances and can be stopped by a layer of wood or metal but can penetrate the outer layer of skin. It can cause skin burns.

**GAMMA** – is the release of pure energy that is fast moving and able to travel longer distances until it hits either concrete or lead. It will pass through the human body resulting in internal and external bodily damage.

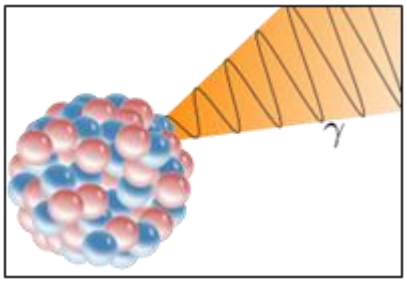
**ALPHA RADIATION:**



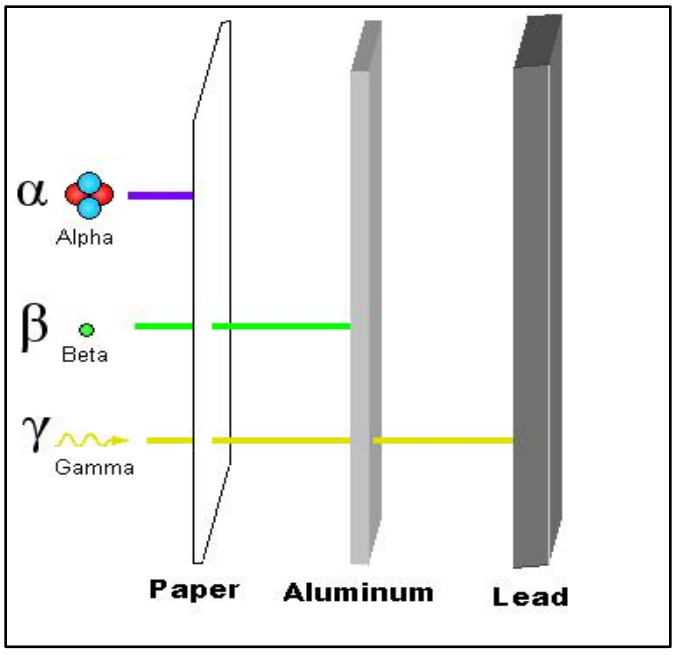

**BETA RADIATION:**




**GAMMA RADIATION:**




**RADIATION:**



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# List of Analytes

**Table 1. Gamma Analytes**

| Radioisotope | Abbreviation |
|---|---|
| Actinium-228 | Ac-228 |
| Americium-241 | Am-241 |
| Beryllium-7 | Be-7 |
| Cerium-144 | Ce-144 |
| Cobalt-58 | Co-58 |
| Cobalt-60 | Co-60 |
| Cesium-134 | Cs-134 |
| Cesium-137 | Cs-137 |
| Europium-152 | Eu-152 |
| Europium-154 | Eu-154 |
| Europium-155 | Eu-155 |
| Iodine-131 | I-131 |
| Potassium-40 | K-40 |
| Plutonium-238 | Pu-238 |
| Plutonium-239/240 | Pu-239/240 |
| Manganese-54 | Mn-54 |
| Sodium-22 | Na-22 |
| Lead-212 | Pb-212 |
| Lead-214 | Pb-214 |
| Radium-226 | Ra-226 |
| Ruthenium-103 | Ru-103 |
| Antimony-125 | Sb-125 |
| Thorium-234 | Th-234 |
| Yttrium-88 | Y-88 |
| Zinc-65 | Zn-65 |
| Zirconium-95 | Zr-95 |

**Table 2. Metal Analytes**

| Analyte | Abbreviation |
|---|---|
| Barium | Ba |
| Beryllium | Be |
| Cadmium | Cd |
| Chromium | Cr |
| Copper | Cu |
| Lead | Pb |
| Manganese | Mn |
| Mercury | Hg |
| Nickel | Ni |
| Zinc | Zn |

**LIST OF ACRONYMS**

| | |
|---|---|
| **ABR** | Allendale Barricade |
| **AEI** | Average Exposed Individual |
| **AIK** | Aiken |
| **AIP** | Agreement in Principle |
| **AKN** | Sample locations in Aiken County |
| **ALD** | Sample locations in Allendale County |
| **ALN** | Allendale |
| **ARESD** | Analytical and Radiological Environmental Services Division |
| **ATSDR** | Agency for Toxic Substances and Disease Registry |
| **B/J** | Beaufort-Jasper Water and Sewer Authority |
| **BGN** | Burial Grounds North |
| **BOD** | Biochemical Oxygen Demand |
| **BWL** | Sample locations in Barnwell County |
| **CDC** | Centers for Disease Control and Prevention |
| **DIL** | Derived Intervention Level |
| **DKH** | Dark Horse at the Williston Barricade |
| **DHEC** | South Carolina Department of Health and Environmental Control |
| **DNR** | South Carolina Department of Natural Resources |
| **DO** | Dissolved Oxygen |
| **DOE** | Department of Energy |
| **DOE-SR** | Department of Energy-Savannah River |
| **DW** | Drinking Water |
| **ESOP** | Environmental Surveillance and Oversight Program |
| **EPA** | United States Environmental Protection Agency |
| **ESV** | Ecological Screening Value |
| **FDA** | United States Food and Drug Administration |
| **GW** | Groundwater |
| **HLW** | High Level Waste |
| **Hwy. 17** | United States Highway 17 |
| **Hwy. 301** | United States Highway 301 |
| **IAEA** | International Atomic Energy Agency |
| **JAK** | Jackson |
| **LLD** | Lower Limit of Detection |
| **LLW** | Low Level Waste |
| **MCL** | Maximum Contaminant Level |
| **MDA** | Minimum Detectable Activity |
| **MDC** | Minimum Detectable Concentration |
| **MDL** | Minimum Detection Level |
| **MEI** | Maximum Exposed Individual |
| **MPN** | Most Probable Number |
| **NA** | Not Applicable |
| **ND** | Not Detected |
| **NEL** | New Ellenton |
| **NORM** | Naturally Occurring Radioactive Material |
| **NRC** | National Regulatory Commission |
| **NS** | No Sample |
| **NSBLD** | New Savannah Bluff Lock & Dam |



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| | |
|---|---|
| **PCB** | Polychlorinated Biphenyls |
| **PRG** | Preliminary Remediation Goals |
| **RM** | River Mile |
| **RSL** | Regional Screening Level |
| **RSW** | Radiological Surface Water |
| **SCAT** | South Carolina Advanced Technology |
| **SRNL** | Savannah River National Laboratory |
| **SRNS** | Savannah River Nuclear Solutions |
| **SRS** | Savannah River Site |
| **SSL** | Soil Screening Level |
| **SW** | Surface Water |
| **TKN** | Total Kjeldahl Nitrogen |
| **TLD** | Thermoluminescent Dosimeter |
| **TSP** | Total Suspended Particulates |
| **TSS** | Total Suspended Solid |
| **USFS** | United States Forestry Service |
| **USGS** | United States Geological Survey |
| **VOC** | Volatile Organic Compound |

**LIST OF ISOTOPES AND ABBREVIATIONS**

| | |
|---|---|
| **I-129** | Iodine-129 |
| **Sr-89/90** | Strontium-89/90 |
| **Sr-90** | Strontium-90 |

**UNITS OF MEASURE**

| | |
|---|---|
| **<** | Less than |
| **±** | Plus or minus. Refers to one standard deviation unless otherwise stated |
| **±2** | Plus or minus 2 standard deviations. |
| **°C** | Temperature in Celsius |
| **Ci** | Curie |
| **cnt** | Counts |
| **g/mL** | Grams per milliliter |
| **hrs/yr** | Hours per year |
| **kg/yr** | Kilograms per year |
| **L/yr** | Liters per year |
| **$m^3$/yr** | Cubic meters per year |
| **mg/day** | Milligrams per day |
| **mg/kg** | Milligrams per kilogram |
| **mg/L** | Milligrams Per Liter |
| **mL** | Milliliter |
| **mL/L** | Milliliter per liter |
| **MPN** | Most Probable Number |
| **mrem** | Millirem or milliroentgen equivalent man |
| **NTU** | Nephelometric Turbidity Unit |
| **pCi/g** | Picocuries per gram |
| **pCi/L** | Picocuries per liter |
| **pCi/$m^3$** | Picocuries per cubic meter |



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| | |
|---|---|
| **pCi/mL** | Picocuries per milliliter |
| **SU** | Standard units |



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# Introduction

In 1950, the U.S. Atomic Energy Commission established the Savannah River Site (SRS) (1954-1992) with the mission of producing nuclear materials, primarily tritium and plutonium. SRS is a Department of Energy (DOE) facility located approximately 20 miles from Aiken, South Carolina. SRS boundaries lie within Aiken, Allendale, and Barnwell counties and span approximately 310 square miles. During legacy operations, radionuclides were released into the surface water, groundwater, soils, and atmosphere. Although the reactors are no longer operating, work continues at SRS with the primary focus being on cleaning up legacy wastes and remediating areas associated with former operations.

Due to the large number of contaminants that could potentially be released from SRS, the Centers for Disease Control and Prevention (CDC) performed a site assessment to determine the potential health effects of any discharged radionuclides to the off-site public. Most of the radiological releases originated from processes associated with the reactor areas (R, K, P, L, and C) and the separations areas (F and H), but there are other areas of releases as a result of the varied processes at SRS.

P Reactor at SRS – No longer in operation


Tritium was one of the principle nuclear materials produced at SRS to multiply the firepower of plutonium in nuclear weapons (Till et al., 2001). Tritium releases originated from processes associated with the reactors, separations areas, D-Area, and tritium facilities. The two main types of tritium releases came from direct site facility releases and migration from seepage basins in the separations areas, the burial ground, and the K-Area containment basin. In the early operational years, nearly 100 percent of the discharges to streams were related to direct releases. Tritiated water's ability to react chemically like nonradioactive water in living cells lends itself to be more hazardous biologically than tritium gas (CDC SRSHES, 1997).

Alpha-emitting and beta-emitting radionuclides were also released to liquid effluent. Alpha-emitting radionuclide releases from M-Area primarily affected Tims Branch, which ultimately flows into Upper Three Runs Creek. Fourmile Branch is the stream most affected by alpha- and beta-emitting releases coming from the separations areas, and releases from the reactor areas affected all streams except for Upper Three Runs Creek (Till et al., 2001). Steel Creek, Pen Branch, and Lower Three Runs Creek were mainly affected by beta-emitting releases from the reactors. Strontium-90 (Sr-90) is a main contributor of beta activity and came primarily from the reactors (Till et al., 2001).

Plutonium was manufactured at SRS in H-Area from fuel rods and in F-Area from targets (Till et al., 2001). Releases at SRS occurred primarily through the discharge of liquid waste into streams. Iodine-129 (I-129) is a fission product of reactor fuel that has a very long half-life. Most occurred during fuel processing (Till et al., 2001). Technetium-99 (Tc-99) was produced in SRS production reactors as a fission by-product of uranium and plutonium. This radionuclide was released to the environment from the separations areas ventilation systems, the aqueous



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environment from liquid waste in waste tanks, and the Solid Waste Disposal Facility (Westinghouse Savannah River Company [WSRC], 1993).

Strontium was a fission product in SRS reactors, subsequently released from F-area and H-area (WSRC, 1998). SRS operations have also released strontium into the environment through normal site operations and equipment failures.

H Canyon at SRS – Still in operation at the site
Photo by DOE-SR. CC BY 2.0

Routine operations at SRS have released cesium-137 (Cs-137) to the regional environment surrounding SRS. The most significant releases occurred during the early years of site operation when Cs-137 was released to seepage basins and site streams. The SRS facilities that have documented Cs-137 releases are the production reactors, separations areas, liquid waste facilities, the solid waste disposal facility, central shops, heavy water rework facility, Saltstone Facility, and the Savannah River National Laboratory (SRNL).

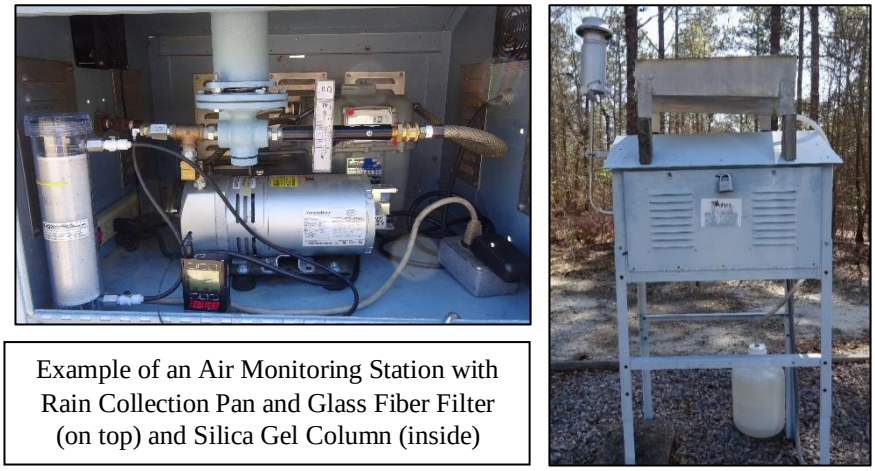
Historically, the Department of Energy-Savannah River (DOE-SR) has been self-regulating regarding environmental monitoring. Until 1995, the public had to rely solely on DOE-SR to ensure their health and the environment was protected. DOE-SR formed an Agreement in Principle (AIP) with the South Carolina Department of Health and Environmental Control (SCDHEC) to perform independent environmental monitoring and oversight of SRS. This partnership provides an extra source of information to the public regarding the effectiveness of the DOE-SR monitoring activities. From this agreement, the Environmental Surveillance and Oversight Program (ESOP) of DHEC was initiated to supplement and compliment monitoring functions of this unique facility. DHEC monitoring provides an added protection due to the potential for environmental releases that pose a threat to the state.

Program development at SRS is stable and evolves based on changing missions. The foremost focus is on legacy waste and materials that are stored or have been disposed of on-site and pose a current risk of release to the environment. Some of DOE-SR's primary activities are concerned with identifying concentrations and migration of radionuclides in the aquatic environment, detecting and verifying accidental releases, characterizing concentration trends, and determining associated impacts on human health and the environment. This report provides results of samples collected by DHEC related to SRS, trending data to document how contaminants are changing, and information on how these changes may impact the surrounding communities. The data reported by DHEC is based on detections only. DHEC's ESOP will continue its mission of monitoring and oversight around SRS to ensure the site's on-going activities continue to be safe for the public and the environment.

**Chapter 1 Radiological Atmospheric Monitoring on and Adjacent to SRS**

### 1.1.0 PROJECT SUMMARY

Atmospheric transport has the potential to impact the citizens of South Carolina from releases associated with activities at SRS. The Atmospheric Monitoring Project conducts routine, quantitative monitoring of atmospheric radionuclide releases associated with SRS, which it uses to identify concentration trends that could require further investigation. Air monitoring capabilities in 2022 included 19 dosimeter monitoring locations and seven air monitoring stations that collected samples using glass fiber filters, rain collection pans, and silica gel columns. Glass fiber filters are used to collect total suspended particulates (TSP) in the air. Particulates are screened weekly for gross alpha- and beta-emitting activity. Precipitation, when present, and silica gel distillates of atmospheric moisture are sampled and analyzed monthly for tritium. Dosimeters are collected and analyzed every quarter for ambient beta/gamma levels. Radiological atmospheric monitoring sites were established to provide spatial coverage of the project area (Sections 1.4.0, Map and 1.5.0, Table 1). One air monitoring station is located at the center of the site, three are at the SRS perimeter, and three are found outside of the site boundary within public areas. Thirteen of the dosimeters are on or near the site perimeter, one is in the center of the site, and five are within 25 miles of the site in surrounding population centers. DHEC emphasizes monitoring SRS perimeter locations for radionuclides in atmospheric media for potential public exposure.



Example of an Air Monitoring Station with Rain Collection Pan and Glass Fiber Filter (on top) and Silica Gel Column (inside)

### 1.2.0 RESULTS AND DISCUSSION

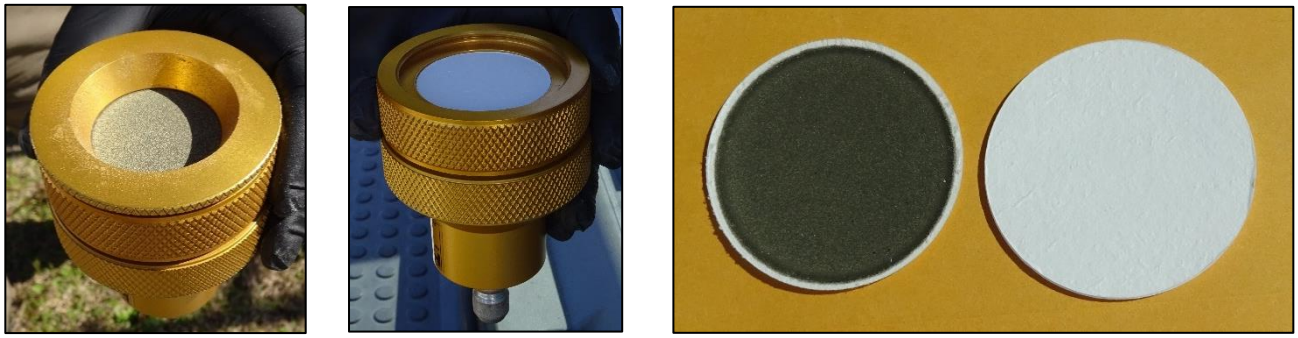
Air Monitoring Summary Statistics can be found in Section 1.6.0 and all Air Monitoring Data can be found in the 2022 DHEC Data File.

#### 1.2.1 Total Suspended Particulates

DHEC and the Department of Energy-Savannah River (DOE-SR) had both gross alpha and gross beta detections in 2022. Small seasonal variations at each monitoring location have been consistent with historically reported DHEC values (DHEC, 2022). Section 1.5.0 illustrates trends for the last five years for average gross alpha activity (Figure 1) and average gross beta activity (Figure 2) at SRS perimeter locations.

#### 1.2.2 Ambient Beta/Gamma

DHEC conducts ambient beta/gamma monitoring through the deployment of dosimeters around the perimeter of SRS. In 2022, ambient beta/gamma average quarterly totals ranged from 19.25 (TLD-



Glass fiber filter being collected for total suspended particulates: Used filter (left) vs. unused filter (right)

07) to 28.75 (TLD-02) mrem. Section 1.5.0, Figure 3 shows data trends at the SRS perimeter for average ambient beta/gamma values in dosimeters for DHEC and DOE-SR.

### 1.2.3 Tritium

Tritium continues to be the predominant radionuclide detected in the perimeter samples. Most of the tritium detected in DHEC perimeter samples may be attributed to the release of tritium from tritium facilities, separations areas, and from wide-spread and fleeting sources (SRNS, 2023).

Tritium in Air

Tritium in air values reported by DHEC are the result of using the historical method of calculating an air concentration of tritium based on the upper limit value of absolute humidity (11.5 grams of atmospheric moisture per cubic meter) in the geographic region (NCRP, 1984). This number is a dose equivalent concentration that would yield approximately 10 mrem to a member of the public at the site boundary (EPA, 1989).

The perimeter average for DHEC tritium in air activity (3.82 pCi/$m^3$) was lower than the DOE-SR perimeter average activity (12.08 pCi/$m^3$). These variations could be caused by different sampling locations, number of locations, sample frequency, and method of calculating air concentration.

Average tritium in air activity at the SRS perimeter reported by DHEC for 2022 was higher than reported in 2021, whereas DOE-SR activity was lower in 2022. These levels have fluctuated over the last five years. Section 1.5.0, Figure 4 illustrates data trends of atmospheric tritium activity for DHEC and DOE-SR as measured and calculated at the SRS perimeter.


Example of dosimeters present at 19 locations

Tritium in Precipitation

In 2022, DHEC and DOE-SR averages for tritium activity in precipitation were well below the Environmental Protection Agency standard of 20,000 pCi/L for drinking water (EPA, 2020). Section 1.5.0, Figure 5 shows average tritium in precipitation activity for SRS perimeter



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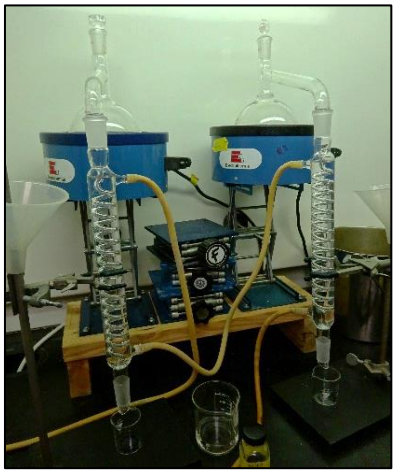
locations and illustrates trending tritium in precipitation values for DHEC and DOE-SR from the last five years.

Collecting atmospheric moisture from silica gel through distillation



Silica Gel Column

During the 2022 sampling period, tritium detected in precipitation ranged from 309.44 pCi/L (Jackson, S.C. Air Station (JAK)) to 7447.84 pCi/L (Burial Grounds North, SRS (BGN)). The maximum reported value for DHEC perimeter locations was collected at the New Ellenton, S.C. Air Station (NEL) air station with 683.83 pCi/L. The DHEC average measured activity for perimeter locations above the lower limit of detection for tritium in precipitation was 463 (± 196.28) pCi/L. The DOE-SR average measured value for tritium activity in precipitation at the SRS perimeter locations was 589 (± 408.71) pCi/L (SRNS, 2023).

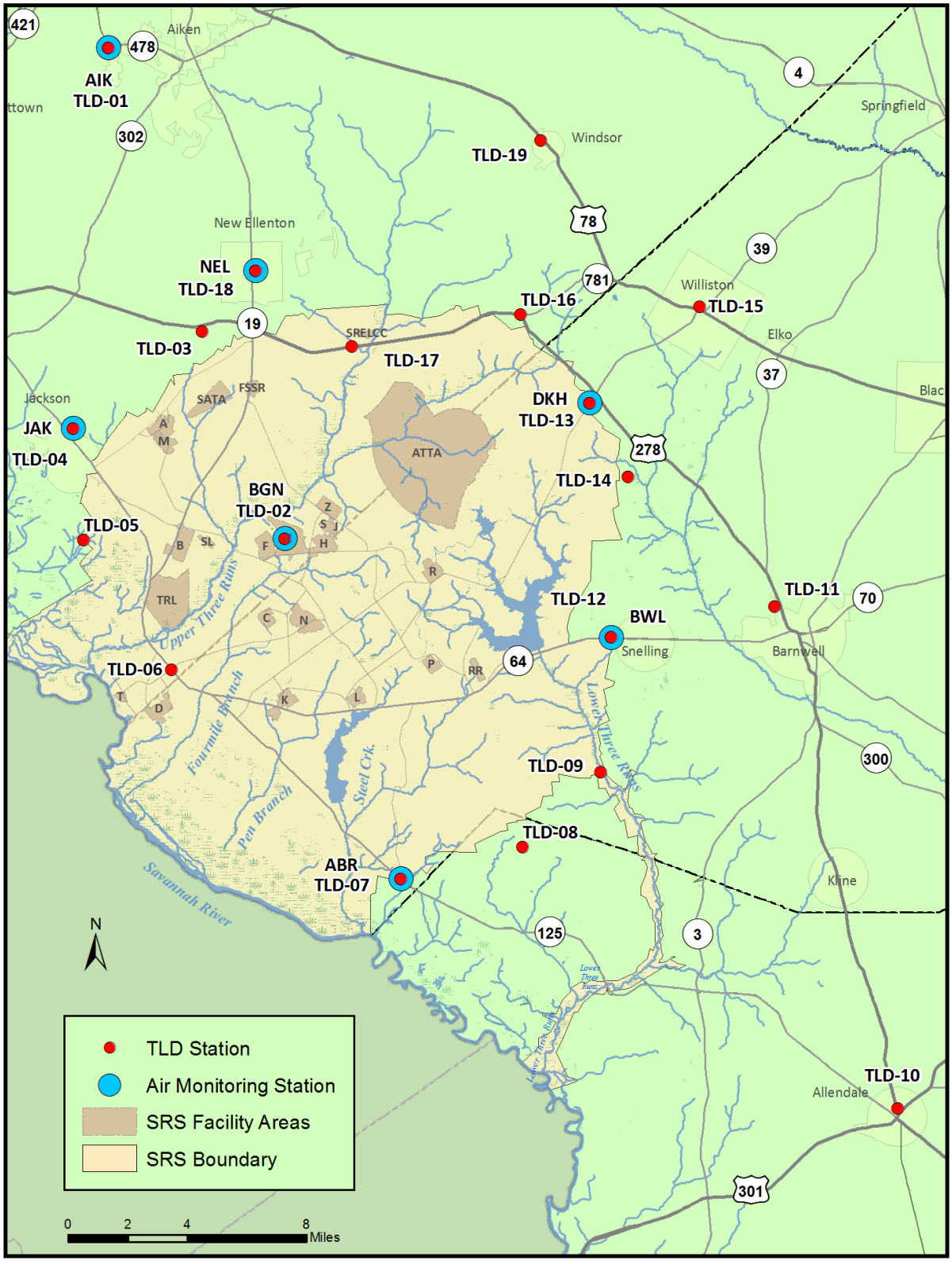
### 1.3.0 CONCLUSIONS AND RECOMMENDATIONS

All DHEC data collected in 2022 confirmed reported DOE-SR values for gross alpha/beta, ambient beta/gamma, and tritium in the environment at the SRS boundary with no anomalous data noted for any monitored parameters.

Due to continued potential releases from site facilities (tritium facilities, separations areas, etc.), DHEC will continue to collect weekly TSP for gross alpha/beta, monthly atmospheric and precipitation tritium samples, and quarterly ambient beta/gamma samples.

### 1.4.0 MAP

# Radiological Atmospheric Monitoring Sample Locations




2022 ESOP Radiological Air Monitoring Map www.scdhec.gov



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## 1.5.0 TABLES AND FIGURES

### Table 1. Radiological Atmospheric Monitoring Locations

### Dosimeter Sample Locations

| Sample ID | Location | Proximity to SRS |
|---|---|---|
| TLD-01 | Collocated with AIK Air Station | Within 25 miles of SRS |
| TLD-02 | Collocated with BGN Air Station | Center of SRS |
| TLD-03 | Savannah River Research Park | SRS Perimeter |
| TLD-04 | Collocated with JAK Air Station | SRS Perimeter |
| TLD-05 | Crackerneck Gate | SRS Perimeter |
| TLD-06 | Ellenton Memorial at Hwy 125 | SRS Perimeter |
| TLD-07 | Collocated with ABR Air Station | SRS Perimeter |
| TLD-08 | Junction of Millet Road and Round Tree Road | SRS Perimeter |
| TLD-09 | Patterson Mill Road at Lower Three Runs Creek | SRS Perimeter |
| TLD-10 | Collocated with ALN Air Station | Within 25 miles of SRS |
| TLD-11 | Barnwell Health Department | Within 25 miles of SRS |
| TLD-12 | Collocated with BWL Air Station | SRS Perimeter |
| TLD-13 | Collocated with DKH Air Station | SRS Perimeter |
| TLD-14 | Seven Pines Road Collocated with SRS Air Station | SRS Perimeter |
| TLD-15 | Williston Police Department | Within 25 miles of SRS |
| TLD-16 | Junction of US-278 and SC-781 | SRS Perimeter |
| TLD-17 | US-278 SREL Conference Center and Hwy 125 | SRS Perimeter |
| TLD-18 | Collocated with NEL Air Station | SRS Perimeter |
| TLD-19 | Windsor Post Office | Within 25 miles of SRS |

### Air Monitoring Stations

| Sample ID | Location | Proximity to SRS |
|---|---|---|
| BGN | Burial Grounds North, SRS | Center of SRS |
| BWL | Barnwell Barricade | SRS Perimeter |
| ABR | Allendale Barricade | SRS Perimeter |
| DKH | Dark Horse | SRS Perimeter |
| NEL | New Ellenton, S.C. | SRS Perimeter/ Population Area |
| JAK | Jackson, S.C. | SRS Perimeter/ Population Area |
| AIK | Aiken Elementary Water Tower | Within 25 miles of SRS/ Population Area |

## TABLES AND FIGURES

**Figure 1. DOE-SR and DHEC Comparison of Average Gross Alpha for Total Suspended Particulates at the SRS Perimeter (SRNS, 2019-2023; DHEC, 2020a-2022a)**

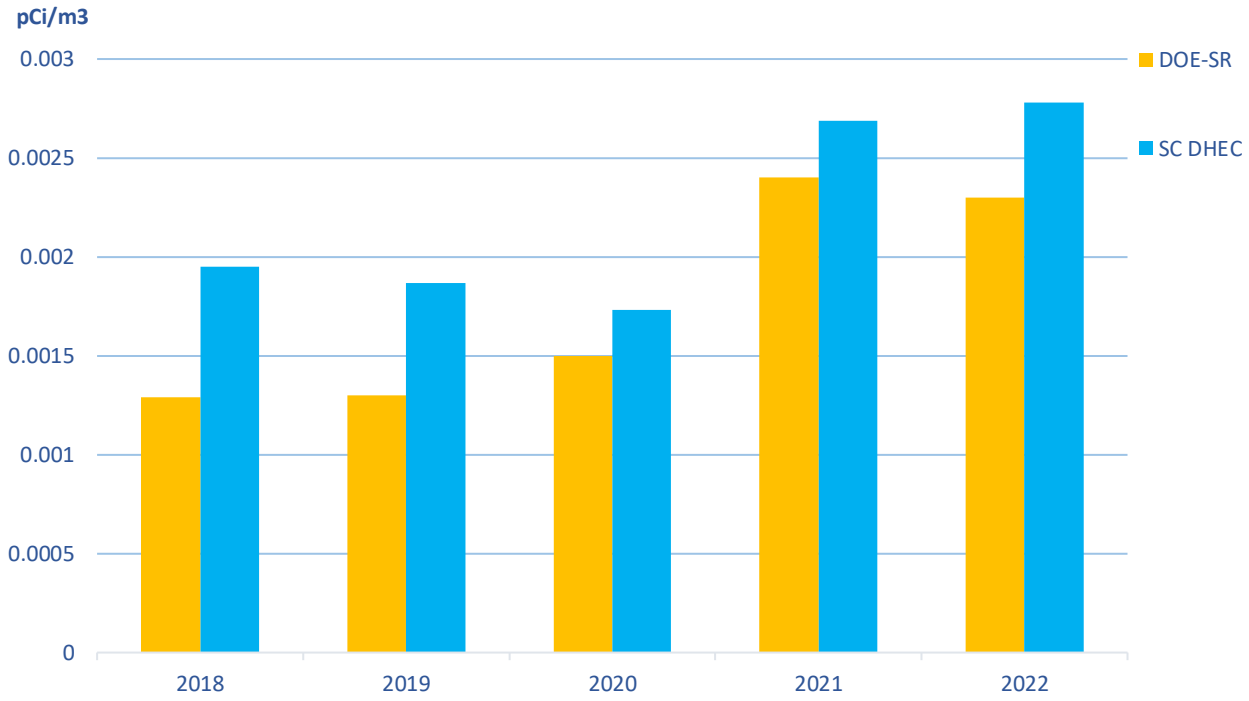
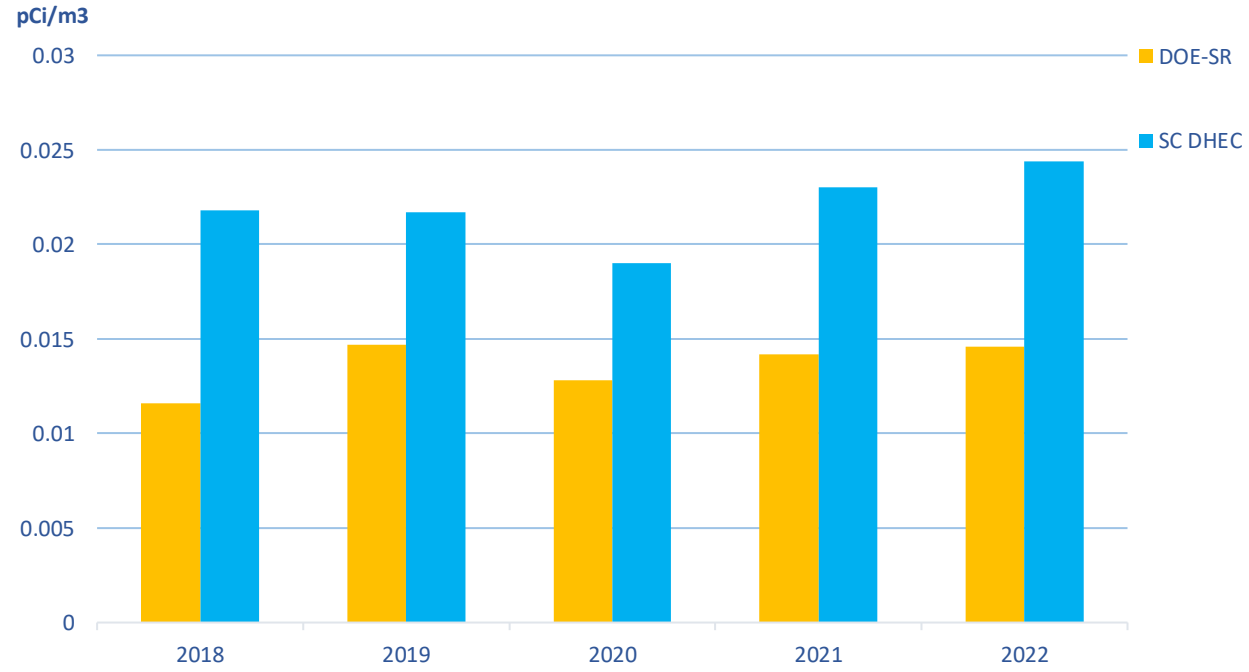



**Figure 2. DOE-SR and DHEC Comparison of Average Gross Beta for Total Suspended Particulates at the SRS Perimeter (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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## TABLES AND FIGURES

**Figure 3. DOE-SR and DHEC Comparison of Yearly Average Ambient Beta/Gamma in Dosimeters at the SRS Perimeter (SRNS, 2019-2023; DHEC, 2020a-2022a)**

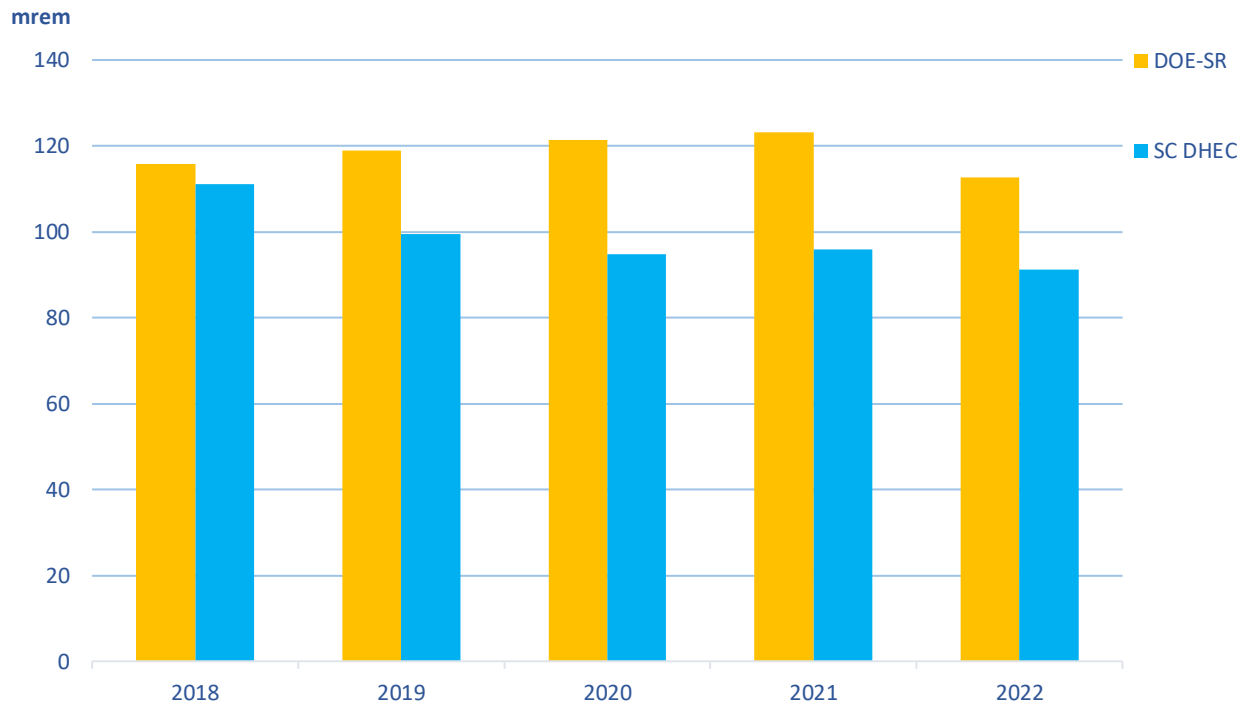
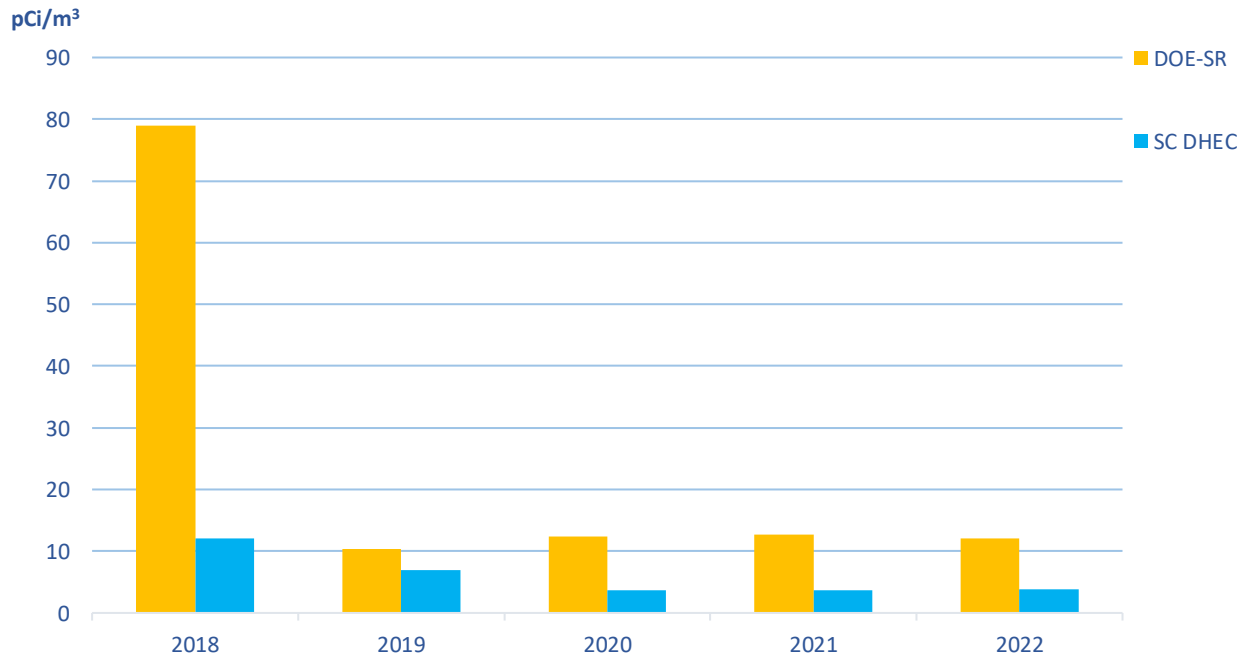



**Figure 4. DOE-SR and DHEC Comparison of Average Tritium in Air at the SRS Perimeter (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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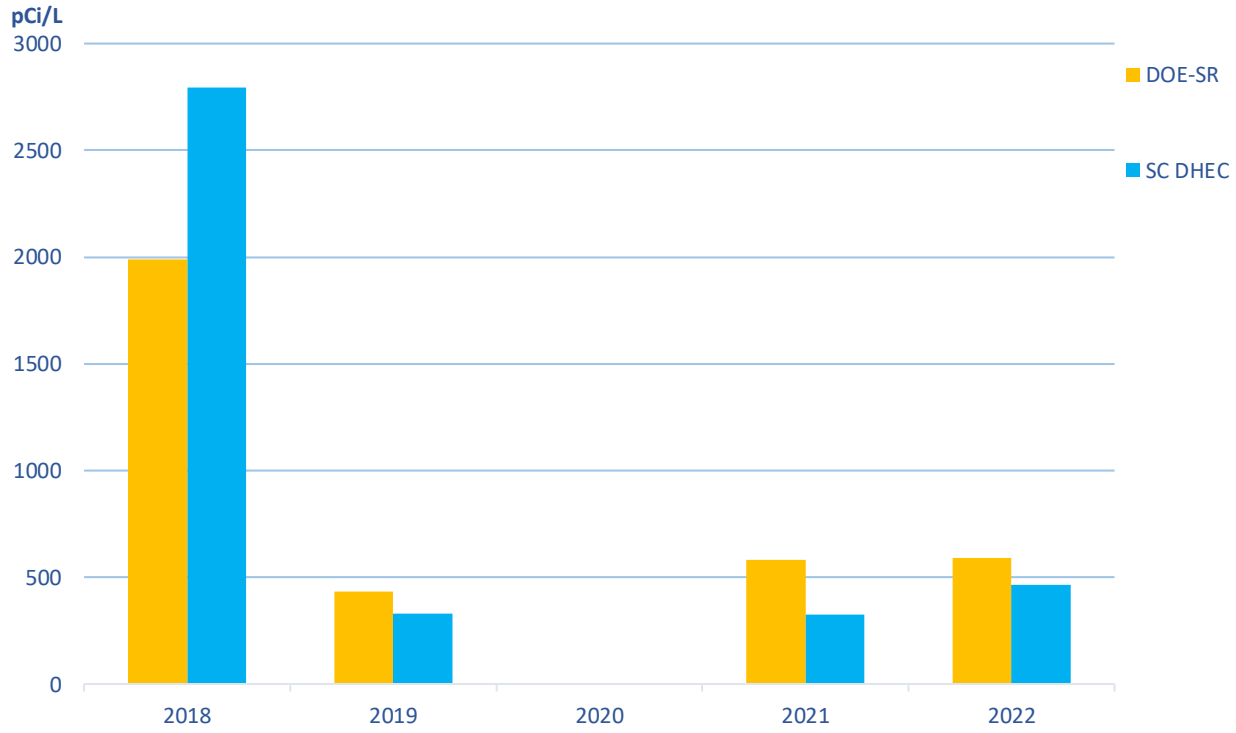
## TABLES AND FIGURES

**Figure 5. DOE-SR and DHEC Comparison of Average Tritium in Precipitation at the SRS Perimeter (SRNS, 2019-2023; DHEC, 2020a-2022a)**




Neither DHEC nor DOE-SR had detections above the LLD for tritium in 2020.



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### 1.6.0 SUMMARY STATISTICS

**2022 DHEC Quarterly Averages of Ambient Dosimeter Beta/Gamma Data**

| Sample ID | Average (mrem) | Standard Deviation (mrem) | Median (mrem) | Minimum (mrem) | Maximum (mrem) |
|---|---|---|---|---|---|
| TLD-01 | 19.75 | 2.06 | 19.50 | 18.00 | 22.00 |
| TLD-02 | 28.75 | 2.87 | 27.50 | 27.00 | 33.00 |
| TLD-03* | 23.75 | 0.96 | 23.50 | 23.00 | 25.00 |
| TLD-04* | 20.75 | 0.96 | 20.50 | 20.00 | 22.00 |
| TLD-05* | 26.00 | 0.82 | 26.00 | 25.00 | 27.00 |
| TLD-06* | 20.75 | 0.96 | 20.50 | 20.00 | 22.00 |
| TLD-07* | 19.25 | 0.50 | 19.00 | 19.00 | 20.00 |
| TLD-08* | 24.00 | 1.41 | 23.50 | 23.00 | 26.00 |
| TLD-09* | 26.25 | 0.50 | 26.00 | 26.00 | 27.00 |
| TLD-10 | 23.00 | 2.00 | 24.00 | 20.00 | 24.00 |
| TLD-11 | 26.00 | 1.41 | 25.50 | 25.00 | 28.00 |
| TLD-12* | 22.75 | 0.96 | 22.50 | 22.00 | 24.00 |
| TLD-13* | 21.25 | 0.50 | 21.00 | 21.00 | 22.00 |
| TLD-14* | 27.25 | 1.71 | 27.50 | 25.00 | 29.00 |
| TLD-15 | 26.00 | 1.63 | 26.00 | 24.00 | 28.00 |
| TLD-16* | 21.67 | 0.58 | 22.00 | 21.00 | 22.00 |
| TLD-17* | 24.50 | 1.29 | 24.50 | 23.00 | 26.00 |
| TLD-18* | 23.50 | 1.00 | 23.00 | 23.00 | 25.00 |
| TLD-19 | 23.50 | 1.91 | 24.00 | 21.00 | 25.00 |

* Denotes a perimeter location.

## SUMMARY STATISTICS

### 2022 DHEC Air Station Gross Alpha Data in pCi/m$^3$

| Location | Average | Standard Deviation | Median | Minimum | Maximum | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| Allendale Barricade (ABR)* | 0.0027 | 0.0013 | 0.0024 | 0.0010 | 0.0067 | 50 | 51 |
| Darkhorse (DKH)* | 0.0034 | 0.0024 | 0.0026 | 0.0011 | 0.0145 | 51 | 51 |
| Aiken Elementary Water Tower (AIK) | 0.0024 | 0.0013 | 0.0021 | 0.0007 | 0.0066 | 52 | 52 |
| New Ellenton, S.C. (NEL)* | 0.0029 | 0.0013 | 0.0028 | 0.0011 | 0.0069 | 49 | 49 |
| Jackson, S.C. (JAK)* | 0.0024 | 0.0012 | 0.0021 | 0.0006 | 0.0064 | 51 | 51 |
| Burial Ground North (BGN) | 0.0030 | 0.0015 | 0.0027 | 0.0009 | 0.0082 | 51 | 51 |
| Barnwell Barricade (BWL)* | 0.0026 | 0.0012 | 0.0023 | 0.0010 | 0.0071 | 50 | 50 |

* Denotes a perimeter location.

### 2022 DHEC Air Station Gross Beta Data in pCi/m$^3$

| Location | Average | Standard Deviation | Median | Minimum | Maximum | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| Allendale Barricade (ABR)* | 0.0248 | 0.0085 | 0.0231 | 0.0130 | 0.0554 | 51 | 51 |
| Darkhorse (DKH)* | 0.0300 | 0.0181 | 0.0247 | 0.0127 | 0.0998 | 51 | 51 |
| Aiken Elementary Water Tower (AIK) | 0.0190 | 0.0060 | 0.0184 | 0.0102 | 0.0356 | 52 | 52 |
| New Ellenton, S.C. (NEL)* | 0.0229 | 0.0075 | 0.0223 | 0.0123 | 0.0469 | 49 | 49 |
| Jackson, S.C. (JAK)* | 0.0202 | 0.0071 | 0.0189 | 0.0101 | 0.0448 | 51 | 51 |
| Burial Ground North (BGN) | 0.0289 | 0.0125 | 0.0256 | 0.0124 | 0.0709 | 51 | 51 |
| Barnwell Barricade (BWL)* | 0.0241 | 0.0092 | 0.0230 | 0.0114 | 0.0569 | 50 | 50 |

* Denotes a perimeter location.



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## SUMMARY STATISTICS

### 2022 DHEC Air Station Tritium Data in pCi/m$^3$

| Location | Average | Standard Deviation | Median | Minimum | Maximum | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| Allendale Barricade (ABR)* | ND | ND | ND | ND | ND | 0 | 12 |
| Darkhorse (DKH)* | 4.58 | 0.68 | 4.70 | 3.65 | 5.26 | 4 | 12 |
| Aiken Elementary Water Tower (AIK) | ND | ND | ND | ND | ND | 0 | 12 |
| New Ellenton, S.C. (NEL)* | 3.56 | 0.41 | 3.44 | 3.25 | 4.29 | 5 | 12 |
| Jackson, S.C. (JAK)* | 3.48 | 0.53 | 3.43 | 2.92 | 4.15 | 4 | 12 |
| Burial Ground North (BGN) | 227.80 | 112.68 | 198.71 | 32.70 | 416.94 | 12 | 12 |
| Barnwell Barricade (BWL)* | 3.60 | 0.78 | 3.60 | 3.05 | 4.15 | 2 | 12 |

* Denotes a perimeter location.
ND is Not Detected

### 2022 DHEC Tritium in Precipitation Data in pCi/L

| Location | Average | Standard Deviation | Median | Minimum | Maximum | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| Allendale Barricade (ABR)* | ND | ND | ND | ND | ND | 0 | 12 |
| Darkhorse (DKH)* | ND | ND | ND | ND | ND | 0 | 12 |
| Aiken Elementary Water Tower (AIK) | ND | ND | ND | ND | ND | 0 | 12 |
| New Ellenton, S.C. (NEL)* | 539.12 | 204.65 | 539.12 | 394.41 | 683.83 | 2 | 12 |
| Jackson, S.C. (JAK)* | 309.44 | NA | NA | NA | NA | 1 | 12 |
| Burial Ground North (BGN) | 2667 | 1873.67 | 2340.47 | 365.00 | 7447.84 | 12 | 12 |
| Barnwell Barricade (BWL)* | ND | ND | ND | ND | ND | 0 | 12 |

* Denotes a perimeter location.
NA is Not Applicable
ND is Not Detected

**Chapter 2 Ambient Groundwater Monitoring Adjacent to SRS**



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### 2.1.0 PROJECT SUMMARY

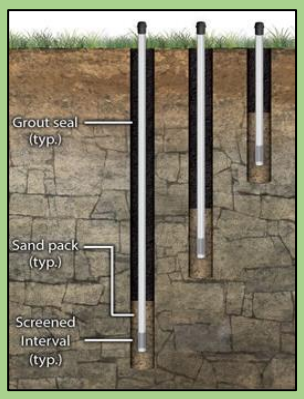
DHEC currently utilizes a regional groundwater monitoring well network consisting of cluster wells (C-wells) and network wells (private wells and public water systems). This groundwater well network consists of approximately 98 wells that are cyclically sampled every five years by DHEC. The C-wells are owned and maintained by the South Carolina Department of Natural Resources (DNR). These cluster wells are screened from shallow surficial aquifers to deeper aquifers up to depths exceeding 1,400 feet below ground surface. The C-well clusters are situated around the perimeter of SRS.

Groundwater samples are collected from wells within a 20-mile site boundary. A 20-mile sampling perimeter was selected based on regional well availability and comparative review of known or suspected sources of groundwater contamination and local groundwater flow patterns. The project map in Section 2.4.0 depicts the network groundwater well locations, the extent of the study area, and the wells sampled in 2022. DHEC evaluates four aquifer zones (Upper Three Runs, Gordon, Crouch Branch, and McQueen Branch).

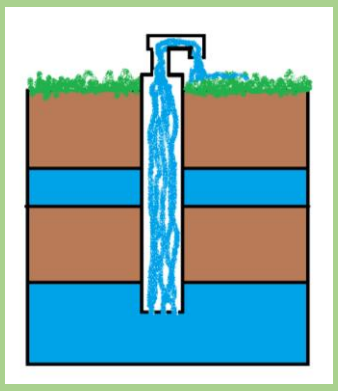
An **AQUIFER** is soil and/or rock containing water below the ground surface.

**CLUSTER WELLS vs. NETWORK WELLS**

**CLUSTER WELLS** are multiple wells that are at the same location but are drilled to varying depths to screen different aquifers.




**NETWORK WELLS** are single wells at a specific location screened in a specific aquifer.



### 2.2.0 RESULTS AND DISCUSSION

Groundwater Monitoring Data can be found in Section 2.6.0 and in the 2022 DHEC Data File.

DHEC collected groundwater from 21 wells. Based on a review of the tritium, gross alpha, non-volatile beta, and gamma-emitting radioisotope analytical data provided by the DHEC Analytical and Radiological Environmental Services Division (ARESD) laboratories, the only gamma-emitting radioisotope detected was Lead-214 (Pb-214). Pb-214 is a naturally occurring radioactive or NORM contaminant and was detected in 1 out of the 21 groundwater wells sampled. See Section 2.5.0, Table 1 for a list of the network of sampling wells with their assigned aquifer.

Groundwater investigations performed by state and federal agencies such as DHEC, DNR, and the United States Geological Survey (USGS) have confirmed the presence of naturally occurring radionuclides in groundwater across South Carolina (ATSDR, 2007). If known contaminants are found in wells located within the DHEC sampling network, the affected wells would be investigated further to help determine the source.

Residential Well

The United States Environmental Protection Agency (EPA) has a drinking water Maximum Contaminant Level (MCL) of 20,000 pCi/L for tritium, 15 pCi/L for gross alpha, and 50 pCi/L minus natural potassium-40 (K-40) for non-volatile beta (EPA, 2020). In 2022, DHEC did not detect tritium in any wells. 4 wells in 2 different aquifers (McQueen Branch and Upper Three Runs) had gross alpha detects below the EPA MCL. 2 wells in 2 different aquifers (McQueen Branch and Steed Pond) had non-volatile beta detects well below the EPA MCL.

With groundwater locations having a five-year collection cycle, the wells sampled in 2022 were last studied in 2017. Wells that were sampled in both 2017 and 2022 were found to have comparable data which can be found in the tables in Section 2.6.0. 19 new wells were added to the groundwater sampling network in 2022, so no data from 2017 were available for comparison. Wells that were not sampled were due to groundwater pump failures.

### 2.3.0 CONCLUSIONS AND RECOMMENDATIONS

DOE-SR collects groundwater samples from a separate on-site monitoring well network; therefore, direct DHEC off-site groundwater comparisons could not be made. However, the 2022 SRS report identifies various contaminants such as volatile organic compounds (VOCs), tritium, and gross alpha/beta radionuclides in numerous areas of groundwater throughout the SRS property (SRNS, 2023).

Collecting well water for analysis



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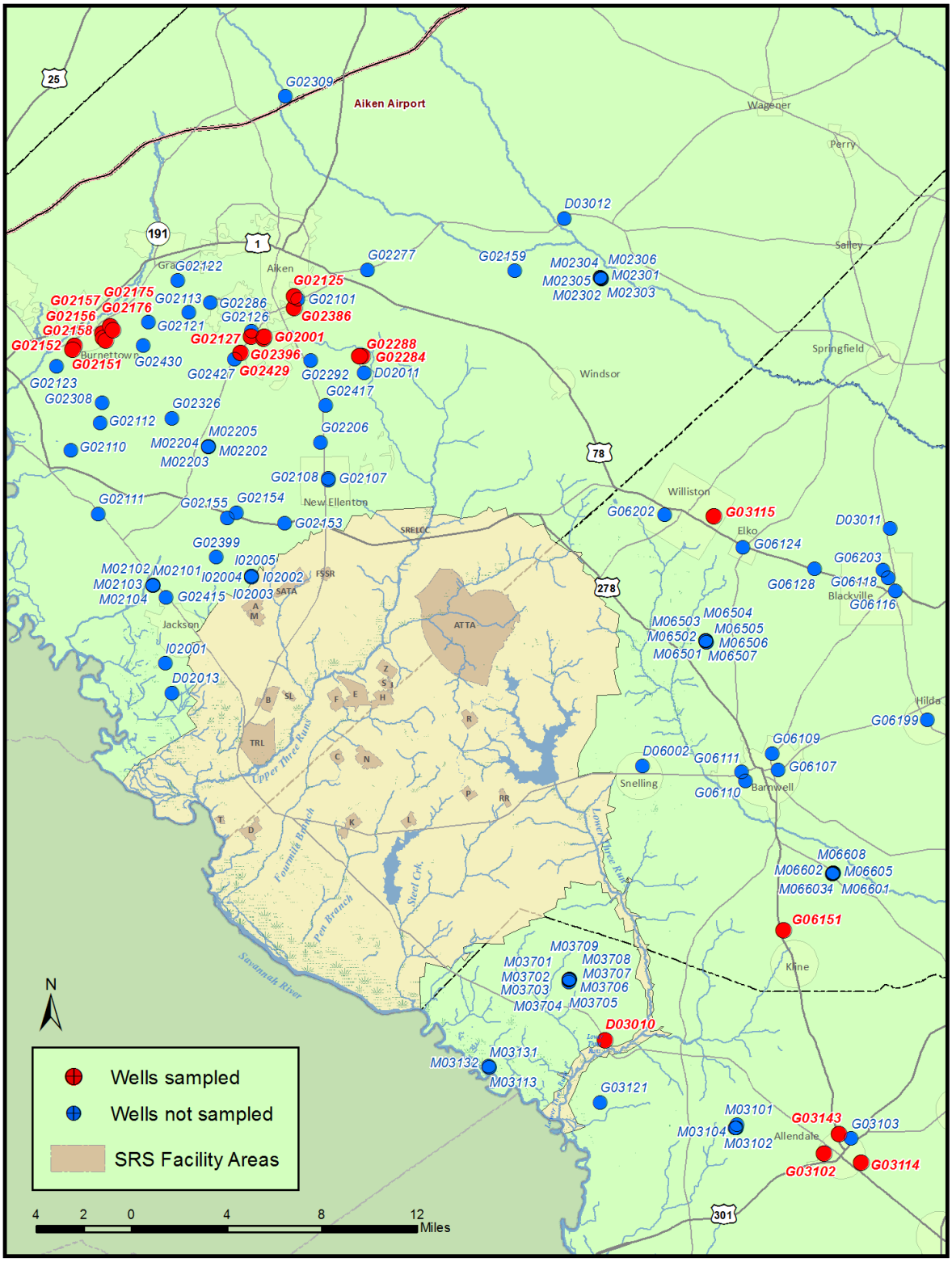
### 2.4.0 MAP

# Groundwater Sampling Locations




2022 ESOP Groundwater Monitoring Map www.scdhec.gov



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## 2.5.0 TABLES AND FIGURES

### Table 1. DHEC Groundwater Monitoring Wells

| Well No. | Well Name | Sample Year | Top of Casing Elevation (ft amsl) | Total Depth (ft bgs) | Aquifer |
|---|---|---|---|---|---|
| G02001 | Hidden Haven 2 | **2022** | 471 | 484 | MB |
| G02125 | Aiken Douglas Dr | **2022** | 483 | 480 | MB |
| G02127 | Aiken Woodside | **2022** | 491 | 407 | MB |
| G02429 | Aiken Silver Bluff 2 | **2022** | 451 | * | MB |
| G02386 | Aiken Robin Rd | **2022** | 492 | 430 | MB |
| G02396 | Aiken Hidden Haven 1 | **2022** | 494 | 504 | MB |
| G02284 | Aiken Vale 2 | **2022** | 435 | 300 | CB |
| G02288 | Aiken Vale/Tank | **2022** | 439 | 363 | CB |
| D03010 | Martin Post Office | **2022** | 108 | 105 | UTR |
| G02292** | Hunter's Glen | **2022** | 487 | 210 | SP |
| G03102 | Allendale, Water St. | **2022** | 201 | 343 | UTR |
| G03103** | Allendale, Googe St. | **2022** | 180 | 347 | UTR |
| G03114 | Allendale Patterson Street | **2022** | 172 | 308 | UTR |
| G03143 | Allendale Spruce Street | **2022** | 185 | 335 | UTR |
| G06151 | Chappels Labor Camp | **2022** | 250 | 260 | UTR |
| G02151 | Bath Well One - Tank Well | **2022** | 194 | 150 | SP |
| G02152 | Bath Well Two -Hill Well | **2022** | 217 | 100 | SP |
| G02157 | Burnettown Well Two | **2022** | 272 | 173 | SP |
| G02156 | Burnettown Well One | **2022** | 306 | 245 | SP |
| G02158 | Burnettown Well Three | **2022** | 312 | 180 | SP |
| G02175 | Langley Well One | **2022** | 206 | 100 | SP |
| G02176 | Langley Well Two | **2022** | 249 | 105 | SP |
| G03115 | Martin District Fire Department | **2022** | 95 | * | * |
| I02002 | Greene Irrigation 1 | 2023 | 381 | 278 | SP |
| I02003 | Greene Irrigation 2 | 2023 | 381 | 280 | SP |
| I02004 | Greene Irrigation 3 | 2023 | 373 | 276 | SP |
| I02005 | Greene Irrigation 4 | 2023 | 373 | 236 | SP |
| M02101 | SCDNR Cluster C-01, AIK-2378 | 2023 | 220.3 | 185 | CB |
| M02102 | SCDNR Cluster C-01, AIK-2379 | 2023 | 224.2 | 266 | CB |
| M02103 | SCDNR Cluster C-01, AIK-2380 | 2023 | 228.9 | 385 | MB |
| M02104 | SCDNR Cluster C-01, AIK-902 | 2023 | 231.9 | 511 | MB |
| M02202 | SCDNR Cluster C-02, AIK-825 | 2023 | 418.8 | 231 | CB |
| M02203 | SCDNR Cluster C-02, AIK-824 | 2023 | 418.6 | 365 | CB |
| M02204 | SCDNR Cluster C-02, AIK-818 | 2023 | 418.3 | 425 | MB |
| M02205 | SCDNR Cluster C-02, AIK-817 | 2023 | 418.9 | 535 | MB |
| M02301 | SCDNR Cluster C-03, AIK-849 | 2023 | 301.6 | 97 | SP |
| M02302 | SCDNR Cluster C-03, AIK-848 | 2023 | 299.7 | 131 | CB |
| M02303 | SCDNR Cluster C-03, AIK-847 | 2023 | 299 | 193 | CB |
| M02304 | SCDNR Cluster C-03, AIK-846 | 2023 | 297.8 | 255 | CB |
| M02305 | SCDNR Cluster C-03, AIK-845 | 2023 | 296.9 | 356 | MB |
| M02306 | SCDNR Cluster C-03, AIK-826 | 2023 | 294.9 | 500 | MB |
| M06501 | SCDNR Cluster C-05, BRN-360 | 2023 | 264.3 | 140 | UTR |
| M06502 | SCDNR Cluster C-05, BRN-359 | 2023 | 265.5 | 214 | GOR |
| M06503 | SCDNR Cluster C-05, BRN-367 | 2023 | 263.8 | 285 | GOR |
| M06504 | SCDNR Cluster C-05, BRN-368 | 2024 | 265.1 | 443 | CB |
| M06505 | SCDNR Cluster C-05, BRN-365 | 2024 | 263.5 | 539 | CB |
| M06506 | SCDNR Cluster C-05, BRN-366 | 2024 | 266.7 | 715 | MB |



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| | | | | | |
|---|---|---|---|---|---|
| M06507 | SCDNR Cluster C-05, BRN-358 | 2024 | 265.6 | 847 | MB |
| M03706 | SCDNR Cluster C-07, ALL-368 | 2024 | 246.6 | 691 | CB |
| M03707 | SCDNR Cluster C-07, ALL-369 | 2024 | 242.1 | 800 | CB |
| M03708 | SCDNR Cluster C-07, ALL-370 | 2024 | 245.1 | 975 | MB |
| M03709 | SCDNR Cluster C-07, ALL-358 | 2024 | 243.1 | 1123 | MB |
| M03701 | SCDNR Cluster C-07, ALL-363 | 2024 | 246.1 | 105 | UTR |
| M03702 | SCDNR Cluster C-07, ALL-364 | 2024 | 245.2 | 225 | UTR |
| M03703 | SCDNR Cluster C-07, ALL-365 | 2024 | 244.3 | 333 | GOR |
| M03704 | SCDNR Cluster C-07, ALL-366 | 2024 | 243.5 | 400 | GOR |
| M03705 | SCDNR Cluster C-07, ALL-367 | 2024 | 245.7 | 566 | CB |
| M06601 | SCDNR Cluster C-06, BRN-351 | 2024 | 207.3 | 95 | UTR |
| M06602 | SCDNR Cluster C-06, BRN-350 | 2024 | 207.4 | 170 | UTR |
| M06603 | SCDNR Cluster C-06, BRN-352 | 2024 | 207.1 | 293 | GOR |
| M06604 | SCDNR Cluster C-06, BRN-354 | 2024 | 207.6 | 411 | GOR |
| M06605 | SCDNR Cluster C-06, BRN-353 | 2024 | 207.7 | 588 | CB |
| M06608 | SCDNR Cluster C-06, BRN-349 | 2024 | 208.6 | 1045 | MB |
| M03101 | SCDNR Cluster C-10, ALL-347 | 2024 | 281.6 | 1423 | MB |
| M03102 | SCDNR Cluster C-10 ALL-372 | 2024 | 282 | 155 | UTR |
| M03103 | SCDNR Cluster C-10 ALL-371 | 2024 | 282.2 | 217 | UTR |
| M03113 | SCDNR Cluster C-13 Artesian | 2024 | 73 | * | GOR |
| M03132 | SCDNR Cluster C-13 ALL-378 | 2024 | 90 | 1060 | MB |
| M03131 | SCDNR Cluster C-13, Artesian | 2024 | 80 | ***** | GOR |
| M03104 | SCDNR Cluster C-10, ALL-374 | 2024 | 280.9 | 580 | GOR |
| G02206 | Oak Hill Subdivision | 2025 | 445 | 240 | SP |
| G06124 | Elko | 2025 | 351 | 353 | UTR |
| G06116 | Blackville Lartique St. | 2025 | 295 | 380 | UTR |
| G06118 | Blackville Greene Well | 2025 | 292 | 620 | GOR |
| G06203 | Blackville Industrial Park | 2025 | 273 | 425 | UTR |
| G06199 | Hilda | 2025 | 271 | 345 | UTR |
| G02309 | Aiken Shiloh Springs | 2025 | 362 | 50 | SP |
| G02101 | Aiken Pine Log Road | 2025 | 483 | 407 | MB |
| G02126 | Aiken Town Creek | 2025 | 508 | 400 | MB |
| G02427 | Aiken Silver Bluff | 2025 | 467 | * | MB |
| G02121 | Vally PSA Gloverville | 2025 | 413 | 242 | CB |
| G02286 | Vally PSA Walker | 2025 | 471 | 400 | MB |
| G02122 | Vally PSA Howlandville | 2025 | 483 | 323 | CB |
| G02123 | Valley PSA Johnstown | 2025 | 259 | 150 | CB |
| G02259 | Aiken State Park | 2025 | 262 | ***** | SP |
| G02153 | Talatha well #1 | 2025 | 420 | 280 | SP |
| G02154 | Talatha Well #2 | 2025 | 250 | 185 | CB |
| G02155 | Talatha Well #3 | 2025 | 343 | 240 | SP |
| G02399 | Jackson Well #3` | 2025 | 405 | 450 | CB |
| G02415 | Jackson Well #4 | 2025 | 339 | 400 | CB |
| G02110 | Beech Island Well #2 | 2025 | 417 | 468 | CB |
| G02111 | Beech Island Well #3 | 2025 | 369 | 460 | MB |
| G02112 | Beech Island Well #4 | 2025 | 380 | 600 | MB |
| G02113 | Beech Island Well #5 | 2025 | 508 | 438 | CB |
| G02308 | Beech Island Well #6 | 2025 | 448 | 400 | CB |
| G02430 | Beech Island Well Piney Hieghts | 2025 | 453 | 490 | CB |
| G02326 | Boyd Pond (Former ORA) | 2025 | 300 | 397 | MB |
| D02013 | Cowden Plantation, Well 2 | 2025 | 124 | ***** | SP |
| I02001 | Cowden Plantation, Well 1 | 2025 | 132 | ***** | CB |
| D02011 | Mettlen Well | 2025 | 400 | 180 | SP |



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| | | | | | |
|---|---|---|---|---|---|
| G02108 | New Elenton Well #1 | 2025 | 422 | 427 | CB |
| G02107 | New Elenton Well #2 | 2025 | 422 | 425 | CB |
| G02417 | New Ellenton Well #4 | 2025 | 488 | 565 | MB |
| G02277 | Montmorenci WD Office Well | 2025 | 504 | 363 | CB |
| G02159 | Montmorenci Well 1 | 2025 | 504 | 330 | CB |
| G06110 | Barnwell #10 Shuron | 2025 | 190 | 276 | UTR |
| G06109 | Barnwell, Hwy. 3 | 2026 | 230 | 146 | UTR |
| G06111 | Barnwell, Rose St. | 2026 | 220 | 166 | UTR |
| G06107 | Barnwell Shop Well | 2026 | 224 | 314 | GOR |
| D03011 | Healing Springs | 2026 | 240 | * | CB |
| D03012 | Cedar Creek Spring | 2026 | 271 | * | CB |
| G06128 | Edisto Station | 2026 | 322 | 360 | GOR |
| G06202 | Williston, Schuler St. | 2026 | 352 | 220 | GOR |
| D06002 | Moore Well | 2026 | 240 | * | UTR |

**Notes:**
ft amsl is feet above mean sea level
ft bgs is feet below ground surface
CB is Crouch Branch
MB is McQueen Branch
SP is Steeds Pond
UTR is Upper Three Runs
GOR is Gordon
* is total depth/top of casing information unknown.
** Well was unable to be sampled during the sampling cycle; however, it will remain in the network



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## 2.6.0 SUMMARY STATISTICS

### 2022 DHEC Alpha Detects in Groundwater Data in pCi/L

| Location Description | 2022 Result | Aquifer | 2017 Result |
|---|---|---|---|
| G02386 | <LLD | MB | NS – new location in 2022 |
| G02125 | 4.03E+00 | MB | NS – new location in 2022 |
| G02127 | 2.16E+00 | MB | NS – new location in 2022 |
| G02396 | <LLD | MB | NS – new location in 2022 |
| G02429 | <LLD | MB | NS – new location in 2022 |
| G02001 | 3.09E+00 | MB | NS – new location in 2022 |
| G02284 | <LLD | CB | NS – new location in 2022 |
| G02288 | <LLD | CB | NS – new location in 2022 |
| D03010 | <LLD | UTR | <LLD |
| G03115 | <LLD | * | <LLD |
| G03143 | <LLD | UTR | NS – new location in 2022 |
| G03102 | <LLD | UTR | NS |
| G03114 | 5.26E-01 | UTR | NS – new location in 2022 |
| G06151 | <LLD | UTR | <LLD |
| G03103 | NS | UTR | NS – new location in 2022 |
| G02175 | <LLD | SP | NS – new location in 2022 |
| G02176 | <LLD | SP | NS – new location in 2022 |
| G02157 | <LLD | SP | NS – new location in 2022 |
| G02156 | <LLD | SP | NS – new location in 2022 |
| G02158 | <LLD | SP | NS – new location in 2022 |
| G02151 | <LLD | SP | NS – new location in 2022 |
| G02152 | <LLD | SP | NS – new location in 2022 |
| G02292 | NS | SP | NS – new location in 2022 |

**2022 DHEC Beta Detects in Groundwater Data in pCi/L**

| Location Description | 2022 Result | Aquifer | 2017 Result |
|---|---|---|---|
| G02386 | <LLD | MB | NS – new location in 2022 |
| G02125 | 4.03E+00 | MB | NS – new location in 2022 |
| G02127 | 2.16E+00 | MB | NS - new location in 2022 |
| G02396 | <LLD | MB | NS – new location in 2022 |
| G02429 | <LLD | MB | NS – new location in 2022 |
| G02001 | 3.09E+00 | MB | NS – new location in 2022 |
| G02284 | <LLD | CB | NS – new location in 2022 |
| G02288 | <LLD | CB | NS – new location in 2022 |
| D03010 | <LLD | UTR | <LLD |
| G03115 | <LLD | * | <LLD |
| G03143 | <LLD | UTR | NS – new location in 2022 |
| G03102 | <LLD | UTR | NS |
| G03114 | 5.26E-01 | UTR | NS – new location in 2022 |
| G06151 | <LLD | UTR | <LLD |
| G03103 | NS | UTR | NS – new location in 2022 |
| G02175 | <LLD | SP | NS – new location in 2022 |
| G02176 | <LLD | SP | NS – new location in 2022 |
| G02157 | <LLD | SP | NS – new location in 2022 |
| G02156 | <LLD | SP | NS – new location in 2022 |
| G02158 | <LLD | SP | NS – new location in 2022 |
| G02151 | <LLD | SP | NS – new location in 2022 |
| G02152 | <LLD | SP | NS – new location in 2022 |
| G02292 | NS | SP | NS – new location in 2022 |

* is total depth/top of casing information unknown. NS means Not Sampled
<LLD means Less than the Lower Limit of Detection
2017 results are found in the *2017 ESOP Data Report* (DHEC, 2019)



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**Chapter 3 Radiological Monitoring of Drinking Water Adjacent to SRS**



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### 3.1.0 PROJECT SUMMARY

DHEC evaluates drinking water quality to provide information on the radiological impact of SRS to community drinking water systems adjacent to and downstream of the site. DHEC samples five drinking water systems. Monthly composite samples are taken from three Savannah River-fed systems: one upstream location (North Augusta) and two downstream of SRS (Purrysburg Beaufort/Jasper (B/J) and Chelsea B/J). Additionally, two public drinking water systems that are not primarily served by the Savannah River but draw from surface water sources were sampled each month (Aiken Public Shaw Creek Water Works Treatment Plant and Breezy Hill Water Treatment Plant). These systems are located outside of the SRS perimeter and are up to 30 miles from the center of the site (Map, Section 3.4.0).

**SURFACE WATER** – water that collects on the surface of the ground in the form of streams, ponds, lakes, rivers, or the ocean.

**GROUNDWATER**– water stored underground in sediment pores or crevices in rock. It may eventually be used by plants, taken up through wells by humans, or discharge into another body of water.

**DRINKING WATER** – surface water or groundwater that has been treated through a cleaning process to be available for healthy consumption by humans.

In 2022, DOE-SR collected drinking water from two surface water-fed systems (North Augusta and Purrysburg B/J) that are collocated with the DHEC Savannah River-fed systems. Currently, DOE-SR does not conduct drinking water sampling from other public systems off SRS property. DHEC and DOE-SR analyze and compare all samples for gross alpha, non-volatile beta, gamma-emitting radionuclides, and tritium.

### 3.2.0 RESULTS AND DISCUSSION


Three locations' samples waiting to be analyzed

In 2022, DHEC and DOE-SR detected tritium above the lower limit of detection (LLD) in the Savannah River-fed systems downstream of SRS. These activities are well below the EPA established 20,000 pCi/L drinking water limit (EPA, 2020).

Gamma-emitting radionuclides in the List of Analytes, Table 1, page ix, were not detected above the MDA for the drinking water samples collected by DHEC or in DOE-SR's collocated samples in 2022.

Gross alpha, tritium and non-volatile beta sample results are presented in the following tables in Section 3.5.0 and can be found in the 2022 DHEC Data File. All results are below their respective EPA MCLs.



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### 3.3.0 CONCLUSIONS AND RECOMMENDATIONS

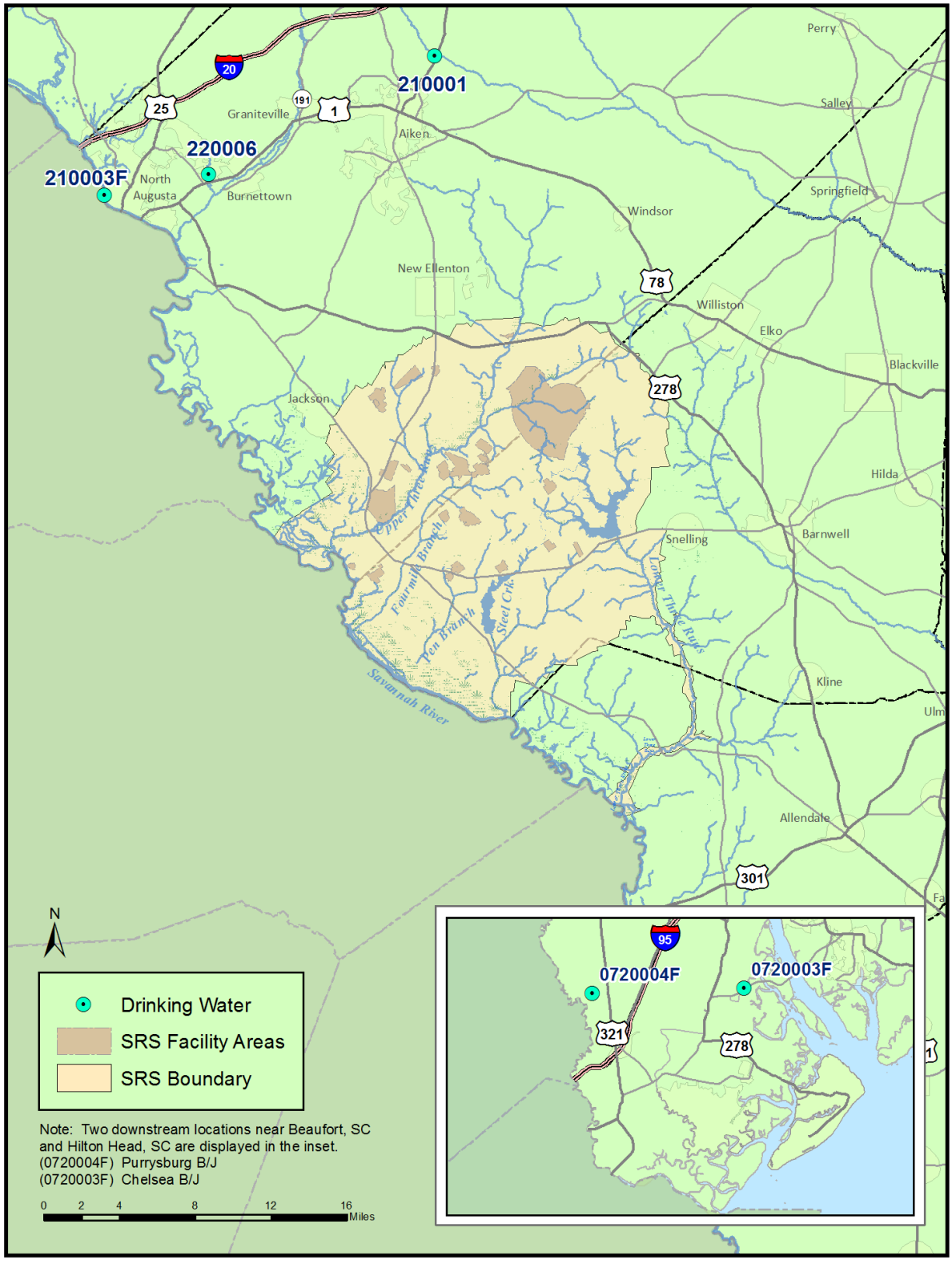
Tritium continues to be the most abundant radionuclide detected in public drinking water supplies potentially affected by SRS. Observed tritium activities were low when compared to the EPA MCL for tritium in drinking water, which is 20,000 pCi/L. Detections of gross alpha and non-volatile beta were all below their respective MCLs. DOE-SR does not sample systems not served by the Savannah River; therefore, DHEC will continue to monitor these off-site public water systems in the event these wells are affected by contaminated groundwater from SRS.

The DHEC Drinking Water Monitoring Project continues to be an important source of essential data for assessing human health exposure pathways. DHEC will continue to monitor surface water quality due to the extent of the surface water contamination on SRS and its potential to migrate, and potentially affect, drinking water systems downstream from SRS. Continued sampling will also provide the public with an independent source of radiological data for drinking water systems within the SRS study area.

DHEC continues to reevaluate the drinking water systems monitored by the drinking water project. Primary and background drinking water systems will be added and removed from the list of sampled drinking water systems as deemed necessary to maintain monitoring coverage.

### 3.4.0 MAP

## Drinking Water Sampling Locations

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### 3.5.0 TABLES AND FIGURES

**Table 1. Drinking Water Systems Sampled by DHEC**

| System Number | System Name | Number of Taps | Population |
|---|---|---|---|
| 210001 | Aiken | 20,292 | 45,090 |
| 220006 | Breezy Hill Water District | 7,709 | 17,822 |
| 0210003F | North Augusta | 13,366 | 30,110 |
| 0720003F | Chelsea B/J | 61,769 | 196,061 |
| 0720004F | Purrysburg B/J | 96 | 280 |
| | **Total** | | |
| | Savannah River-fed systems downstream from SRS | 61,865 | 196,341 |
| | Systems not fed from the Savannah River downstream of SRS | 41,367 | 93,022 |

Data was obtained from DHEC's Environmental Facility Information System database.

**Note for Table 2-6: Summary statistics are not shown for locations whose analytes had either no detections or only one detection. If a location did have multiple detections for a specific analyte, the summary statistics are written as a note below its table.**

**Table 2: 2022 DHEC and DOE-SR DW Data for North Augusta (DW210003F) in pCi/L (SRNS, 2023)**

| Month | DHEC Total Alpha | DHEC Nonvolatile Beta | DHEC Tritium | DOE-SR Total Alpha | DOE-SR Nonvolatile Beta | DOE-SR Tritium |
|---|---|---|---|---|---|---|
| **JAN** | ND | ND | ND | ND | 1.96 | 139 |
| **FEB** | ND | ND | ND | ND | 1.55 | ND |
| **MAR** | ND | ND | ND | ND | 2.06 | ND |
| **APR** | AE | AE | ND | ND | 1.83 | ND |
| **MAY** | AE | AE | ND | ND | 1.52 | ND |
| **JUN** | ND | ND | ND | ND | 1.63 | 148 |
| **JUL** | ND | ND | ND | ND | 2.81 | ND |
| **AUG** | ND | ND | ND | ND | 1.79 | ND |
| **SEP** | ND | ND | ND | ND | 1.96 | ND |
| **OCT** | ND | ND | ND | ND | 2.06 | ND |
| **NOV** | ND | 3.76 | ND | ND | 2.01 | ND |
| **DEC** | ND | ND | ND | ND | 1.87 | ND |

Note: 1) In pCi/L, DOE-SR Nonvolatile Beta summary statistics: Average = 1.92, Standard Deviation = 0.34, Median = 1.92, Minimum = 1.52, Maximum = 2.81, Number of Detections = 12, Number of Samples = 12.
2) In pCi/L, DOE-SR Tritium Summary Statistics: Average = 143.50, Standard Deviation = 6.36, Median = 143.50, Minimum = 139.00, Maximum = 148.00, Number of Detects = 2, Number of Samples = 12.

**TABLES AND FIGURES CONT.**

**Table 3: 2022 DHEC and DOE-SR DW Data for Purrysburg B/J Water Treatment Plant (DW720004F) in pCi/L (SRNS, 2023)**

| Month | DHEC Total Alpha | DHEC Nonvolatile Beta | DHEC Tritium | DOE-SR Total Alpha | DOE-SR Nonvolatile Beta | DOE-SR Tritium |
|---|---|---|---|---|---|---|
| **JAN** | ND | ND | 324 | ND | 1.56 | ND |
| **FEB** | ND | ND | ND | ND | 1.63 | ND |
| **MAR** | ND | ND | ND | ND | 2.16 | 305 |
| **APR** | AE | AE | 256 | ND | 2.05 | 174 |
| **MAY** | AE | AE | ND | ND | 1.84 | 145 |
| **JUN** | ND | ND | ND | ND | 1.91 | 195 |
| **JUL** | ND | ND | 290 | ND | 1.54 | ND |
| **AUG** | ND | 6.74 | ND | ND | 2.32 | ND |
| **SEP** | ND | ND | 330 | 0.55 | 1.49 | ND |
| **OCT** | ND | ND | ND | ND | 2.15 | ND |
| **NOV** | ND | ND | ND | ND | 1.84 | ND |
| **DEC** | ND | ND | 329 | ND | 2.26 | 374 |

Note: 1). In pCi/L, DHEC Tritium summary statistics: Average = 305.82, Standard Deviation = 32.45, Median = 324.00, Minimum = 255.86, Maximum = 330.18, Number of Detections = 5, Number of Samples = 12.
2). In pCi/L, DOE-SR Nonvolatile Beta summary statistics: Average = 1.90, Standard Deviation = 0.29, Median = 1.88, Minimum = 1.49, Maximum = 2.32, Number of Detections = 12, Number of Samples = 12.
3). In pCi/L, DOE-SR Tritum summary statistics: Average = 238.60, Standard Deviation = 96.92, Median = 195.00, Minimum = 145.00, Maximum = 374.00, Number of Detections = 5, Number of Samples = 12.



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**TABLES AND FIGURES CONT.**

**Table 4: 2022 DHEC DW Data for Chelsea B/J Water Treatment Plant (DW720003F) in pCi/L**

| Month | Total Alpha | Nonvolatile Beta | Tritium |
|---|---|---|---|
| **JAN** | ND | 3.68 | ND |
| **FEB** | ND | ND | ND |
| **MAR** | ND | ND | 450 |
| **APR** | AE | AE | ND |
| **MAY** | AE | AE | ND |
| **JUN** | ND | ND | ND |
| **JUL** | ND | ND | ND |
| **AUG** | ND | ND | 270 |
| **SEP** | ND | ND | ND |
| **OCT** | ND | ND | ND |
| **NOV** | ND | ND | ND |
| **DEC** | ND | 6.24 | 323 |

Note: 1) Tritium summary statistics in pCi/L were calculated as: Average = 347.50, Standard Deviation = 92.41, Median = 323.41, Minimum = 269.51, Maximum = 449.57, Number of Detections = 3, Number of Samples = 12.
2) Nonvolatile Beta summary statistics in pCi/L were calculated as: Average = 4.96, Standard Deviation = 1.81, Median = 4.96, Minimum = 3.68, Maximum = 6.24, Number of Detections = 2, Number of Samples = 12.

**Table 5: 2022 DHEC DW Data for Aiken Public Shaw Creek Water Works Treatment Plant (DW210001) in pCi/L**

| Month | Total Alpha | Nonvolatile Beta | Tritium |
|---|---|---|---|
| **JAN** | ND | ND | ND |
| **FEB** | ND | ND | ND |
| **MAR** | 2.22 | ND | ND |
| **APR** | AE | AE | ND |
| **MAY** | AE | AE | ND |
| **JUN** | ND | ND | ND |
| **JUL** | ND | ND | ND |
| **AUG** | ND | ND | ND |
| **SEP** | ND | ND | ND |
| **OCT** | ND | ND | ND |
| **NOV** | ND | ND | ND |
| **DEC** | ND | ND | ND |



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**TABLES AND FIGURES CONT.**

**Table 6: 2022 DHEC DW Data for Breezy Hill Water Treatment Plant (DW220006) in pCi/L**

| Month | Total Alpha | Nonvolatile Beta | Tritium |
|---|---|---|---|
| **JAN** | ND | ND | ND |
| **FEB** | ND | ND | ND |
| **MAR** | ND | ND | ND |
| **APR** | AE | AE | AE |
| **MAY** | AE | AE | AE |
| **JUN** | ND | ND | ND |
| **JUL** | ND | ND | ND |
| **AUG** | ND | ND | ND |
| **SEP** | ND | ND | ND |
| **OCT** | ND | ND | ND |
| **NOV** | ND | ND | ND |
| **DEC** | ND | ND | ND |

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## Chapter 4 Radiological Monitoring of Surface Water on and Adjacent to SRS

### 4.1.0 PROJECT SUMMARY

The focus of the Radiological Monitoring of Surface Water (RSW) project is to test and survey the streams and creeks on SRS as well as the Savannah River. Since the Savannah River is the primary drinking water source for some downstream communities, it is important to monitor radionuclide concentrations in the river. Surface water samples are collected and analyzed for radionuclides, and the results are compared to DOE-SR data. DHEC supports DOE-SR's objectives to ensure that the primary goal of drinking water safety is established and met.

Collecting a composite sample

DHEC collects surface water samples from 13 specific locations within and outside of the SRS boundary as part of an ambient sampling network (Section 4.4.0, Map). Section 4.5.0, Table 1, identifies sample ID, location, rationale, and frequency. Some locations were chosen because they are considered public access locations. All but one of the public access locations are downstream of SRS, which provide a potential means for exposure to radionuclides. Jackson Boat Landing (SV-2010) is upstream from SRS activities and is a public access location.

Quarterly samples are collected for tritium analysis from the 5 creek mouths that flow from SRS directly into the Savannah River (Upper Three Runs Creek, Fourmile Branch, Steel Creek, Vogtle Output, and Lower Three Runs Creek). Pen Branch is not sampled because the Savannah River Swamp interrupts the flow of this creek and there is no creek mouth access.

An enhanced surface water monitoring program was implemented to provide downstream drinking water systems with advance notice of the potential for increased tritium levels in the Savannah River. This early detection facet is possible because of the continuous monitoring of the five SRS streams that flow to the Savannah River. Samples for tritium analysis are collected from six locations with automatic water samplers. Additionally, a grab sample is collected from Johnson's Boat Landing (SV-2080) and U.S. Highway 301 at the Savannah River (SV-118).

Example of a Grab Sample

In 2019, the Supplemental Surface Water Monitoring Program was modified from serving as an early detection system for unplanned releases from SRS source term areas to being collected monthly. Samples from Upper Three Runs, Fourmile Branch, and Steel Creek are analyzed for gamma-emitting radionuclides. In 2019, Steel Creek (SV-2052) began being sampled on a weekly basis and analyzed for tritium.

Quarterly sampling for I-129 and Tc-99 is conducted at the supplemental location on Fourmile Branch at Road C (SV-



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2044) due to concerns that these are possible constituents related to effluent from the burial grounds, which could enter the surface water.

### 4.2.0 RESULTS AND DISCUSSION

Radiological Monitoring of Surface Water Summary Statistics can be found in Section 4.6.0 and all Radiological Monitoring of Surface Water Data can be found in the 2022 DHEC Data File. The data presented in this section concerns the DHEC ambient sampling network including the Savannah River and on-site streams. The enhanced sample data are not displayed in the annual report and data file due to their sole purpose of serving as an early detection system for downstream drinking water users.

DHEC data from 2022 was compared to DOE-SR reported results (Section 4.5.0, Tables 2, 3, and 4). The DHEC and DOE-SR collocated sampling sites were Tims Branch at Road C, Upper Three Runs Creek at Road A, Fourmile Branch at Road A-12.2, Pen Branch at Road A-13.2, Steel Creek at Road A, the Savannah River at U.S. Highway 301 Bridge, and Lower Three Runs Creek at Road B. DOE-SR sampled at several other locations along these streams. However, the data comparisons are only for the collocated sample sites.

Pouring a sample to be tested for gamma-emitting radionuclides

Tritium

In 2022, DHEC and DOE-SR had detections for tritium at all collocated sample locations except for Lower Three Runs for DOE (Section 4.5.0, Table 2). DHEC average tritium activities at Jackson Boat Landing (SV-2010) and Upper Three Runs Creek at United States Forestry Service (USFS) Road 2-1 (SV-2027) were not directly affected by SRS operations. These locations are upstream from SRS impacts and are considered background locations. DHEC and DOE-SR samples indicate that Fourmile Branch (SV-2039) and Pen Branch (SV-2047) have the highest average tritium activity of all SRS streams. The 2022 DHEC and DOE-SR tritium results appear to be consistent with historically reported data values (Section 4.5.0, Figures 2-7). Section 4.5.0, Figure 1 shows trending data for DHEC tritium averages for the past five years.

Collecting grab samples during a boat run

Tritium activity in the Savannah River at the creek mouths of the 5 SRS streams are typically monitored on a quarterly basis. Samples collected at the creek mouth of Steel Creek (SV-2017) had the highest average tritium activity of 742 pCi/L of all creek mouth locations.

Gamma

As part of a gamma spectroscopy analysis, samples were analyzed monthly for gamma-emitting radionuclides (List of Analytes, Table 1, page ix). DHEC had no detections of Cs-137 or Pb-214 which is considered NORM. For DOE-SR, there were no detections of Cs-137 in creek mouths and on-site but there were detections of Am-241 (average of 0.01 pCi/L) at RWSV-118. RWSV-2047, RWSV-325, and RWSV-2017. Pu-238, U-234, U-235, and U-238 were not detected in DOE-SR..

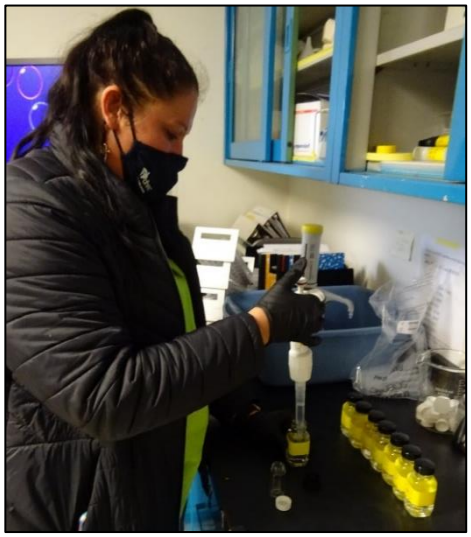
Iodine-129 and Technetium-99

4 quarterly I-129 samples at Fourmile Branch at Road C had a detection above the MDA with an average of 0.83 pCi/L. 4 quarterly samples had no Tc-99 detections. DHEC and DOE-SR do not have collocated sampling sites for I-129 and Tc-99.

I-129 and Tc-99 are included under the EPA established MCL of 4 millirem per year. The average concentration of I-129, which is assumed to yield 4 millirem per year, is 1 pCi/L. If other radionuclides emitting beta particles and photon radioactivity are present in addition to I-129 and Tc-99, the sum of the annual dose from all the radionuclides shall not exceed 4 millirem/year (EPA, 2020).

Alpha

DHEC's and DOE-SR's Upper Three Runs Creek at SC 125 samples exhibited the highest alpha activity of the collocated locations with an average of 4.34 pCi/L (DHEC) and 15.03 pCi/L (DOE-SR) (Section 4.5.0, Table 3, SRNS, 2023). Historically, Upper Three Runs Creek at SC 125 (SV-325) yields detections for alpha activity (DHEC, 2019-2022). Isotopic analysis performed by DOE-SR revealed the source to be natural uranium (SRNS, 2013). This may contribute to the common occurrence of alpha detections at this location. The 2022 average alpha activity was below the EPA MCL for drinking water of 15 pCi/L (EPA, 2020). Beginning in 2009, samples collected at this location exhibited particles of sediment and detritus. This increase in turbidity seems to be related to storm events. Samples with high turbidity can have potential



Pipetting samples in preparation for tritium analysis



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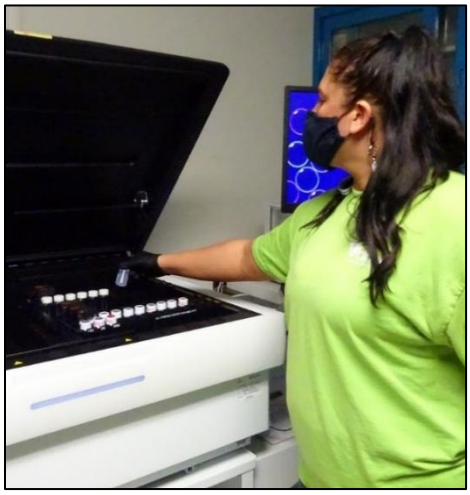
interferences during alpha/beta analysis. Alpha particles, and to a lesser extent, beta particles, are reduced by salts and solids dried onto a sampling planchet (Floeckher, 2000). Pump tubing is evaluated during each sample collection at all locations to ensure no blockage of sediment has occurred.



Preparing for tritium analysis in a Liquid Scintillation Counter

Beta

The sample exhibiting the highest average gross beta activity for DHEC was from Fourmile Branch at Rd. A-12.2 (SV-2039) with an average of 5.92 pCi/L (DHEC) while the highest average gross beta activity for DOE-SR was from Upper Three Runs Creek (SV-325) with an average of 8.45 pCi/L (DOE-SR) (SRNS, 2023).. EPA has established a Maximum Contaminant Level (MCL) of 4 millirem per year for beta particle and photon radioactivity from man-made radionuclides in drinking water. The EPA screening MCL for gross beta-emitting particles for drinking water systems is 50 pCi/L minus natural potassium-40 (K-40) (EPA, 2020). All averages were below this limit.

### 4.3.0 CONCLUSIONS AND RECOMMENDATIONS

Differences in average values between DHEC and DOE-SR could be attributed, in part, to the nature of the medium and the specific point and time of when the sample was collected. DHEC will continue independent collection and analysis of surface water on and adjacent to SRS. This monitoring effort will provide an improved understanding of radionuclide levels in SRS surface waters. DHEC will periodically evaluate modifying the monitoring activities to better accomplish the project's goals and objectives. Further refinement of the RSW project may result in additional sampling locations being incorporated into the ambient or enhanced monitoring regimes. Monitoring will continue for as long as there are activities at SRS that create the potential for contamination to enter the environment, as well as past radioactive contamination that still exists due to unexpired half-lives.



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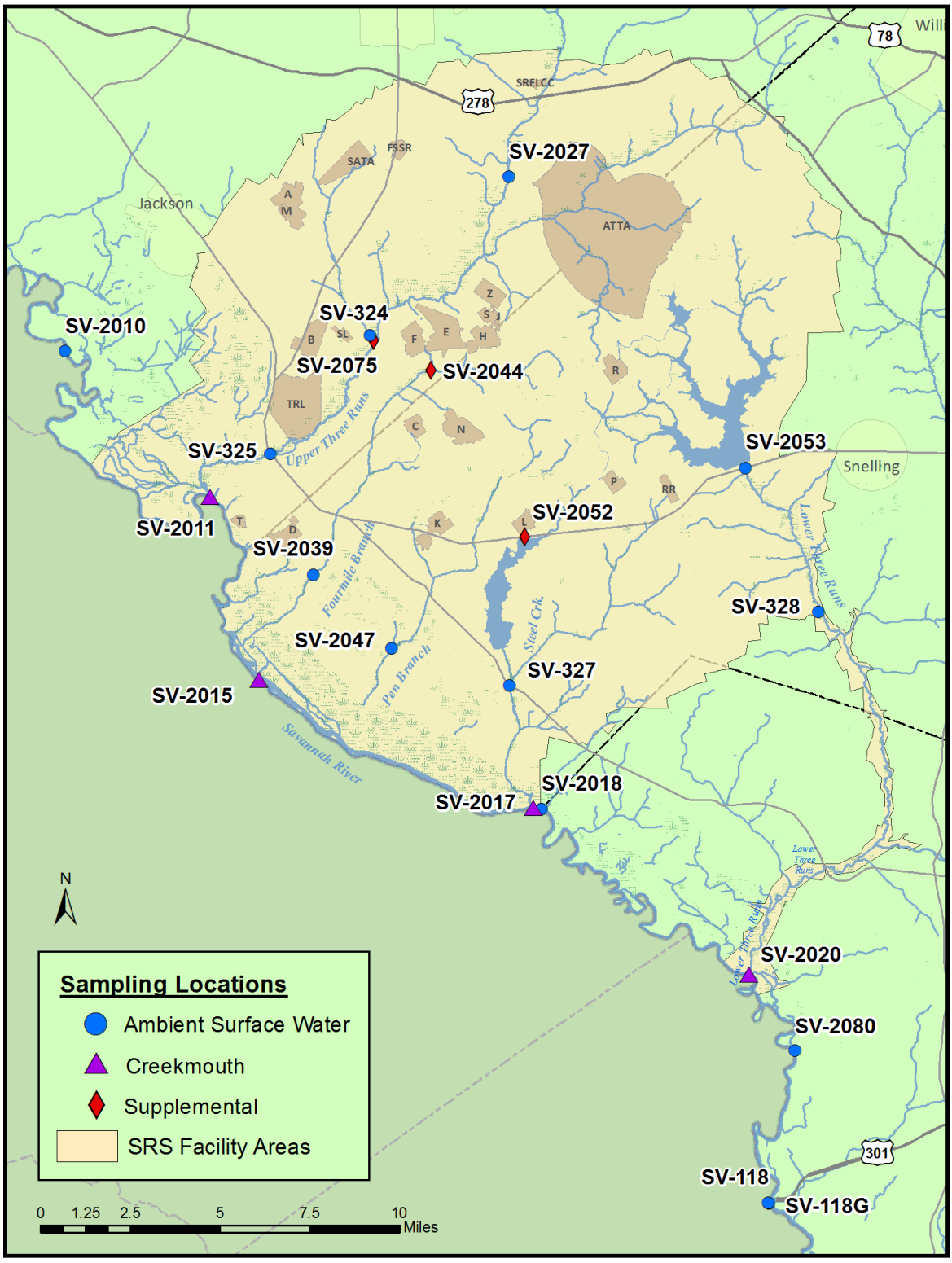
### 4.4.0 MAP

## Radiological Surface Water Monitoring Locations

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## 4.5.0 TABLES AND FIGURES

### Table 1. 2022 Surface Water Sampling Locations and Frequency

### Ambient Monitoring Locations

| ID | Location | Rationale | Frequency |
|---|---|---|---|
| **SV-2010** | Savannah River at RM 170.5 (Jackson Boat Landing) | Accessible to public; upstream all SRS operations; Near Jackson population center; Up-river control; River monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-324*** | Tims Branch at SRS Road C | Within SRS perimeter; Downstream of SRS operations areas; Tributary monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-325*** | Upper Three Runs Creek at S.C. 125 (SRS Road A) | Within SRS perimeter; Downstream of SRS operations areas; Tributary monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-2039*** | Fourmile Branch at Road A-12.2 | Within SRS perimeter; Downstream of SRS operations areas; Tributary monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-2047*** | Pen Branch at Road A-13.2 | Within SRS perimeter; Downstream of SRS operations areas; Tributary monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-327*** | Steel Creek at S.C. 125 (SRS Road A) | Within SRS perimeter; Downstream of SRS operations areas; Tributary monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-2018** | Savannah River at RM 141 (Steel Creek Boat Landing) | Accessible to the public; Adjacent to SRS perimeter; Downstream of SRS operations; River monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-2080** | Savannah River at RM 125 (Johnson's Boat Landing) | Accessible to the public; Downstream of SRS operations and tributaries; River monitoring | Tri-weekly tritium grab |
| **SV-118*** | Savannah River at RM 118.8 (Hwy 301 Bridge) | Accessible to the public; Downstream of SRS operations and tributaries; River monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-328** | Lower Three Runs Creek at Patterson Mill Road | Within SRS perimeter; Downstream of SRS operations and Par Pond; Tributary monitoring | Weekly tritium grab |
| **SV-2053*** | Lower Three Runs Creek at Road B | Within SRS perimeter; Downstream of SRS operations and Par Pond; Tributary monitoring | Weekly tritium; Monthly Alpha, Beta, and Gamma composite |
| **SV-2027** | Upper Three Runs Creek at SRS Road 2-1 | Within SRS perimeter; Upstream from SRS operations; Upstream control; Tributary monitoring | Weekly tritium grab |
| **SV-2040** | Beaver Dam Creek | Downstream of past operations in D Area | Monthly tritium grab |

## TABLES AND FIGURES

### Table 1. (Cont.)

### Creek Mouth Locations

| ID | Location | Rationale | Frequency |
|---|---|---|---|
| **SV-2011** | Upper Three Runs Creek Mouth at RM 157.4 | Accessible to public; Adjacent to SRS; Downstream of SRS operation areas; Tributary monitoring | Quarterly tritium |
| **SV-2015** | Fourmile Branch at RM 150.6 | Accessible to public; Adjacent to SRS; Downstream of SRS operation areas; Tributary monitoring | Quarterly tritium |
| **SV-2017** | Steel Creek Mouth at RM 141.5 | Accessible to public; Adjacent to SRS; Downstream of SRS operation areas; Tributary monitoring | Quarterly tritium |
| **SV-2020** | Lower Three Runs Creek at RM 129.1 | Accessible to public; Adjacent to SRS; Downstream of SRS operation areas; Tributary monitoring | Quarterly tritium |
| **VOGTLE** | Vogtle output | Adjacent to SRS; Tributary monitoring; Adjacent Nuclear Power Station | Quarterly tritium |

### Supplemental Locations

| ID | Location | Rationale | Frequency |
|---|---|---|---|
| **SV-2075*** | Upper Three Runs Creek at Road C | Downstream from F-and H-Areas HLW Tanks | Monthly gamma composite |
| **SV-2044*** | Fourmile Branch at Road C | Downstream from F-and H-Areas HLW I Tanks | Monthly gamma composite |
| **SV-2052*** | Steel Creek at the top of L-Lake | Downstream from P- and L- Areas | Weekly tritium, Monthly gamma composite |

Notes:
1). ID is Sampling Location Identification Code Number
2). RM is River Mile
3). HLW is High-Level Waste
4). LLW is Low-Level Waste
5). Tri-Weekly Enhanced sample data is used for detection purposes only
6). * Indicates a location that is collocated with DOE sampling



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## TABLES AND FIGURES

**Table 2. 2022 Tritium Data Comparison for DHEC and DOE-SR Collocated Sampling Locations**

| Sample Location | Sample ID | Average Concentration (pCi/L) | Standard Deviation (pCi/L) | Median (pCi/L) | Minimum Detect (pCi/L) | Maximum Detect (pCi/L) | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|---|
| Tims Branch at Road C | SV-324 | 301 | 52 | 280 | 243 | 405 | 16 | 52 |
| | TB-5 | 543.33 | 147.86 | 462.00 | 454.00 | 714.00 | 3 | 12 |
| Upper Three Runs Creek at Road A | SV-325 | 567 | 239 | 511 | 271 | 1343 | 52 | 52 |
| | U3R-4 | 587.00 | 126.78 | 546.00 | 478.00 | 773.00 | 5 | 13 |
| Fourmile Branch at Road A-12.2 | SV-2039 | 18916 | 2257 | 19650 | 12714 | 22427 | 48 | 48 |
| | FM-6 | 17358.33 | 1835.74 | 17400.00 | 14200.00 | 19900.00 | 12 | 12 |
| Pen Branch at Road A-13.2 | SV-2047 | 9086 | 1610 | 9076 | 5066 | 11984 | 52 | 52 |
| | PB-3 | 8230.83 | 994.59 | 8120.00 | 6820.00 | 9710.00 | 12 | 12 |
| Steel Creek at Road A | SV-327 | 1621 | 1053 | 1416 | 1078 | 7817 | 52 | 52 |
| | SC-4 | 1197.58 | 262.46 | 1120.00 | 879.00 | 1710.00 | 12 | 12 |
| Highway 301 Bridge at RM 118.8 | SV-118 | 467 | 211 | 397 | 274 | 1116 | 20 | 52 |
| | RM 118 | 308.24 | 190.36 | 240.00 | 134.00 | 1080.00 | 38 | 53 |
| Lower Three Runs Creek at Road B | SV-2053 | 271 | 31 | 264 | 241 | 324 | 6 | 52 |
| | L3R-1A | ND | ND | ND | ND | ND | 0 | 12 |

Shaded areas represent DHEC data and unshaded areas represent DOE-SR data
DOE-SR data is from the SRS Environmental Data Report for 2022 (SRNS, 2023)
ND is Not Detected
NA is Not Applicable
* Indicates a single detection



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## TABLES AND FIGURES

**Table 3. 2022 Alpha Data Comparison for DHEC and DOE-SR Collocated Sampling Locations**

| Sample Location | Sample ID | Average Concentration (pCi/L) | Standard Deviation (pCi/L) | Median (pCi/L) | Minimum Detect (pCi/L) | Maximum Detect (pCi/L) | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|---|
| Tims Branch at Road C | SV-324 | 2.56 | 1.07 | 2.24 | 1.40 | 4.53 | 7 | 12 |
| | TB-5 | 4.85 | 6.35 | 3.10 | 1.48 | 24.60 | 12 | 12 |
| Upper Three Runs Creek at Road A | SV-325 | 4.34 | 2.25 | 3.37 | 2.22 | 8.52 | 8 | 12 |
| | U3R-4 | 15.03 | 12.21 | 13.10 | 2.00 | 39.13 | 13 | 13 |
| Fourmile Branch at Road A-12.2 | SV-2039 | ND | ND | ND | ND | ND | 0 | 12 |
| | FM-6 | 1.75 | 1.78 | 1.76 | 0.21 | 6.38 | 11 | 12 |
| Pen Branch at Road A-13.2 | SV-2047 | ND | ND | ND | ND | ND | 0 | 12 |
| | PB-3 | 3.36 | 3.68 | 1.22 | 0.39 | 9.83 | 11 | 12 |
| Steel Creek at Road A | SV-327 | ND | ND | ND | ND | ND | 0 | 12 |
| | SC-4 | 1.78 | 2.74 | 0.84 | 0.26 | 10.20 | 12 | 12 |
| Highway 301 Bridge at RM 118.8 | SV-118 | ND | ND | ND | ND | ND | 0 | 12 |
| | RM 118 | 0.34 | 0.08 | 0.32 | 0.22 | 0.51 | 22 | 54 |
| Lower Three Runs Creek at Road B | SV-2053 | 2.41 | NA | NA | NA | NA | 1 | 12 |
| | L3R-1A | 0.65 | 0.40 | 0.68 | 0.22 | 1.46 | 8 | 12 |

Shaded areas represent DHEC data and unshaded areas represent DOE-SR data
DOE-SR data is from the SRS Environmental Data Report for 2022 (SRNS, 2023)
ND is Not Detected
NA is Not Applicable
* Indicates a single detection



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## TABLES AND FIGURES

**Table 4. 2022 Beta Data Comparison for DHEC and DOE-SR Collocated Sampling Locations**

| Sample Location | Sample ID | Average Concentration (pCi/L) | Standard Deviation (pCi/L) | Median (pCi/L) | Minimum Detect (pCi/L) | Maximum Detect (pCi/L) | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|---|
| Tims Branch at Road C | SV-324 | ND | ND | ND | ND | ND | 0 | 12 |
| | TB-5 | 2.43 | 2.01 | 1.76 | 0.88 | 8.35 | 12 | 12 |
| Upper Three Runs Creek at Road A | SV-325 | 5.02 | 1.05 | 5.02 | 4.28 | 5.76 | 2 | 12 |
| | U3R-4 | 8.45 | 7.46 | 7.28 | 0.91 | 25.80 | 13 | 13 |
| Fourmile Branch at Road A-12.2 | SV-2039 | 5.92 | 1.73 | 5.85 | 3.41 | 8.18 | 6 | 12 |
| | FM-6 | 5.48 | 1.86 | 4.85 | 3.11 | 10.00 | 12 | 12 |
| Pen Branch at Road A-13.2 | SV-2047 | 3.36* | NA | NA | NA | NA | 1 | 12 |
| | PB-3 | 2.86 | 2.28 | 1.66 | 0.90 | 7.25 | 12 | 12 |
| Steel Creek at Road A | SV-327 | ND | ND | ND | ND | ND | 0 | 12 |
| | SC-4 | 2.51 | 2.56 | 1.66 | 1.13 | 10.40 | 12 | 12 |
| Highway 301 Bridge at RM 118.8 | SV-118 | ND | ND | ND | ND | ND | 0 | 12 |
| | RM 118 | 2.11 | 0.26 | 2.14 | 1.32 | 2.56 | 54 | 54 |
| Lower Three Runs Creek at Road B | SV-2053 | 3.81* | NA | NA | NA | NA | 1 | 12 |
| | L3R-1A | 1.39 | 0.50 | 1.27 | 0.85 | 2.47 | 12 | 12 |

Shaded areas represent DHEC data and unshaded areas represent DOE-SR data
DOE-SR data is from the SRS Environmental Data Report for 2022 (SRNS, 2023)
ND is Not Detected
NA is Not Applicable
* Indicates a single detection



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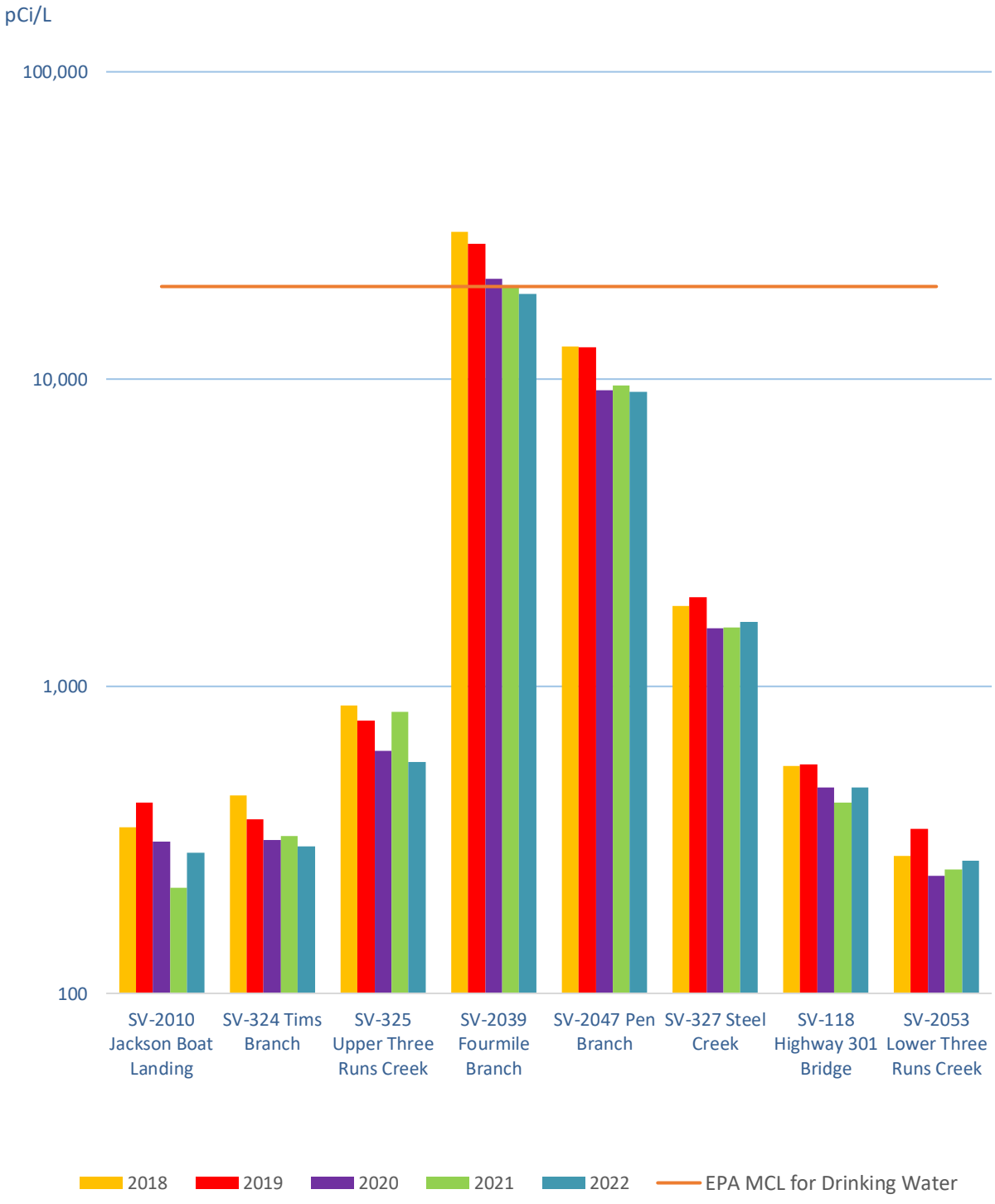
## TABLES AND FIGURES

**Figure 1. DHEC Average Tritium Data Trends for 2018-2022 (DHEC, 2020a-2022a)**



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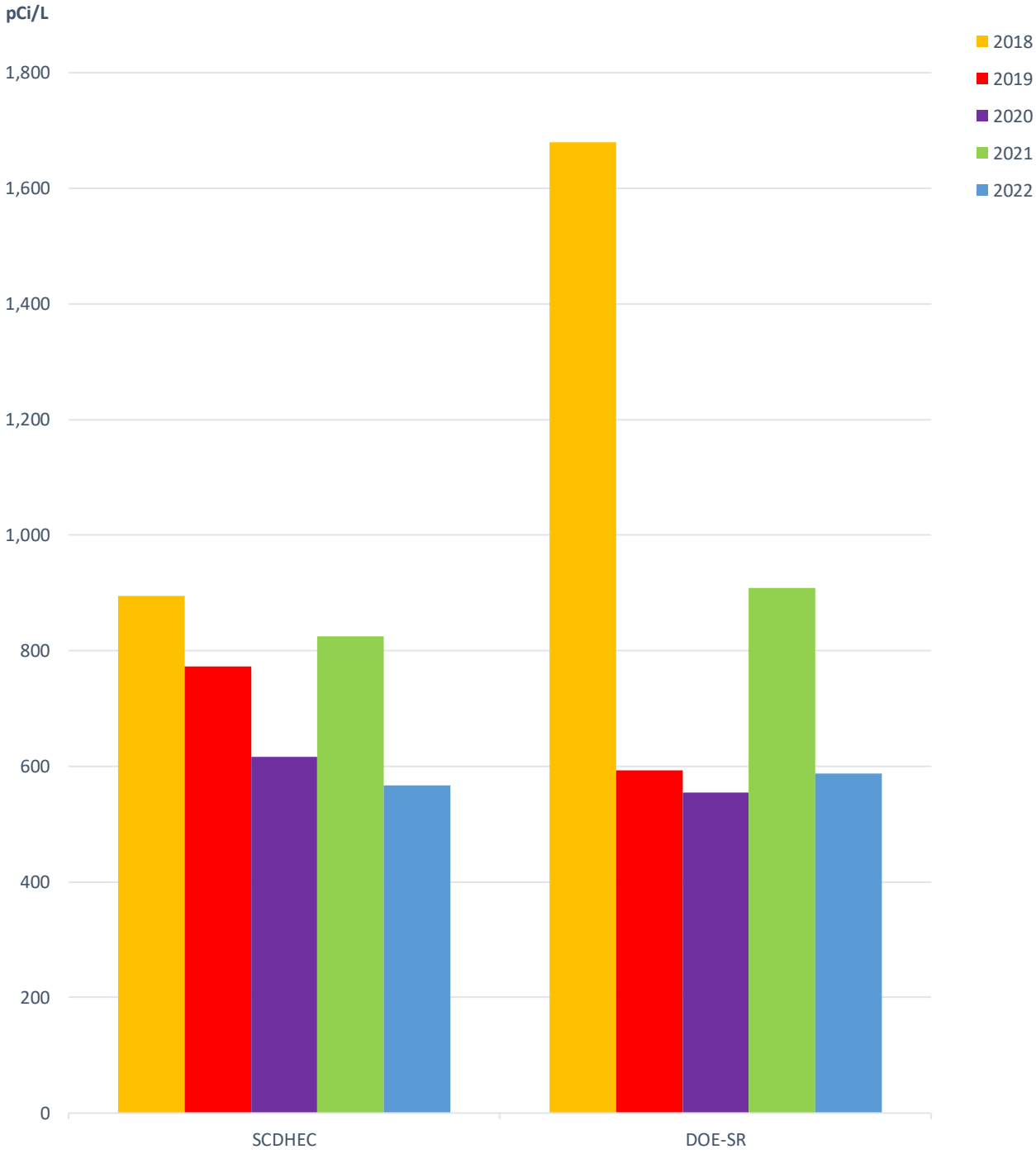
## TABLES AND FIGURES

**Figure 2. 2018-2022 Average Tritium Data Trends for DHEC and DOE-SR for Upper Three Runs Creek at S.C. Highway 125 (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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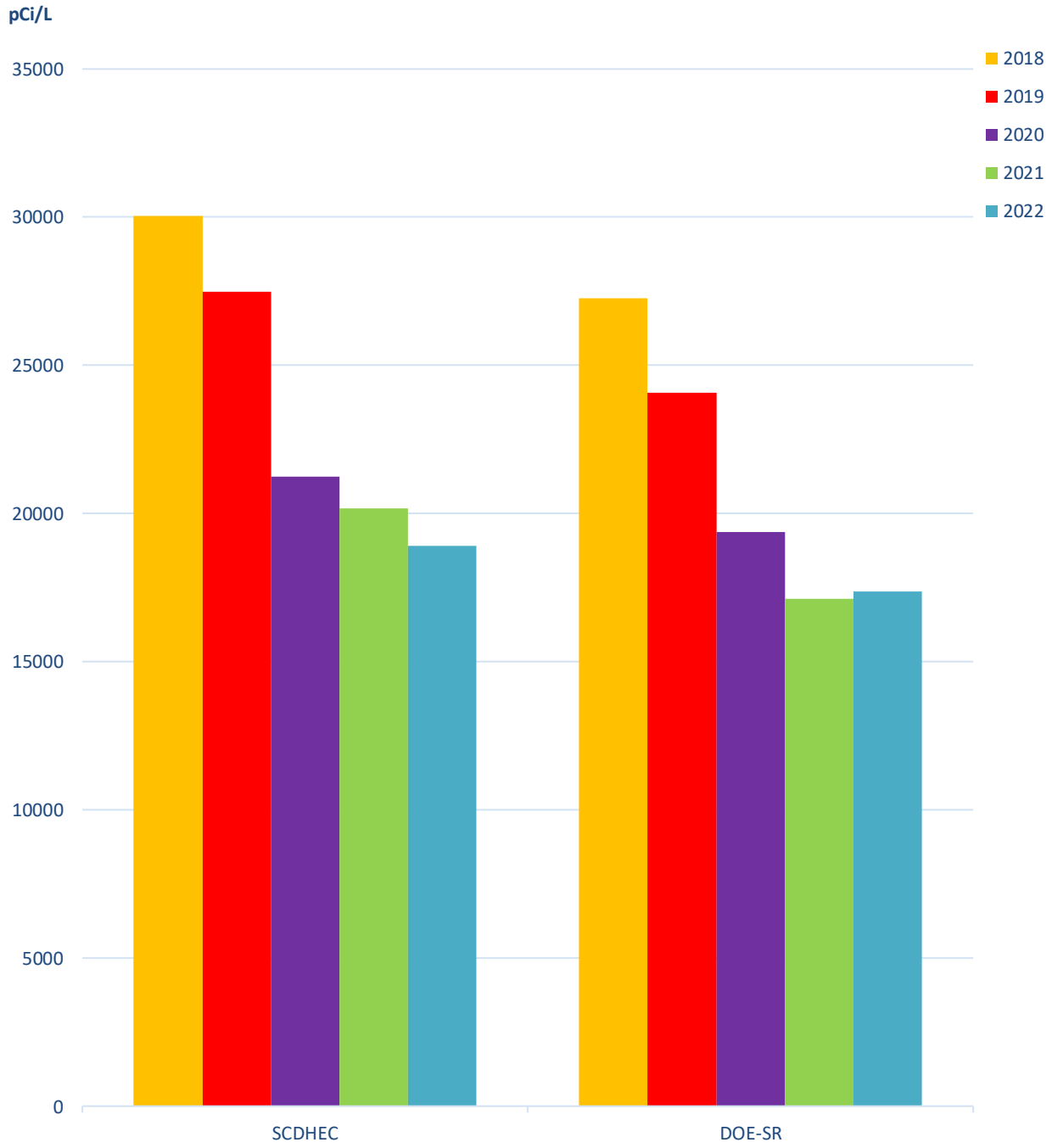
## TABLES AND FIGURES

**Figure 3. 2018-2022 Average Tritium Data Trends for DHEC and DOE-SR for Fourmile Branch at Road A-12.2 (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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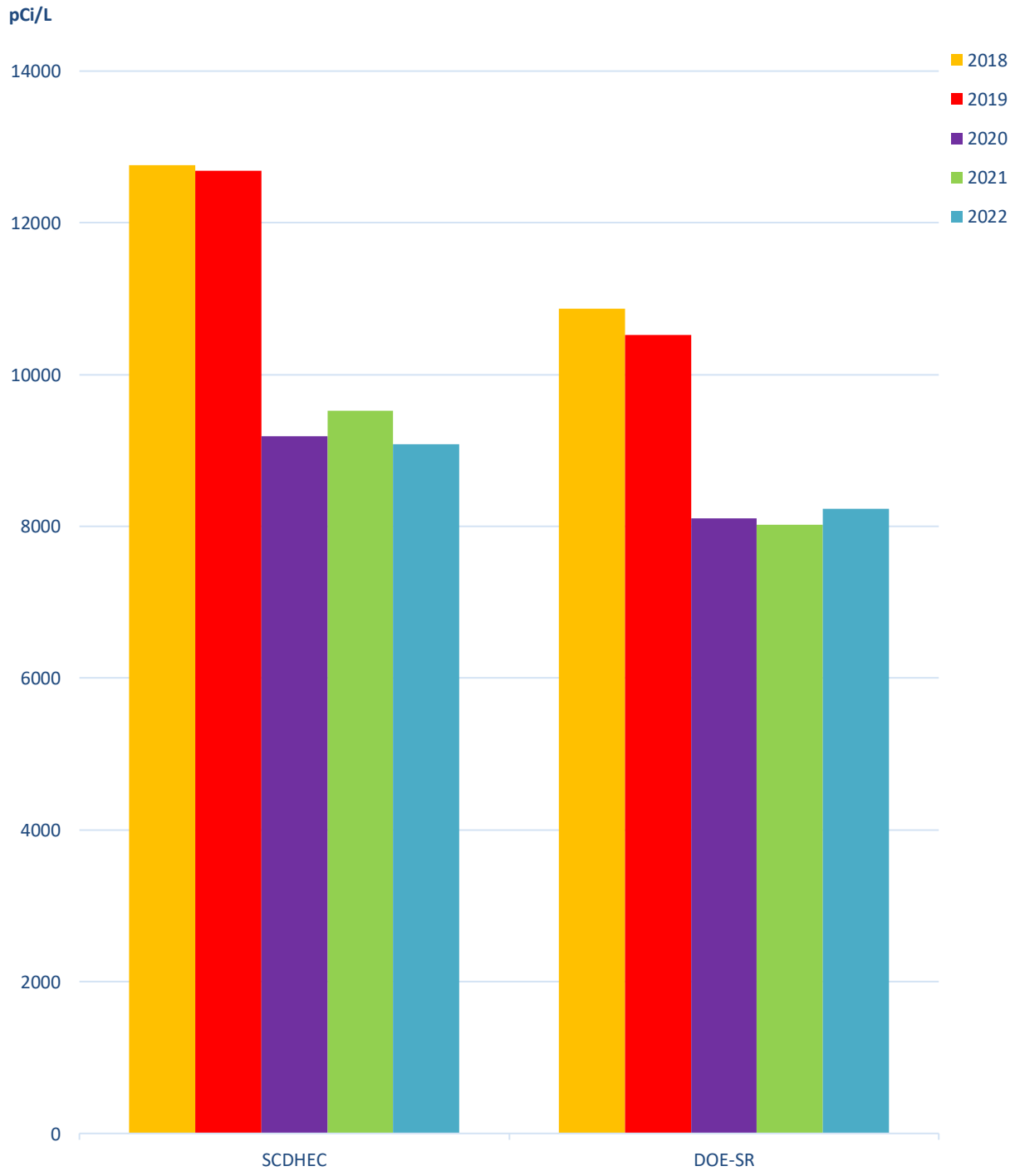
## TABLES AND FIGURES

**Figure 4. 2018-2022 Average Tritium Data Trends for DHEC and DOE-SR for Pen Branch at Road A-13.2 (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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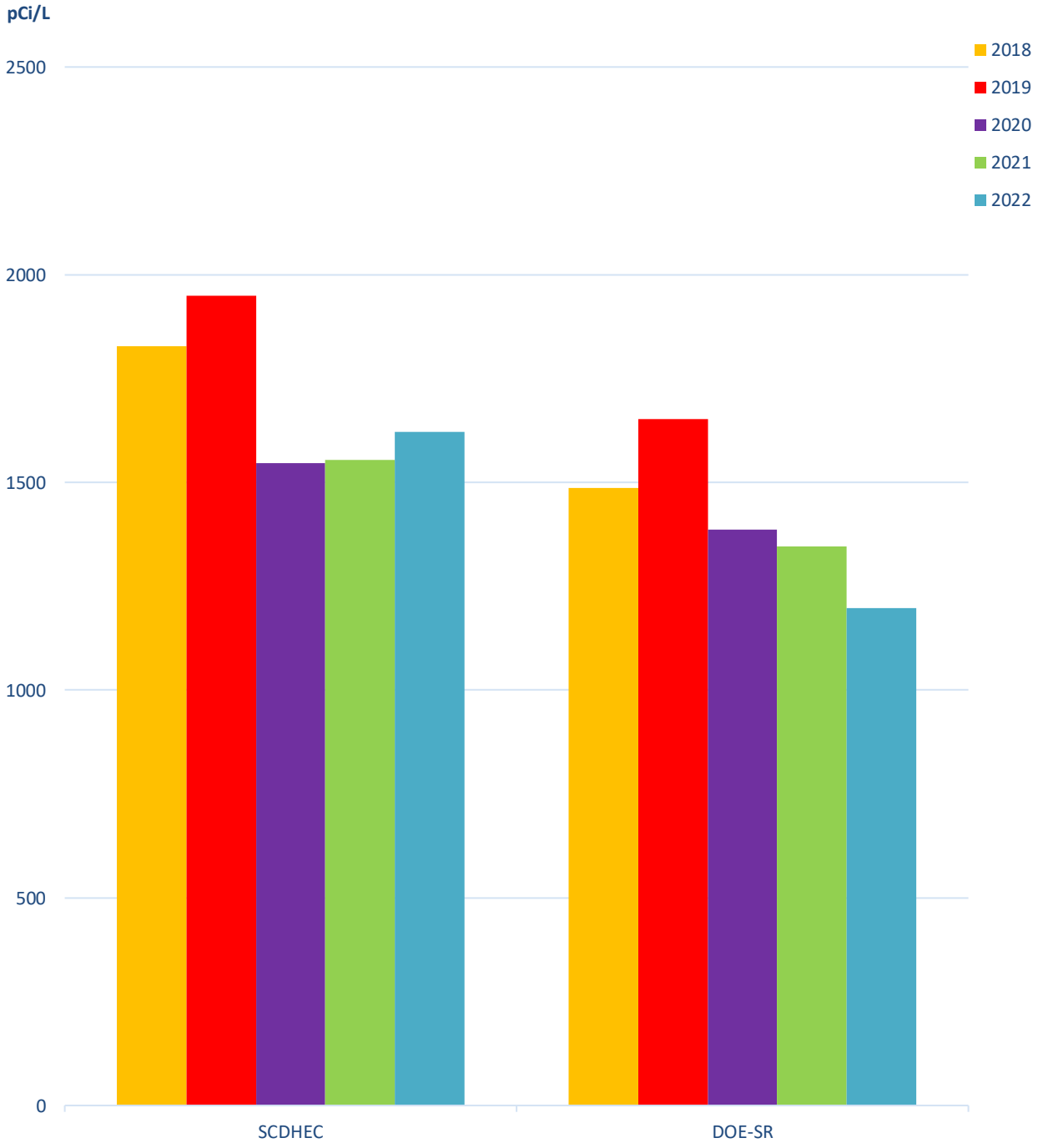
## TABLES AND FIGURES

**Figure 5. 2018-2022 Average Tritium Data Trends for DHEC and DOE-SR for Steel Creek at S.C. Highway 125 (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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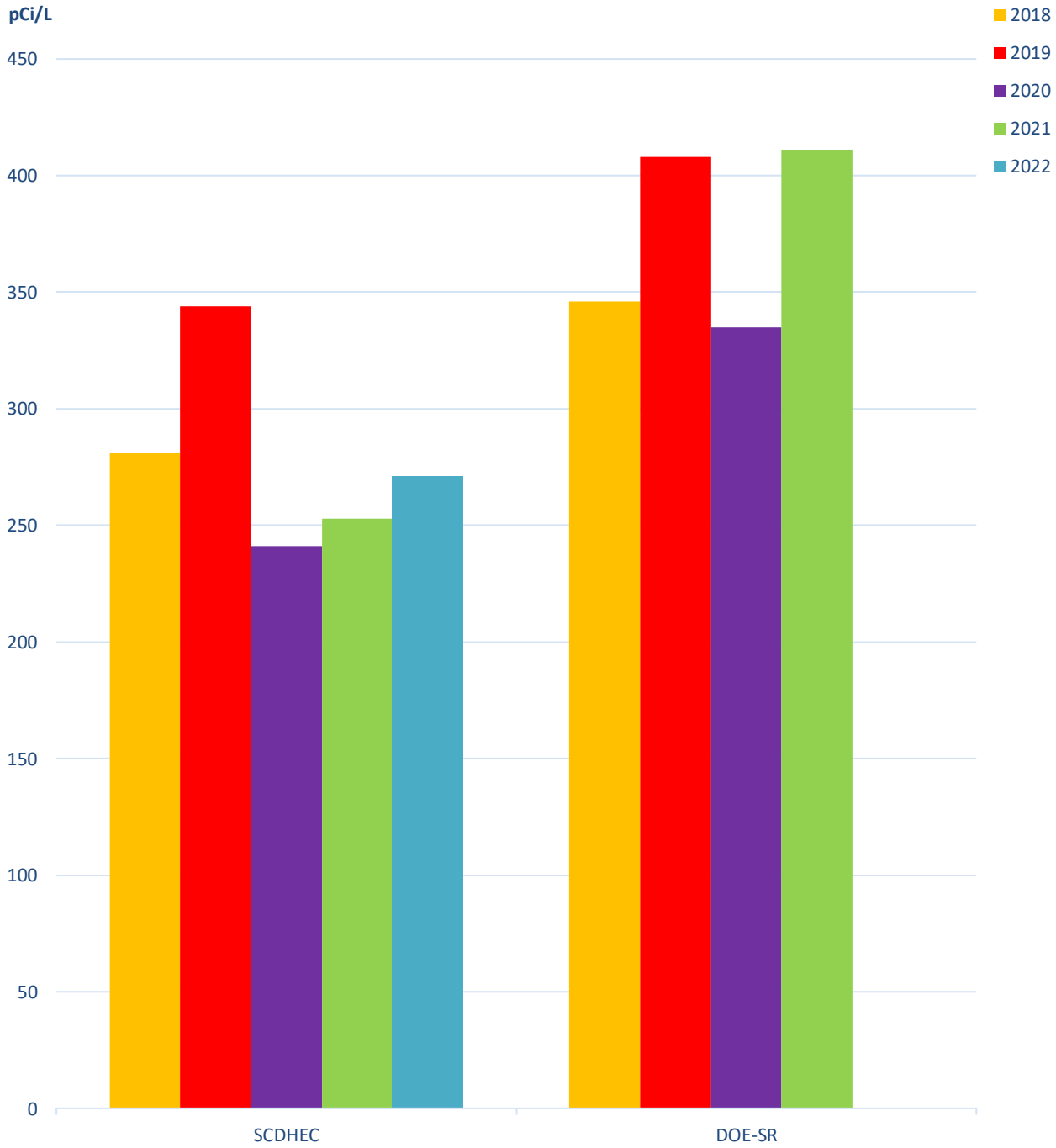
## TABLES AND FIGURES

**Figure 6. 2018-2022 Average Tritium Data Trends for DHEC and DOE-SR for Lower Three Runs Creek at SRS Road B (SRNS, 2019-2023; DHEC, 2020a-2022a)**




In 2020, DOE-SR's data is not an average due to there only being one detection during the year with a reading of 335 pCi/L**.**

**In 2022, DOE-SR had no detections for tritium at Lower Three Runs Creek at SRS Road B.**



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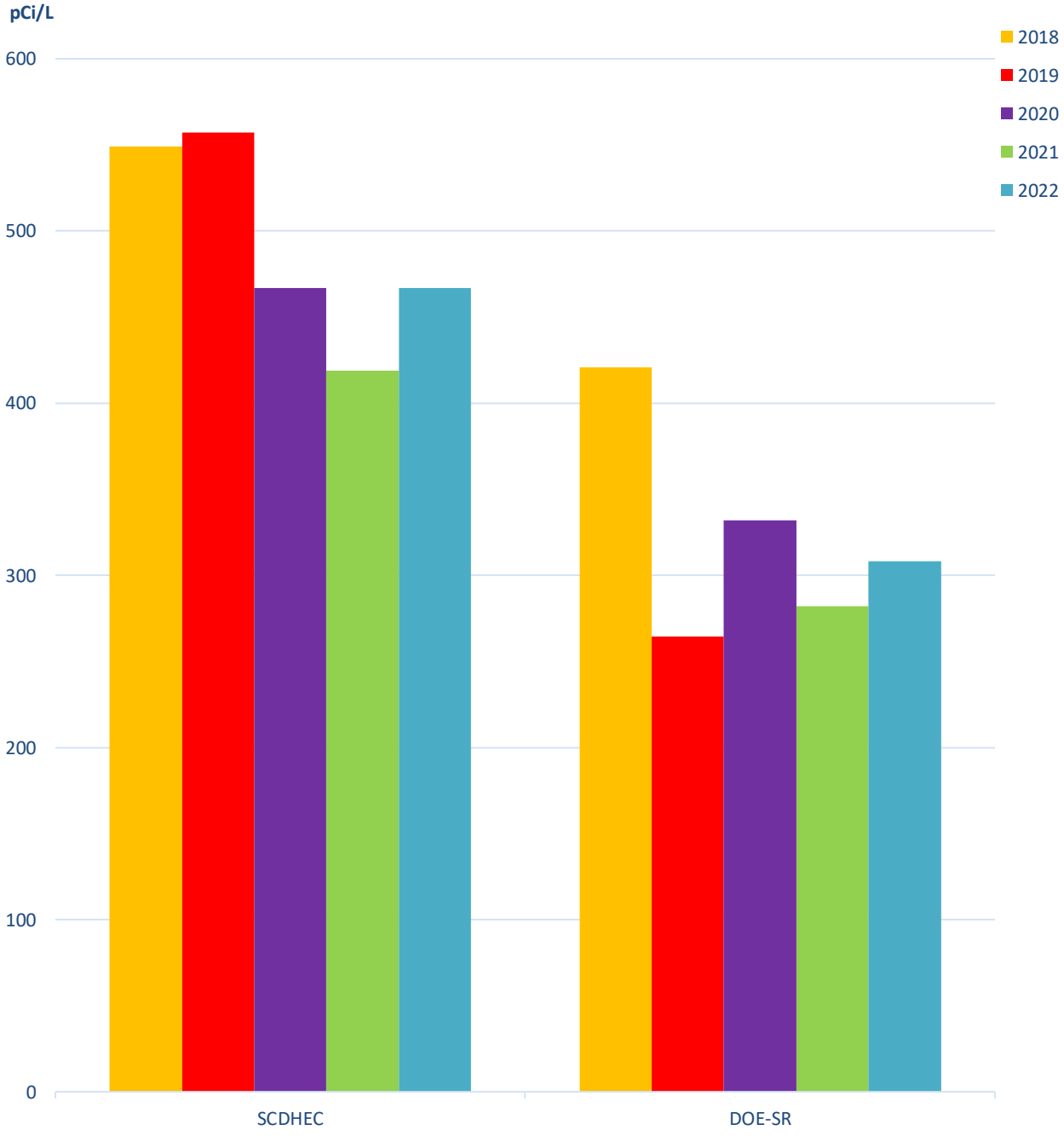
## TABLES AND FIGURES

**Figure 7. 2018-2022 Average Tritium Data Trends for DHEC and DOE-SR for the Savannah River at US Highway 301 Bridge (SRNS, 2019-2023; DHEC, 2020a-2022a)**



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### 4.6.0 SUMMARY STATISTICS

**2022 DHEC Ambient Monitoring Data-Tritium in pCi/L**

| Sample Location | Average Concentration | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| Jackson Boat Landing (SV-2010) | 287 | 7 | 290 | 280 | 292 | 3 | 49 |
| Tims Branch (SV-324)* | 301 | 52 | 280 | 243 | 405 | 16 | 52 |
| Upper Three Runs Creek at SC 125 (SV-325)* | 567 | 239 | 511 | 271 | 1,343 | 52 | 52 |
| Fourmile Branch (SV-2039)* | 18,916 | 2,257 | 19,650 | 12,714 | 22,427 | 48 | 48 |
| Pen Branch (SV-2047)* | 9,086 | 1,610 | 9,076 | 5,066 | 11,984 | 52 | 52 |
| Steel Creek (SV-327)* | 1,621 | 1,053 | 1,416 | 1,078 | 7,817 | 52 | 52 |
| Steel Creek Boat Landing (SV-2018) | 1,028 | 1,600 | 358 | 257 | 5,643 | 19 | 50 |
| Highway 301 Bridge (SV-118)* | 467 | 211 | 397 | 274 | 1,116 | 20 | 52 |
| Lower Three Runs Creek at Patterson Mill Rd. (SV-328) | 7,96 | 168 | 8,40 | 398 | 981 | 17 | 17 |
| L-Lake Spill Way (SV-2052)* | 379 | 224 | 301 | 260 | 994 | 10 | 52 |
| Lower Three Runs Creek at Road B (SV-2053)* | 271 | 31 | 264 | 241 | 324 | 6 | 52 |
| Upper Three Runs Creek at SRS Road 2-1 (SV-2027) | 264 | 3 | 264 | 261 | 268 | 4 | 16 |
| **Creek Mouths** | **Average Concentration** | **Standard Deviation** | **Median** | **Minimum Detect** | **Maximum Detect** | **Number of Detects** | **Number of Samples** |
| Upper Three Runs Mouth @ RM 157.4 (SV-2011) | 311 | 22 | 308 | 291 | 335 | 3 | 4 |
| Four Mile Creek @ RM 150.6 (SV-2015) | ND | ND | ND | ND | ND | 0 | 4 |
| Steel Creek Mouth @ RM 141.5 (SV-2017) | 742 | 559 | 431 | 407 | 1,388 | 3 | 4 |
| Lower Three Runs Mouth @ RM 129.1 (SV-2020) | 369 | 73 | 358 | 302 | 447 | 3 | 4 |
| Vogtle Output (RWSV-VOGTLE) | 323 | 79 | 323 | 268 | 379 | 2 | 4 |

Notes for the above tables and ones on the next page:
* Indicates locations that are collocated with DOE-SR sampling sites.
NA means Not Applicable
ND means Not Detected



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### 4.6.0 SUMMARY STATISTICS continued

### 2022 DHEC Ambient Monitoring Data-Alpha

| Sample Location | Average Concentration (pCi/L) | Standard Deviation | Median (pCi/L) | Minimum Detect (pCi/L) | Maximum Detect (pCi/L) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Jackson Boat Landing (SV-2010)** | 1.68* | NA | NA | NA | NA | 1 | 12 |
| **Tims Branch (SV-324)** | 2.56 | 1.07 | 2.24 | 1.40 | 4.53 | 7 | 12 |
| **Upper Three Runs Creek at S.C. 125 (SV-325)** | 4.34 | 2.25 | 3.37 | 2.22 | 8.52 | 8 | 12 |
| **Fourmile Branch (SV-2039)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Pen Branch (SV-2047)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Steel Creek (SV-327)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Steel Creek Boat Landing (SV-2018)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Highway 301 Bridge (SV-118)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Lower Three Runs Creek at Road B (SV-2053)** | 2.41* | NA | NA | NA | NA | 1 | 12 |

**2022 DHEC Ambient Monitoring Data-Beta**

| Sample Location | Average Concentration (pCi/L) | Standard Deviation | Median (pCi/L) | Minimum Detect (pCi/L) | Maximum Detect (pCi/L) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Jackson Boat Landing (SV-2010)** | 4.98 | 1.04 | 4.98 | 4.24 | 5.71 | 2 | 12 |
| **Tims Branch (SV-324)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Upper Three Runs Creek at S.C. 125 (SV-325)** | 5.02 | 1.05 | 5.02 | 4.28 | 5.76 | 2 | 12 |
| **Fourmile Branch (SV-2039)** | 5.92 | 1.73 | 5.85 | 3.41 | 8.18 | 6 | 12 |
| **Pen Branch (SV-2047)** | 3.36* | NA | NA | NA | NA | 1 | 12 |
| **Steel Creek (SV-327)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Steel Creek Boat Landing (SV-2018)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Highway 301 Bridge (SV-118)** | ND | ND | ND | ND | ND | 0 | 12 |
| **Lower Three Runs Creek at Road B (SV-2053)** | 3.81* | NA | NA | NA | NA | 1 | 12 |

For both charts above: * Indicates a single detection



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**Chapter 5 Non-radiological Monitoring of Surface Water on SRS**

### 5.1.0 PROJECT SUMMARY

The streams located on SRS receive a wide variety of permitted point source discharges and non-point source run-off from on-site facilities and operations. These discharges specifically include, but are not limited to, industrial storm water, utility water, treated industrial and sanitary wastewater, and run-off from land-disturbing activities.

**POINT SOURCE POLLUTION:** "Pollution that comes from a specific, identifiable source, such as a pipe or channel"

**NONPOINT SOURCE POLLUTION:** "Sources that are diffuse, without a single identifiable point of origin, including runoff from agriculture, forestry, and construction sites"

Source: EPA

DHEC assessed the surface water quality for non-radiological parameters in 2022 at SRS by sampling the on-site streams for inorganic and organic constituents. As an indication of possible water quality issues, DHEC data is compared to the freshwater standard guidelines in DHEC's Water Classifications and Standards, Regulation 61-68 (DHEC, 2020c). These guidelines give numeric criteria for specific parameters and narrative criteria that indicate conditions of biological integrity and water quality for aquatic life and human health. The fact that a stream does not meet the specified numeric standards for a particular parameter does not mean the stream is polluted or of poor quality. Natural conditions can cause streams to exceed the standards.

Ten DHEC sample locations were strategically chosen to monitor ambient surface water conditions and detect the non-radiological impact from DOE-SR operations. A map of DHEC sample locations can be found in Section 5.4.0. Six of the DHEC sample locations are collocated with DOE-SR sample locations to provide data comparisons (Section 5.5.0, Table 1). The stream sample locations were selected based on accessibility and their proximity upstream and downstream of DOE-SR operations before flowing into the publicly accessible Savannah River. A list of water quality parameter analyses and sample frequency can be found in Section 5.5.0, Table 2.

Using a Horiba Water Quality Meter to determine field parameters

### 5.2.0 RESULTS AND DISCUSSION

Non-radiological Monitoring of Surface Water Summary Statistics can be found in Section 5.6.0 and all Non-radiological Monitoring of Surface Water Data can be found in the 2022 DHEC Data File.

Many chemical and biological processes in surface waters can be affected by pH, a measurement that indicates the



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alkalinity or acidity of a substance (EPA, 1997). The streams encountered at SRS are typical of southeastern streams characterized as blackwater. A blackwater stream is one that has a deep, slow-moving channel that flows through forested swamps and wetlands. Decaying vegetation in the water results in the leaching of tannins from the vegetation which results in transparent, acidic water that is darkly stained, resembling tea or coffee. Low pH is typical for blackwater streams such as those sampled at SRS (Hughes et al., 2000).


Water sample to be analyzed by the lab in DHEC's Columbia office

The pH standard for all South Carolina freshwater streams is between 6.0 and 8.5 standard units (SU) (DHEC, 2020c). All DHEC locations had yearly averages within the standard except for Beaver Dam Creek (NWSV-2040) with a pH average of 4.71 and Tinker Creek at Road 2-1 (NWSV-2061) with an average pH of 5.56. These streams are blackwater streams, which could contribute to them having a pH lower than 6. See Section 5.5.0, Figure 1 for a comparison of DHEC and DOE-SR data for collocated samples (SRNS, 2023).

Oxygen is cycled through the environment and is both produced and consumed in streams. The amount of oxygen in its dissolved form in water is the Dissolved Oxygen (DO). The Biochemical Oxygen Demand (BOD) is the amount of oxygen consumed by microorganisms in stream water.

Recording field parameters: DO, pH, temperature, conductivity, and total dissolved solids

Water quality is diminished when the BOD is high, which depletes the oxygen in the water. Low DO means less oxygen to support higher forms of aquatic life (EPA, 1997). The South Carolina freshwater standard for DO is a daily average of no less than 5.0 mg/L with no individual sample to be below 4.0 mg/L (DHEC, 2020c). All individual samples and yearly averages met the DO standard in 2022. A DO comparison of DHEC and DOE-SR data for collocated samples can be found in Section 5.5.0, Figure 2 (SRNS, 2023). There are no numeric criteria in the South Carolina freshwater standards for a maximum BOD level; however, in 2022, DHEC samples had no detections above the LLD of 2.0 mg/L except for SV-328 which had one sample at 2.40 mg/L, and SV-2055 with one sample at 2.80 mg/L. DOE-SR did not collect BOD samples in 2022, therefore, no comparison can be made for BOD.

Water samples to be analyzed by the lab in DHEC's Columbia office

Temperature can affect biological and chemical processes in a stream. All aquatic organisms can be negatively affected by temperatures that vary from the naturally occurring range (EPA, 1997). The South Carolina freshwater standards state that the temperature of free-flowing freshwater shall not exceed a maximum of 32.2°C (DHEC, 2020c). DHEC data showed that the stream temperatures during each sampling event were comparable to each other and did not exceed the maximum of 32.2°C.

The South Carolina freshwater *E. coli* standard is a daily maximum of 349 Most Probable Number per 100mL (MPN/100mL). All streams sampled had individual samples that exceeded 349 MPN/100mL except for NWSV-2040 which was not sampled for E. coli, but all locations had yearly averages below the standard except SV-328, SV-2027, SV-2055, and SV-2061 (DHEC, 2022). DOE-SR did not collect samples for *E. coli* in 2022, therefore, no comparison can be made.

Phosphorous and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web. However, in excess they can cause significant water quality problems. Phosphorous and nitrogen cycle through the environment in a variety of forms and can indirectly impact DO and other water quality indicators (EPA, 1997). In 2022, DHEC sampled for total phosphorous and various forms of nitrogen, including nitrate/nitrite, total Kjeldahl nitrogen (TKN), and ammonia. There are no numeric criteria in the South Carolina freshwater standard for total phosphorus, TKN, or ammonia.

DHEC uses the most conservative of the federally established drinking water standards for nitrate/nitrite levels to indicate ambient water quality in freshwater streams for nutrients. The EPA drinking water standards for nitrate/nitrite levels are 10 mg/L and 1 mg/L, respectively, and are designed to protect the public from consumption of high levels of these nutrients (DHEC, 2020c). As a conservative measure, DHEC uses a maximum of 1 mg/L as an indication of possible water quality issues.

Overall, the nutrient levels on SRS are comparable to the levels found throughout the Savannah River Basin. DOE-SR did not sample for TKN or ammonia in 2022; therefore, no comparison can be made. A comparison of DHEC and DOE-SR data from collocated samples for total phosphorous and nitrate/nitrite, respectively, can be found in Section 5.5.0, Figures 3 and 4.

Most metals are considered pollutants, including some that are toxic or known carcinogens. In 2022, DHEC personnel collected samples for the following metals: aluminum, beryllium, cadmium, calcium,

Water sample to be analyzed



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chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, thallium, and zinc. Due to the potential health effects of some metals, a yearly average, even if based on a single detection that exceeds the freshwater standards, may indicate a water quality issue. These metals, with the exceptions of aluminum, calcium, iron, magnesium, and manganese, have numeric criteria for the protection of human health and aquatic life in the South Carolina freshwater quality standards.

The freshwater quality standard for cadmium in South Carolina streams is not to exceed 0.00025 mg/L (DHEC, 2020c). DHEC found 3 individual samples above the limit at NWSV-2040, but the averages from all locations were below the standard of cadmium. DOE-SR had no levels above the standard of cadmium (SRNS, 2023).

The freshwater quality standards for chromium, copper, and nickel in South Carolina streams are not to exceed 0.011 mg/L, 0.0029 mg/L and 0.016 mg/L, respectively (DHEC, 2020c). DHEC detected nickel above the standard in 4 samples at NWSV-2040 (0.022 mg/L) but did not detect chromium or copper above standard in any other sample in 2022. Due to copper's standard of 0.0029 mg/L being lower than the DHEC laboratory's limit of detection of <0.010 mg/L, all samples were found to be <0.010 mg/L and were considered non-detects. DOE-SR detected chromium, copper, and nickel below the standard in their collocated sample locations with the exception of copper in NWSV-328 (single detect of 0.0060 mg/L)and NWSV-2039 (single detect of 0.0054 mg/L) (SRNS, 2023).


Samples are individually bottled and transported on ice

The freshwater quality standard for lead in South Carolina streams is not to exceed 0.00054 mg/L (DHEC, 2020c). Due to laboratory limitations, DHEC has a lower limit of detection (LLD) higher than the standard. Therefore, any detection of lead would be over the standard. DHEC did not detect lead in any samples above the standard. Beginning in August 2018, DOE-SR changed their laboratory analysis for lead to achieve a lower detection limit. DOE-SR had no locations with average lead detections above the standard in 2022. (SRNS, 2023).

The freshwater quality standard for mercury in South Carolina streams is not to exceed 0.00005 mg/L (DHEC, 2020c). Mercury was not detected in any of the DHEC samples but was detected below the standard in DOE-SR's individual samples at NWSV-327, NWSV-328, and NWSV-2039, (SRNS, 2023).

The freshwater quality standard for zinc in South Carolina streams is not to exceed 0.037 mg/L (DHEC, 2020c). DHEC had 7 individual samples at NWSV-2040 (average – 0.041 mg/L) that exceeded the zinc standard while all other samples were below the standard. DOE-SR had all

locations' averages below the zinc(SRNS, 2023). A zinc comparison of DHEC and DOE-SR yearly averages for collocated samples can be found in Section 5.5.0, Figure 5.

Samples were also analyzed for beryllium and thallium whose freshwater quality standards are <0.004 mg/L and <0.00024 mg/L, respectively. DHEC had 8 individual samples at NSWV-2040 (average – 0.005 mg/L) that exceeded beryllium standard while the rest of the samples were below both beryllium and thallium standards. DOE-SR had 1 individual sample at NWSV-325 (0.0005mg/L) that exceeded thallium standard while none of the samples had beryllium detects above the standard (SRNS, 2023).

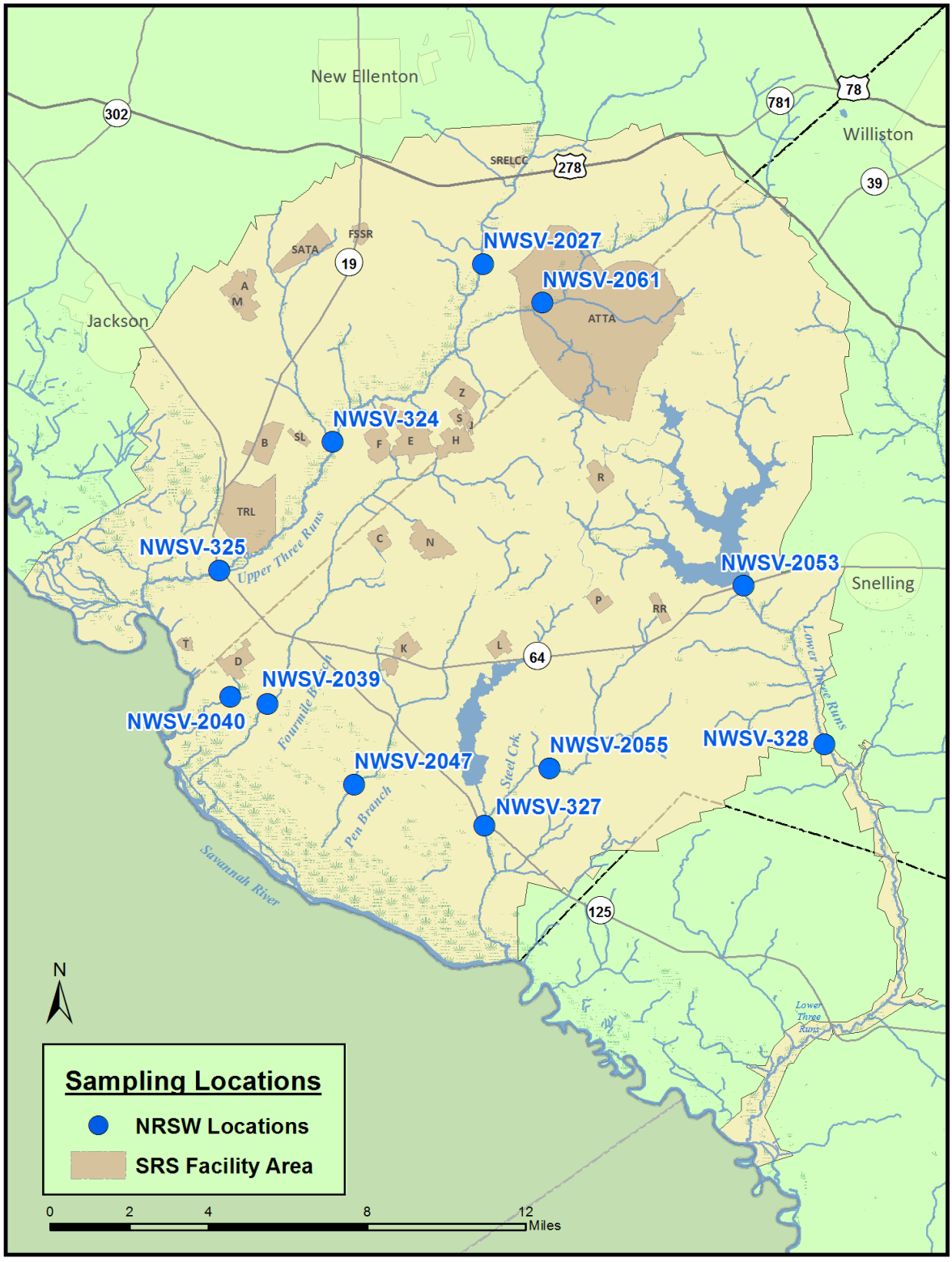
Small discrepancies in data between DOE-SR and DHEC may be attributed to differences in sample collection date and time, sample preservation, and lab analysis. Variances in statistical calculations, such as the yearly averages, may also attribute to dissimilarities. All data less than the LLD were left out of DHEC summary statistics due to lack of numeric information.

### 5.3.0 CONCLUSIONS AND RECOMMENDATIONS

The current parameters will continue to be monitored to establish trends that may warrant further investigation based on EPA or DHEC standards or recommended levels. Overall, the non-radiological water quality on SRS in 2022 compared favorably with the South Carolina Freshwaters Standard or other recommendations for the parameters and monitored locations. The 2022 DHEC results for most parameters were comparable to the DHEC's Bureau of Water data for the Savannah River watershed (DHEC, 2022b). DHEC will continue to evaluate water quality based on the independent, non-radiological testing and surveillance of SRS surface water. Monitoring is required due to continued land disturbance from clean-up activities, new facility construction, logging, and new missions. The locations, number and frequencies of samples, and monitoring parameters are reviewed annually and modified as needed to maximize available resources and address SRS mission changes.

### 5.4.0 MAP

## Non-radiological Surface Water Sampling Locations




2022 ESOP Non-Radiological Surface Water Monitoring www.scdhec.gov



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## 5.5.0 TABLES AND FIGURES

### Table 1. 2022 DHEC Surface Water Sample Locations

| Sample Location | Location Description | Location Rationale |
|---|---|---|
| NWSV-2027 | Upper Three Runs at Road 2-1 | Upstream of most SRS Operations |
| NWSV-2061 | Tinker Creek at Road 2-1 | Downstream of ATTA |
| NWSV-324* | Tims Branch at Road C | Downstream from M- & A-Areas |
| NWSV-325* | Upper Three Runs at Road A | Downstream from F-Area |
| NWSV-2055 | Meyers Branch at Road 9 | Downstream from P-Area |
| NWSV-2039* | Fourmile Branch at Road 12.2 | Downstream from F- and H-Areas |
| NWSV-2047* | Pen Branch at Road A-13.2 | Downstream from K-Area |
| NWSV-327* | Steel Creek at Road A | Downstream from L-Lake |
| NWSV-328* | Lower Three Runs at Patterson Mill Road | Downstream from Par Pond |
| NWSV-2040** | Beaver Dam Creek | Downstream of past operations in D Area |

*Collocated with DOE-SR sample locations.
**NWSV-2040 is only analyzed for metals and mercury as well as field parameters.

### Table 2. 2022 DHEC Water Quality Parameter Analyses

| Laboratory | Frequency | Parameter |
|---|---|---|
| Field | Monthly | Temperature, pH, Specific Conductivity, Dissolved Oxygen, and Total Dissolved Solids (TDS) |
| DHEC Lab Aiken, S.C. | Monthly | Turbidity, BOD, E. Coli, and TSS |
| DHEC Lab Columbia, S.C. | Monthly | Alkalinity, Ammonia, Nutrients, Mercury, and Metals, |

## TABLES AND FIGURES

**Figure 1. pH 2022 Yearly Average DHEC and DOE-SR Comparison (SRNS, 2023)**


**Figure 2. DO 2022 Yearly Average DHEC and DOE-SR Comparison (SRNS, 2023)**




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## TABLES AND FIGURES

**Figure 3. Total Phosphorous 2022 Yearly Average DHEC and DOE-SR Comparison (SRNS, 2023)**

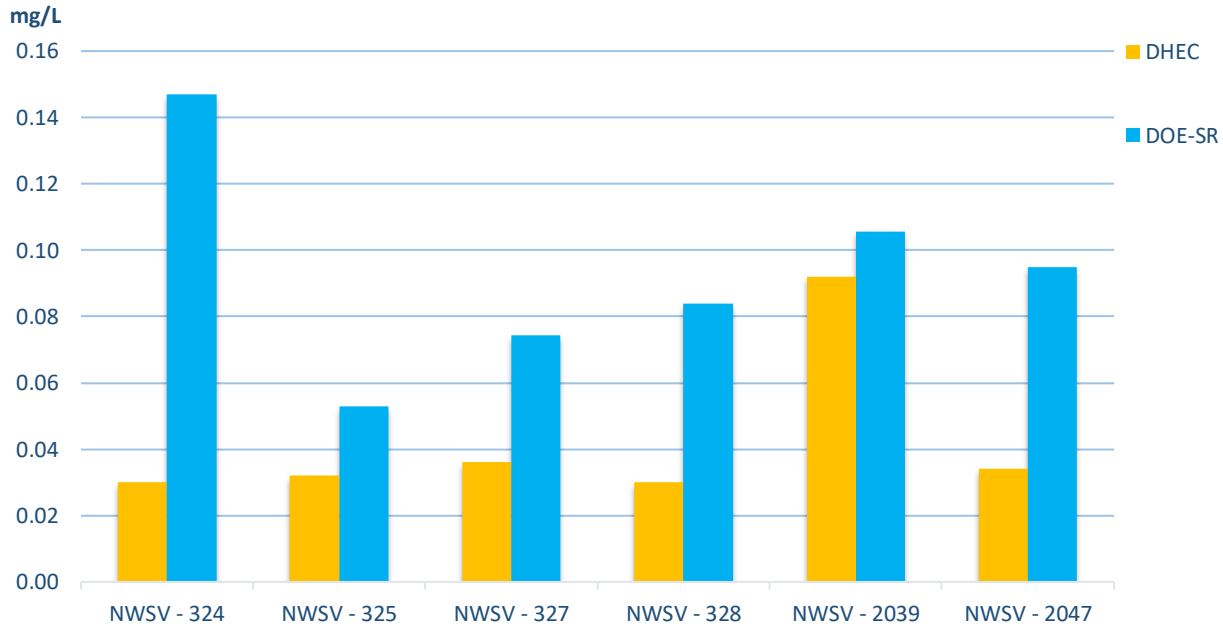
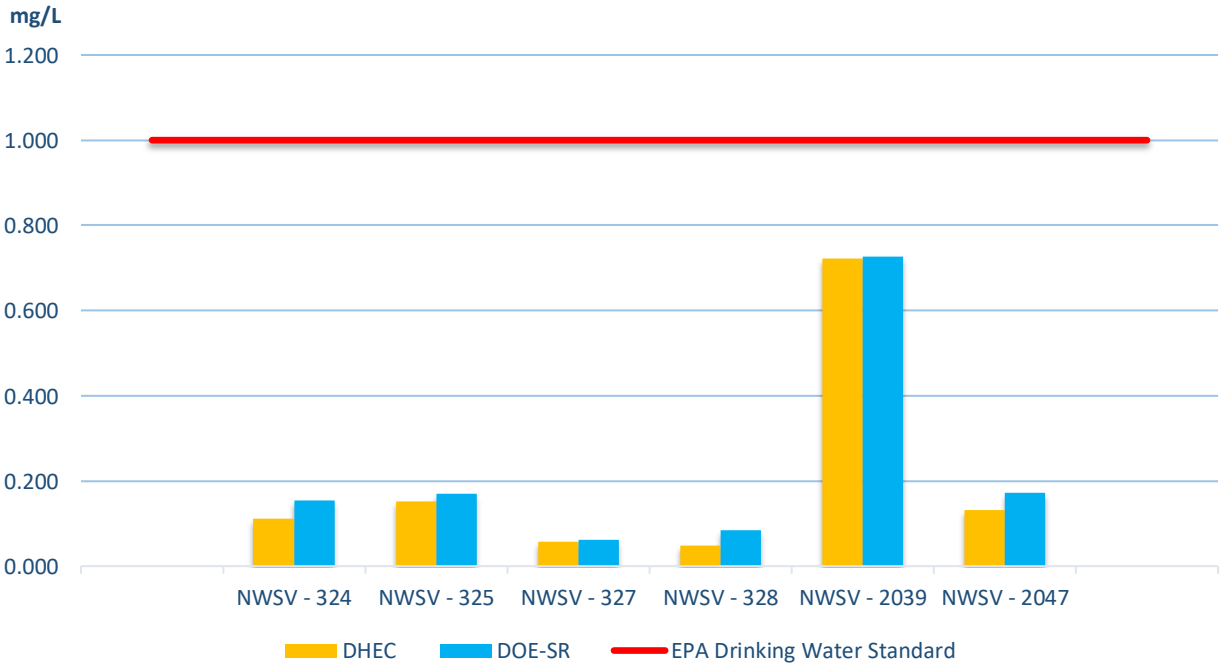



**Figure 4. Nitrate/Nitrite 2022 Yearly Average DHEC and DOE-SR Comparison (SRNS, 2023)**




DOE-SR collects nitrate and nitrite as separate parameters. In this graph, DOE-SR's nitrate and nitrite were added together and then an average of the sum was taken to produce one number representing both nitrate and nitrite at each location in order to have comparable data to DHEC.



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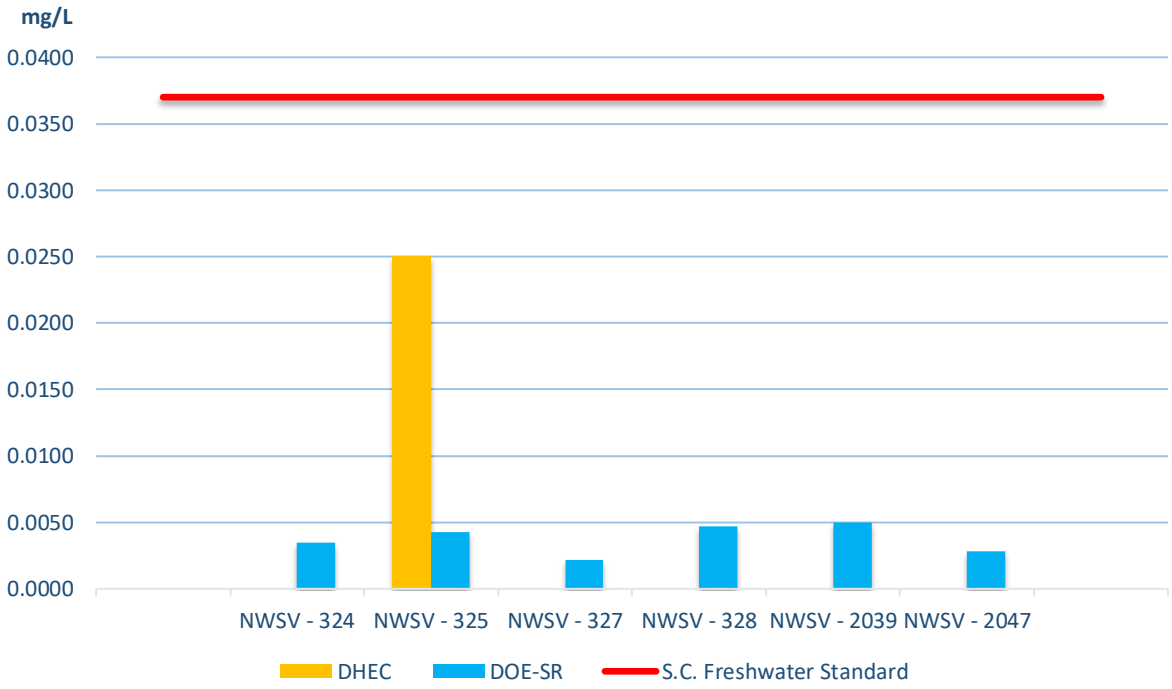
## TABLES AND FIGURES

### Figure 5. Zinc 2022 Yearly Average DHEC and DOE-SR Comparison (SRNS, 2023)




DHEC's NWSV-325only had one sample with a detection, so the number included in the graph is based on a single detect and is not an average.



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## 5.6.0 2022 SUMMARY STATISTICS

**Notes for the 5.6.0 Summary Statistic Tables on pages 62-72:**
NA is Not Applicable.
ND is Not Detected.
NS is Not Sampled.
Chromium, Copper, Mercury, and Thallium are not included in the table due to no detections in 2022 across all locations.

### NWSV–324 Tims Branch at Road C

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.75 | 0.42 | 6.68 | 6.16 | 7.65 | 12 |
| | DO (mg/L) | 10.70 | 3.18 | 10.10 | 7.14 | 16.87 | 12 |
| | Water Temp (°C) | 16.52 | 5.73 | 16.11 | 7.28 | 24.03 | 12 |
| | Conductivity (mS/cm) | 0.03 | 0.013 | 0.02 | 0.02 | 0.07 | 12 |
| Laboratory | Total Alkalinity (mg/L) | 3.82 | 0.74 | 3.80 | 2.10 | 4.90 | 12 |
| | Turbidity (NTU) | 4.66 | 1.83 | 3.90 | 2.80 | 8.60 | 12 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 6.57 | 3.88 | 4.90 | 2.90 | 14.00 | 12 |
| | E. Coli (MPN/100mL) | 296.30 | 336.70 | 161.65 | 58.30 | 1119.90 | 12 |
| | TKN (mg/L) | 0.27 | 0.10 | 0.26 | 0.14 | 0.39 | 10 |
| | Ammonia (mg/L) | 0.06 | NA | NA | NA | NA | 1 |
| | Nitrate/Nitrite (mg/L) | 0.11 | 0.08 | 0.08 | 0.02 | 0.26 | 12 |
| | Total Phosphorus (mg/L) | 0.03 | 0.01 | 0.03 | 0.02 | 0.05 | 10 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 0.87 | 0.13 | 0.88 | 0.67 | 2.10 | 12 |
| | Iron (mg/L) | 1.79 | 0.60 | 1.65 | 1.00 | 2.90 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.43 | 0.04 | 0.45 | 0.35 | 0.48 | 12 |
| | Manganese (mg/L) | 0.06 | 0.03 | 0.05 | 0.04 | 0.14 | 12 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 3.94 | 0.49 | 4.05 | 3.10 | 4.70 | 12 |
| | Aluminum (mg/L) | 0.16 | 0.09 | 0.14 | 0.08 | 0.40 | 12 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-325 Upper Three Runs at Road A

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.06 | 0.33 | 6.04 | 5.42 | 6.63 | 12 |
| | DO (mg/L) | 9.90 | 2.14 | 9.25 | 6.73 | 13.32 | 12 |
| | Water Temp (°C) | 17.84 | 5.78 | 17.62 | 8.42 | 25.77 | 12 |
| | Conductivity (mS/cm) | 0.02 | 0.002 | 0.02 | 0.02 | 0.03 | 12 |
| Laboratory | Total Alkalinity (mg/L) | 3.66 | 0.71 | 3.80 | 2.10 | 4.70 | 11 |
| | Turbidity (NTU) | 3.19 | 0.82 | 3.15 | 1.50 | 4.80 | 12 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 5.36 | 3.57 | 5.30 | 1.70 | 15.00 | 12 |
| | E. Coli (MPN/100mL) | 260.50 | 307.10 | 148.70 | 95.90 | 1203.30 | 12 |
| | TKN (mg/L) | 0.29 | 0.13 | 0.29 | 0.12 | 0.49 | 10 |
| | Ammonia (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Nitrate/Nitrite (mg/L) | 0.15 | 0.05 | 0.15 | 0.09 | 0.27 | 12 |
| | Total Phosphorus (mg/L) | 0.03 | 0.01 | 0.03 | 0.02 | 0.05 | 11 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 2.06 | 0.16 | 2.05 | 1.80 | 2.30 | 12 |
| | Iron (mg/L) | 0.56 | 0.14 | 0.55 | 0.33 | 0.89 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.45 | 0.03 | 0.44 | 0.40 | 0.52 | 12 |
| | Manganese (mg/L) | 0.02 | 0.01 | 0.02 | 0.01 | 0.04 | 12 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | 0.03 | NA | NA | NA | NA | 1 |
| | Hardness (mg/L) | 6.98 | 0.50 | 6.90 | 6.10 | 7.90 | 12 |
| | Aluminum (mg/L) | 0.22 | 0.09 | 0.20 | 0.10 | 0.47 | 12 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-327 Steel Creek at Road A

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.76 | 0.24 | 6.83 | 6.13 | 7.07 | 12 |
| | DO (mg/L) | 9.17 | 2.43 | 8.21 | 6.58 | 14.05 | 12 |
| | Water Temp (°C) | 19.70 | 6.21 | 18.52 | 10.06 | 28.13 | 12 |
| | Conductivity (mS/cm) | 0.05 | 0.002 | 0.05 | 0.05 | 0.05 | 12 |
| Laboratory | Total Alkalinity (mg/L) | 19.50 | 2.91 | 20.50 | 13.00 | 23.00 | 12 |
| | Turbidity (NTU) | 5.47 | 5.51 | 3.85 | 1.60 | 22.00 | 12 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 15.75 | 16.26 | 9.20 | 2.20 | 49.00 | 12 |
| | E. Coli (MPN/100mL) | 212.18 | 356.63 | 88.95 | 31.30 | 1299.70 | 12 |
| | TKN (mg/L) | 0.30 | 0.11 | 0.30 | 0.15 | 0.48 | 9 |
| | Ammonia (mg/L) | 0.05 | 0.004 | 0.05 | 0.05 | 0.06 | 2 |
| | Nitrate/Nitrite (mg/L) | 0.06 | 0.05 | 0.04 | 0.02 | 0.21 | 11 |
| | Total Phosphorus (mg/L) | 0.04 | 0.01 | 0.03 | 0.03 | 0.05 | 5 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 6.53 | 0.84 | 6.70 | 4.70 | 7.80 | 12 |
| | Iron (mg/L) | 0.58 | 0.44 | 0.50 | 0.19 | 1.80 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.79 | 0.10 | 0.77 | 0.64 | 0.97 | 12 |
| | Manganese (mg/L) | 0.05 | 0.05 | 0.04 | 0.01 | 0.19 | 12 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | NA | NA | NA | NA | 0 |
| | Hardness (mg/L) | 19.58 | 1.83 | 20.00 | 16.00 | 23.00 | 12 |
| | Aluminum (mg/L) | 0.32 | 0.30 | 0.22 | 0.08 | 1.10 | 11 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-328 Lower Three Runs at Patterson Mill Road

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.51 | 0.24 | 6.48 | 6.26 | 6.81 | 4 |
| | DO (mg/L) | 12.86 | 0.62 | 12.87 | 12.19 | 13.53 | 4 |
| | Water Temp (°C) | 13.29 | 4.09 | 11.95 | 10.26 | 18.98 | 4 |
| | Conductivity (mS/cm) | 0.06 | 0.01 | 0.07 | 0.04 | 0.07 | 4 |
| Laboratory | Total Alkalinity (mg/L) | 29.00 | 8.76 | 32.50 | 16.00 | 35.00 | 4 |
| | Turbidity (NTU) | 3.80 | 3.63 | 2.20 | 1.60 | 9.20 | 4 |
| | BOD (mg/L) | 2.40 | NA | NA | NA | NA | 1 |
| | TSS (mg/L) | 4.00 | 3.77 | 2.50 | 1.50 | 9.50 | 4 |
| | E. Coli (MPN/100mL) | 600.80 | 924.33 | 163.15 | 90.60 | 1986.30 | 4 |
| | TKN (mg/L) | 0.33 | 0.25 | 0.24 | 0.15 | 0.69 | 4 |
| | Ammonia (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Nitrate/Nitrite (mg/L) | 0.05 | 0.01 | 0.05 | 0.03 | 0.07 | 4 |
| | Total Phosphorus (mg/L) | 0.03 | 0.01 | 0.03 | 0.02 | 0.04 | 3 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 11.95 | 2.25 | 12.50 | 8.80 | 14.00 | 4 |
| | Iron (mg/L) | 0.39 | 0.18 | 0.32 | 0.26 | 0.65 | 4 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.53 | 0.03 | 0.53 | 0.50 | 0.57 | 4 |
| | Manganese (mg/L) | 0.04 | 0.01 | 0.03 | 0.03 | 0.05 | 4 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 32.00 | 5.72 | 33.50 | 24.00 | 37.00 | 4 |
| | Aluminum (mg/L) | 0.18 | 0.20 | 0.09 | 0.06 | 0.48 | 4 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-2027 Upper Three Runs at Road 2-1

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.21 | 0.98 | 6.59 | 4.75 | 6.89 | 4 |
| | DO (mg/L) | 11.28 | 0.93 | 11.41 | 10.08 | 12.20 | 4 |
| | Water Temp (°C) | 13.46 | 3.42 | 12.33 | 10.87 | 18.31 | 4 |
| | Conductivity (mS/cm) | 0.02 | 0.002 | 0.02 | 0.02 | 0.02 | 4 |
| Laboratory | Total Alkalinity (mg/L) | 1.30 | 0.10 | 1.30 | 1.20 | 1.40 | 3 |
| | Turbidity (NTU) | 3.48 | 3.88 | 1.55 | 1.50 | 9.30 | 4 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 4.80 | 3.48 | 3.90 | 2.00 | 9.40 | 4 |
| | E. Coli (MPN/100mL) | 359.53 | 374.18 | 172.50 | 172.30 | 920.80 | 4 |
| | TKN (mg/L) | 0.27 | 0.11 | 0.26 | 0.14 | 0.40 | 4 |
| | Ammonia (mg/L) | 0.12 | #DIV/0! | 0.12 | 0.12 | 0.12 | 1 |
| | Nitrate/Nitrite (mg/L) | 0.31 | 0.07 | 0.34 | 0.20 | 0.34 | 4 |
| | Total Phosphorus (mg/L) | 0.03 | 0.002 | 0.03 | 0.02 | 0.03 | 2 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 0.94 | 0.26 | 0.95 | 0.64 | 1.20 | 4 |
| | Iron (mg/L) | 0.42 | 0.22 | 0.36 | 0.23 | 0.72 | 4 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.46 | 0.02 | 0.47 | 0.43 | 0.48 | 4 |
| | Manganese (mg/L) | 0.02 | 0.004 | 0.02 | 0.02 | 0.03 | 3 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 4.25 | 0.70 | 4.30 | 3.40 | 5.00 | 4 |
| | Aluminum (mg/L) | 0.23 | 0.19 | 0.16 | 0.10 | 0.50 | 4 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-2039 Fourmile Branch at Road 12.2

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.70 | 0.74 | 7.03 | 5.63 | 7.72 | 12 |
| | DO (mg/L) | 10.00 | 2.12 | 9.90 | 6.87 | 13.78 | 12 |
| | Water Temp (°C) | 17.34 | 6.23 | 16.94 | 7.39 | 26.40 | 12 |
| | Conductivity (mS/cm) | 0.05 | 0.01 | 0.05 | 0.04 | 0.09 | 12 |
| Laboratory | Total Alkalinity (mg/L) | 13.35 | 2.91 | 14.00 | 9.20 | 18.00 | 12 |
| | Turbidity (NTU) | 3.68 | 1.66 | 3.45 | 1.50 | 7.00 | 12 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 5.13 | 5.29 | 3.55 | 1.00 | 20.00 | 12 |
| | E. Coli (MPN/100mL) | 161.48 | 204.68 | 70.80 | 30.90 | 727.00 | 12 |
| | TKN (mg/L) | 0.23 | 0.08 | 0.24 | 0.11 | 0.31 | 8 |
| | Ammonia (mg/L) | 0.07 | NA | 0.07 | 0.07 | 0.07 | 1 |
| | Nitrate/Nitrite (mg/L) | 0.72 | 0.21 | 0.69 | 0.45 | 1.10 | 12 |
| | Total Phosphorus (mg/L) | 0.09 | 0.05 | 0.07 | 0.04 | 0.18 | 12 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 3.96 | | 4.00 | 3.00 | 4.50 | 12 |
| | Iron (mg/L) | 0.84 | 0.31 | 0.84 | 0.35 | 1.40 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.57 | 0.04 | 0.58 | 0.48 | 0.61 | 12 |
| | Manganese (mg/L) | 0.05 | 0.03 | 0.04 | 0.02 | 0.11 | 12 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 12.21 | 1.37 | 12.00 | 9.50 | 14.00 | 12 |
| | Aluminum (mg/L) | 0.13 | 0.05 | 0.12 | 0.08 | 0.21 | 10 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-2040 Beaver Dam Creek

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 4.71 | 1.02 | 4.10 | 3.54 | 6.3 | 12 |
| | DO (mg/L) | 7.98 | 2.43 | 6.99 | 4.96 | 11.64 | 12 |
| | Water Temp (°C) | 18.06 | 6.27 | 16.79 | 8.72 | 27.30 | 12 |
| | Conductivity (mS/cm) | 0.17 | 0.026 | 0.17 | 0.12 | 0.21 | 12 |
| Laboratory | Total Alkalinity (mg/L) | NS | NS | NS | NS | NS | NS |
| | Turbidity (NTU) | NS | NS | NS | NS | NS | NS |
| | BOD (mg/L) | NS | NS | NS | NS | NS | NS |
| | TSS (mg/L) | NS | NS | NS | NS | NS | NS |
| | E. Coli (MPN/100mL) | NS | NS | NS | NS | NS | NS |
| | TKN (mg/L) | NS | NS | NS | NS | NS | NS |
| | Ammonia (mg/L) | NS | NS | NS | NS | NS | NS |
| | Nitrate/Nitrite (mg/L) | NS | NS | NS | NS | NS | NS |
| | Total Phosphorus (mg/L) | NS | NS | NS | NS | NS | NS |
| | Cadmium | 0.0002 | 0.0001 | 0.0002 | 0.0001 | 0.0003 | 9 |
| | Calcium (mg/L) | 19.58 | 4.87 | 20.50 | 11.00 | 28.00 | 12 |
| | Iron (mg/L) | 2.12 | 2.18 | 1.14 | 0.32 | 6.90 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 3.41 | 0.65 | 3.45 | 2.20 | 4.50 | 12 |
| | Manganese (mg/L) | 0.47 | 0.08 | 0.44 | 0.35 | 0.60 | 12 |
| | Nickel (mg/L) | 0.02 | 0.001 | 0.02 | 0.02 | 0.023 | 4 |
| | Zinc (mg/L) | 0.04 | 0.01 | 0.05 | 0.02 | 0.06 | 11 |
| | Hardness (mg/L) | NS | NS | NS | NS | NS | NS |
| | Aluminum (mg/L) | 2.82 | 2.26 | 2.95 | 0.35 | 8.90 | 12 |
| | Beryllium (mg/L) | 0.01 | 0.002 | 0.01 | 0.001 | 0.01 | 12 |

### NWSV-2047 Pen Branch at Road A-13.2

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.93 | 0.27 | 6.93 | 6.20 | 7.24 | 12 |
| | DO (mg/L) | 10.65 | 2.42 | 10.08 | 7.97 | 16.99 | 12 |
| | Water Temp (°C) | 17.62 | 5.96 | 17.14 | 8.15 | 26.29 | 12 |
| | Conductivity (mS/cm) | 0.05 | 0.02 | 0.05 | 0.002 | 0.06 | 12 |
| Laboratory | Total Alkalinity (mg/L) | 21.17 | 5.15 | 22.00 | 13.00 | 27.00 | 12 |
| | Turbidity (NTU) | 4.50 | 1.94 | 4.15 | 2.20 | 9.10 | 12 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 4.87 | 3.22 | 3.45 | 1.50 | 12.00 | 12 |
| | E. Coli (MPN/100mL) | 338.65 | 339.22 | 247.75 | 51.20 | 1203.30 | 12 |
| | TKN (mg/L) | 0.29 | 0.14 | 0.25 | 0.11 | 0.45 | 9 |
| | Ammonia (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Nitrate/Nitrite (mg/L) | 0.13 | 0.03 | 0.14 | 0.05 | 0.18 | 12 |
| | Total Phosphorus (mg/L) | 0.03 | 0.01 | 0.03 | 0.02 | 0.05 | 10 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 8.02 | 1.20 | 8.45 | 6.20 | 9.90 | 12 |
| | Iron (mg/L) | 0.69 | 0.21 | 0.65 | 0.36 | 1.00 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.62 | 0.09 | 0.61 | 0.51 | 0.88 | 12 |
| | Manganese (mg/L) | 0.04 | 0.01 | 0.04 | 0.02 | 0.07 | 12 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 22.58 | 3.06 | 23.50 | 19.00 | 28.00 | 12 |
| | Aluminum (mg/L) | 0.21 | 0.12 | 0.18 | 0.05 | 0.44 | 12 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-2055 Meyers Branch at Road 9

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 6.51 | 0.61 | 6.70 | 5.46 | 7.23 | 12 |
| | DO (mg/L) | 11.17 | 2.89 | 10.09 | 8.09 | 18.32 | 12 |
| | Water Temp (°C) | 17.73 | 5.81 | 17.96 | 8.60 | 25.92 | 12 |
| | Conductivity (mS/cm) | 0.07 | 0.11 | 0.04 | 0.03 | 0.42 | 12 |
| Laboratory | Total Alkalinity (mg/L) | 15.07 | 4.78 | 15.00 | 4.80 | 22.00 | 12 |
| | Turbidity (NTU) | 5.09 | 5.93 | 3.30 | 1.40 | 23.00 | 12 |
| | BOD (mg/L) | 2.80 | NA | 2.80 | 2.80 | 2.80 | 1 |
| | TSS (mg/L) | 7.05 | 9.27 | 3.60 | 1.50 | 34.00 | 11 |
| | E. Coli (MPN/100mL) | 484.56 | 539.96 | 344.80 | 131.40 | 1986.30 | 11 |
| | TKN (mg/L) | 0.37 | 0.18 | 0.32 | 0.15 | 0.65 | 10 |
| | Ammonia (mg/L) | 0.10 | NA | 0.10 | 0.10 | 0.10 | 1 |
| | Nitrate/Nitrite (mg/L) | 0.12 | 0.04 | 0.13 | 0.05 | 0.16 | 12 |
| | Total Phosphorus (mg/L) | 0.03 | 0.01 | 0.03 | 0.02 | 0.05 | 3 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 6.72 | 1.11 | 6.85 | 4.00 | 8.00 | 12 |
| | Iron (mg/L) | 0.57 | 0.42 | 0.49 | 0.20 | 1.80 | 12 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.45 | 0.05 | 0.44 | 0.38 | 0.57 | 12 |
| | Manganese (mg/L) | 0.04 | 0.03 | 0.03 | 0.01 | 0.13 | 12 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 18.75 | 2.83 | 19.50 | 12.00 | 22.00 | 12 |
| | Aluminum (mg/L) | 0.29 | 0.37 | 0.17 | 0.05 | 1.40 | 12 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

### NWSV-2061 Tinker Creek at Road 2-1

| Parameters | | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects |
|---|---|---|---|---|---|---|---|
| Field | pH (SU) | 5.56 | 0.57 | 5.58 | 4.85 | 6.24 | 4 |
| | DO (mg/L) | 12.45 | 1.60 | 12.83 | 10.31 | 13.83 | 4 |
| | Water Temp (°C) | 11.87 | 4.65 | 10.51 | 8.17 | 18.28 | 4 |
| | Conductivity (mS/cm) | 0.02 | 0.002 | 0.02 | 0.02 | 0.03 | 4 |
| Laboratory | Total Alkalinity (mg/L) | 4.40 | 0.99 | 4.50 | 3.10 | 5.50 | 4 |
| | Turbidity (NTU) | 4.03 | 2.36 | 3.10 | 2.40 | 7.50 | 4 |
| | BOD (mg/L) | ND | ND | ND | ND | ND | 0 |
| | TSS (mg/L) | 5.00 | 2.36 | 4.85 | 2.60 | 7.70 | 4 |
| | E. Coli (MPN/100mL) | 539.45 | 964.59 | 62.20 | 47.10 | 1986.30 | 4 |
| | TKN (mg/L) | 0.25 | 0.12 | 0.24 | 0.13 | 0.41 | 4 |
| | Ammonia (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Nitrate/Nitrite (mg/L) | 0.05 | 0.02 | 0.05 | 0.02 | 0.07 | 4 |
| | Total Phosphorus (mg/L) | 0.04 | 0.01 | 0.04 | 0.03 | 0.06 | 4 |
| | Cadmium (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Calcium (mg/L) | 2.88 | 0.15 | 2.80 | 2.80 | 3.10 | 4 |
| | Iron (mg/L) | 0.49 | 0.23 | 0.41 | 0.32 | 0.82 | 4 |
| | Lead (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Magnesium (mg/L) | 0.38 | 0.01 | 0.38 | 0.37 | 0.39 | 4 |
| | Manganese (mg/L) | 0.03 | 0.01 | 0.02 | 0.02 | 0.05 | 4 |
| | Nickel (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Zinc (mg/L) | ND | ND | ND | ND | ND | 0 |
| | Hardness (mg/L) | 8.73 | 0.39 | 8.55 | 8.50 | 9.30 | 4 |
| | Aluminum (mg/L) | 0.29 | 0.15 | 0.22 | 0.20 | 0.51 | 4 |
| | Beryllium (mg/L) | ND | ND | ND | ND | ND | 0 |

## Chapter 6 Monitoring of Sediments on and Adjacent to SRS

### 6.1.0 PROJECT SUMMARY

The accumulation of radiological and non-radiological contaminants in sediment can directly affect aquatic organisms which can lead to human exposure. Impacts to water bodies come through direct discharge, atmospheric fallout, and runoff. These accumulated contaminants may re-suspend in streams and rivers or disperse downstream, potentially affecting drinking water supplies and fish consumed by the public. The transportation of sediments is a dynamic process. Stream flow changes can redistribute contaminants or bury them as part of the natural sedimentation process. Patterns of sediment contamination are strongly affected by hydrologic factors and the physical and chemical characterization of the sediment (EPA, 1987).

Collecting sediment sample from the Savannah River

SRS streams receive surface water runoff and water from permitted discharges (DOE, 1995). SRS is within the Savannah River watershed with five major streams feeding into the Savannah River. Dispersal of any contaminants from these streams has the potential to impact the Savannah River.

DHEC personnel evaluate sediment samples for radionuclide and non-radionuclide contaminant concentrations in SRS streams, SRS storm-water basins, creek mouths along the boundary of SRS, the Savannah River, and publicly accessible boat landings in the SRS vicinity. Radionuclide detections in sediment are typically the result of accumulation over many years and do not represent yearly depositions. Sediment samples on SRS are routinely split with DOE-SR to compare results.

A complete list of all radiological and non-radiological analytes can be found in List of Analytes, Table 1 and Table 2 on page ix. DHEC sediment sampling locations are illustrated in Section 6.4.0, Map. DHEC and DOE-SR split samples were collected from seven stream locations on SRS, three SRS storm-water basins, five SRS creek mouths, and one public boat landing. A complete list of sample locations is listed in Section 6.5.0, Table 1.

### 6.2.0 RESULTS AND DISCUSSION

DHEC sediment monitoring summary statistics can be found in Section 6.6.0 and sediment monitoring data can be found in the 2022 DHEC Data File.

#### 6.2.1 Radiological Results

Cesium-137 releases from Z-Area have the potential to contaminate tributaries of McQueen Branch, which flows into Upper Three Runs. The impact from possible contamination warrants long-term monitoring by DHEC along SRS streams and the publicly accessible Savannah River.

The creek mouths of SRS are a potential conduit for the dispersal of radionuclides into publicly accessible water. Cesium-137 activity was found by DHEC in the sediment within several creek mouths at the Savannah River. Actinium-228, beryllium-7, potassium-40, lead-212, lead-214, radium-226, and thorium-234 are NORM decay products that account for the remaining gamma detections. All other gamma-emitting radionuclides had no detections above their respective MDA in 2022.

Sediment is collected and then dried before radiological analysis

DHEC had gross alpha and gross non-volatile beta activity detections in 2022. The summary statistics can be found in Section 6.6.0.

Cesium-137 is the most abundant anthropogenic radionuclide found in the sediment samples. Cesium-137 levels in 2022 data from samples collected outside SRS boundaries are all within the expected range and consistent with previous DHEC background data. Cs-137 in sediment may be attributed, in part, to fallout from past nuclear events in the 1950s and 1960s. The highest level of Cs-137 from all 2022 DHEC and DOE-SR collocated sediment samples occurred at Steel Creek Mouth (1.84 pCi/g for DHEC and 1.54 pCi/g for DOE-SR) and Four Mile Creek (0.74 pCi/g for DHEC and 0.99 pCi/g for DOE-SR) (SRNS, 2023). Cesium-137 contamination in Steel Creek Mouth is well documented and not unexpected. All sample results were well below the Preliminary Remediation Goal (PRG) of 27.9 pCi/g for Cs-137 (Section 6.5.0, Table 2) (EPA, 2022).


Prepped samples being sent to the lab for radionuclide analysis

Figure 1 in Section 6.5.0 illustrates the average Cs-137 activity in sediment samples from all the DHEC locations. DHEC Cs-137 data from the SRS creek mouths were trended for 2018-2022 (Section 6.5.0, Figure 2) and were compared to DOE-SR data (Section 6.5.0, Figure 3).

### 6.2.2 Non-radiological Results

Metals in sediment can be naturally occurring or a result of man-made processes such as those used in SRS operations.. Re-distribution of sediment from flooding can carry contaminants to downstream locations. Geological factors in the Savannah River basin contribute to the levels of



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metals through erosion and sedimentation. All 2022 DHEC and DOE-SR samples had averages below the Ecological Screening Values (ESVs) for beryllium (for which DOE-SR does not test), copper, lead, nickel, and zinc (EPA, 2018). DHEC had no chemicals with detection concentrations above the ESV for the background location in 2022 except for barium, cadmium and manganese.

Comparisons were made to the ESVs for sediment, which do not represent remediation goals or cleanup levels but are used to identify constituents of potential concern (EPA, 2018).

Barium was detected above the ESV of 20 mg/kg by DHEC in all creek mouths, all storm-water basins, 7 on-site streams (SMSV-2062, SMSV-2073, SMSV-2039, SMSV-2048, SMSV-325, SMSV-2040, and SMSV-2069), and 5 of the boat landings (SMJBL-22, SMBF-22, SMJL-22, SMRVP-22, and SMSVC-22)). DOE-SR detected barium above the ESV in all creek mouths and storm-water basins, in 5 on-site streams (McQB @ MO, PB @ Rd 6, U3R-1A, U3R-3, U3R-4).

Preparing sample for non-radionuclide lab analysis

Beryllium does not have an established ESV for sediment, so in lieu of a sediment value, the ESV for soil was used. DHEC had no detects above the ESV of 2.5 mg/kg. DOE-SR did not analyze for beryllium in 2022.

Cadmium was detected above the ESV of 1 mg/kg by DHEC in 2 of the creek mouths (SMSV-2011 and SMSV-2017,), 2 stormwater basins (E-003 and E-001), and 2 of the public boat landings (SMRVP-22 and SMSVC-22). DOE-SR did not detect cadmium above the ESV in any location in 2022.

Chromium was detected above the ESV of 43.4 mg/kg in none of DHEC's or DOE-SR's storm-water basins.

DHEC and DOE-SR did not detect copper above the ESV of 31.6 mg/kg in any samples.

Lead was not detected above the ESV of 35.8 mg/kg at any DHEC or DOE location.

DHEC detected manganese above the ESV of 460 mg/kg in all creek mouths and at 2 boat landings (SMRVP-22 and SMSVC-22). DOE-SR had detections in all creek mouths with results above the ESV.

Mercury was not detected above the ESV of 0.18 mg/kg by DHEC or DOE-.
DHEC non-radiological sediment data can be found in the 2022 DHEC Data File and non-radiological summary statistics can be found in Section 6.6.0.

### 6.3.0 CONCLUSIONS AND RECOMMENDATIONS

SRS sediments should continue to be monitored due to current releases of contaminants and the potential for future discharges from SRS operations, legacy wastes, and clean-up activities. Year-to-year data comparisons are difficult to interpret due to the nature of sediment accumulation. Differences among samples may be due to the fraction of clays that most effectively retain radionuclides. There is also difficulty in replicating the exact sampling point due to erosion and sedimentation. Monitoring of on-site sediments is of great importance since over-land precipitation and streams transport contaminated sediment with radionuclides outside the SRS boundary.

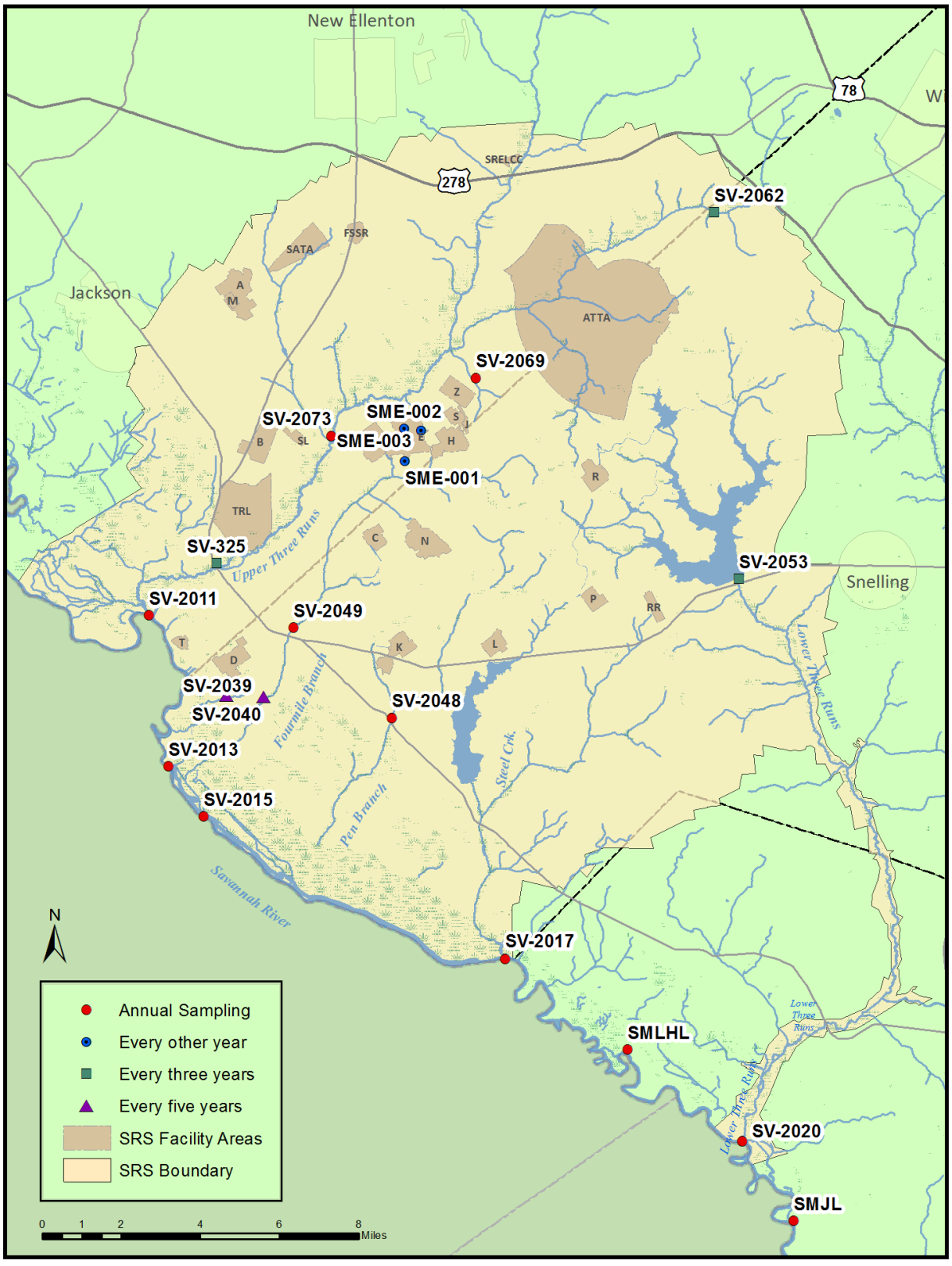
Pieces of rockier sediment are sieved before samples are sent to the Columbia lab for radionuclide analysis

DHEC will continue independent monitoring of sediment on SRS and in the Savannah River to catalogue the presence of radionuclide and non-radionuclide analytes. DHEC will also periodically evaluate and modify the sampling methodology to better accomplish project objectives.

Trending of data over multiple years demonstrates whether radionuclide concentrations in the SRS area are declining through radioactive decay or possibly increasing due to disturbances on SRS. By comparing data throughout the years, DOE-SR can evaluate its results as well as show the differences between its data and results from samples collected through monitoring by DHEC. Cooperation between DOE-SR and DHEC provides credibility and confidence in the information being provided to the public.

### 6.4.0 MAP

## SRS Sediment Sampling Locations




2022 ESOP Sediment Monitoring Map www.scdhec.gov/srs



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## 6.5.0 TABLES AND FIGURES

### Table 1. 2022 DHEC Sediment Sample Locations

| DHEC Sample Location ID | DOE Sample Location ID | Location Description |
|---|---|---|
| **Storm-water Basins** | | |
| SME-001 | E-004 | E-001 E Area Storm-water Basin |
| SME-002 | E-005 | E-002 E Area Storm-water Basin |
| SME-003 | E-006 | E-003 E Area Storm-water Basin |
| **Creek Mouths** | | |
| SMSV-2011 | RM 157.2 U3R | Upper Three Runs Mouth @ RM 157.4 |
| SMSV-2013 | BDC @ RM 152.3 | Beaver Dam Creek Mouth @ RM 152.3 |
| SMSV-2015 | RM 150.2 | Fourmile Branch Creek Mouth @ RM 150.6 |
| SMSV-2017 | SC @ RM 141.5 | Steel Creek Mouth @ RM 141.5 |
| SMSV-2020 | RM-129 L3R | Lower Three Runs Mouth @ RM 129.1 |
| **On-site Streams** | | |
| SMSV-2073 | U3R-3 | Upper Three Runs @ Rd C |
| SMSV-2069 | McQB at MO | McQueen Branch @ Monroe Owens Rd |
| SMSV- 2062 | Tinker Creek 1 (TC-1) | Tinker Creek @ Kennedy Park Rd |
| SMSV-2039 | FM-6 | Fourmile Creek @ Rd A-13 |
| SMSV-2048 | Pen Branch @ Rd A | Pen Branch @ Rd 125 |
| SMSV-2049 | FMC @ Rd 125 | Four Mile Creek @ Rd A (Hwy 125) |
| SMSV-325 | U3R-4 @ Road A | Upper Three Runs @ SC 125 |
| SMSV-2053 | L3R-1A (L3R @Rd B0 | Lower Three Runs @ Rd B |
| SMSV-2040 | BDC | Beaver Dam Creek |
| **Upstream of SRS** | | |
| SMRVP22 | NA | North Augusta Riverview Park Boat Landing |
| SMSVC22 | NA | Steven’s Creek Boat Landing |
| SMJBL22 | RM 170.5 (NS in 2022) | Jackson Boat Landing |
| **Downstream of SRS** | | |
| SMLHL22 | NA | Little Hell Landing |
| SMJL22 | NA | Johnson’s Landing |
| SMBFL22 | RM 118.7 | Burton's Ferry Boat Landing |

| DHEC Sample Location ID | DOE Sample Location ID | Location Description |
|---|---|---|

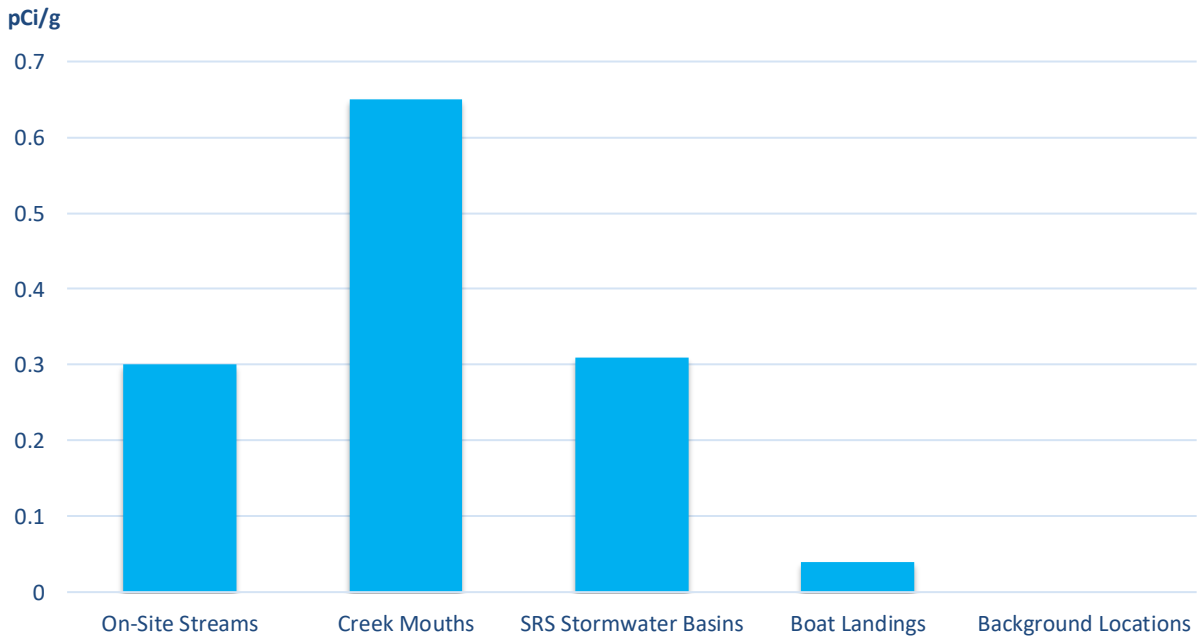
| | | |
|---|---|---|
| SMPKY22 | NA | Pinckney Island National Wildlife Refuge |

**Table 2. Soil Ingestion Preliminary Remediation Goals (PRGs) of Select Anthropogenic Radionuclides (EPA, 2022)**

| Radionuclide | Peak PRG for Exposure through Ingestion (pCi/g) |
|---|---|
| Americium-241 | 4.95 |
| Cesium-137 | 27.9 |
| Cobalt – 60 | 82.8 |
| Iodine-131 | 5980 |
| Plutonium-238 | 4.40 |
| Plutonium-239/240 | 3.92 |

Note: The PRG standards are produced through the EPA's "PRGs for Radionuclides Calculator" which are based on scenarios, select target risk, and media type and are calculated in real time and are not from an established table.

**Figure 1. 2022 Comparisons of Cs-137 Average Activity Among DHEC Sample Location Types**




No bar denotes no detection.



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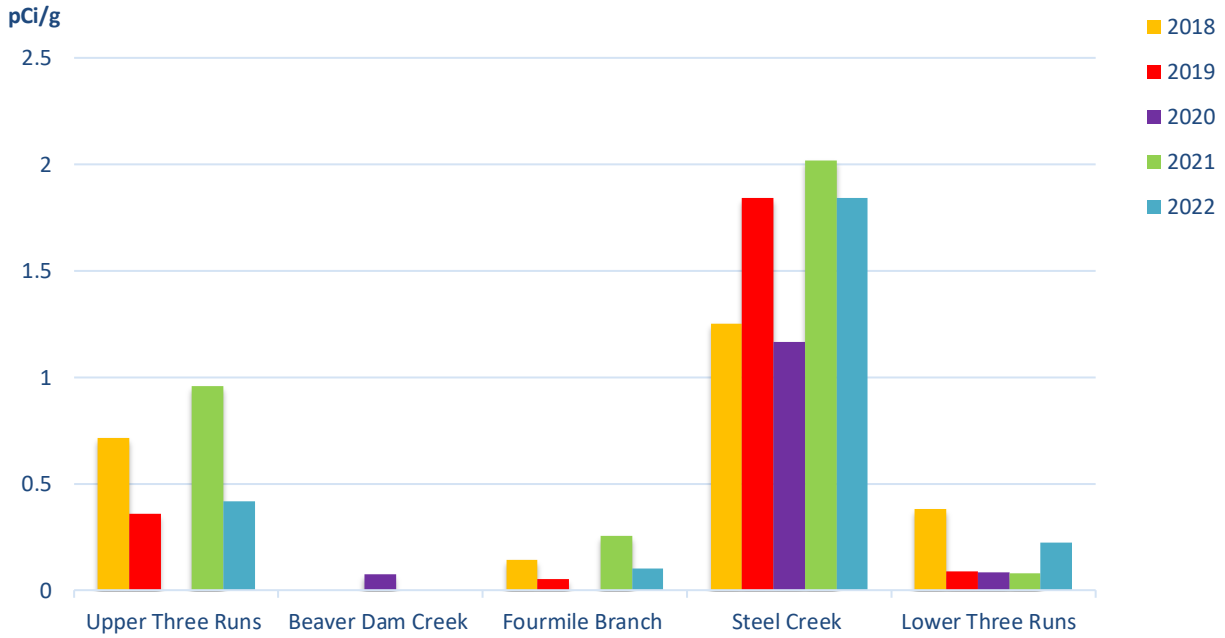
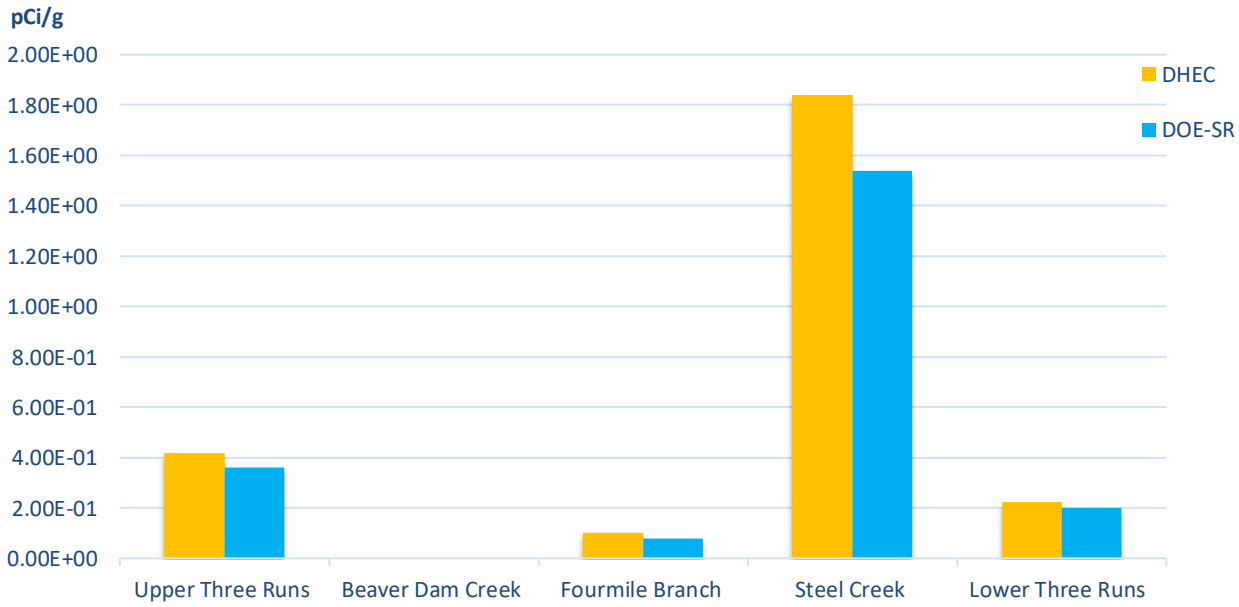
## TABLES AND FIGURES

**Figure 2. 2018-2022 Trending Data for Cs-137 in SRS Creek Mouth Samples (DHEC, 2020a-2023)**




No bar denotes no detection for that year.

**Figure 3. 2022 Cesium-137 in Savannah River Creek Mouths–DHEC Comparison to DOE-SR Data (SRNS, 2023)**




Beaver Dam Creek is a man-made stream that was used for past operations at D-Area



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## 6.6.0 SUMMARY STATISTICS

### 2022 DHEC Radiological Data

#### On-Site Streams

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | 16.64 | 11.83 | 13.50 | 6.44 | 34.50 | 5 | 9 |
| **Gross Beta** | 9.79 | 5.27 | 8.13 | 5.16 | 19.60 | 6 | 9 |
| **Cs-137** | 0.30 | 0.26 | 0.21 | 0.04 | 0.74 | 8 | 9 |

#### Creek Mouths

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | 14.41 | 9.58 | 9.97 | 5.83 | 27.80 | 5 | 5 |
| **Gross Beta** | 22.50 | 7.60 | 21.00 | 13.50 | 34.40 | 5 | 5 |
| **Cs-137** | 0.65 | 0.81 | 0.32 | 0.10 | 1.84 | 4 | 5 |

#### Stormwater Basins

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | 13.90 | 3.47 | 12.10 | 11.70 | 17.90 | 3 | 3 |
| **Gross Beta** | 12.70 | 2.35 | 11.60 | 11.10 | 15.40 | 3 | 3 |
| **Cs-137** | 0.31 | 0.15 | 0.31 | 0.20 | 0.41 | 2 | 3 |

#### Boat Landings

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | 8.94 | 1.35 | 8.89 | 7.60 | 10.40 | 4 | 6 |
| **Gross Beta** | 18.00 | 3.05 | 16.10 | 15.50 | 22.20 | 5 | 6 |
| **Cs-137** | 0.04 | 0.00 | 0.04 | 0.04 | 0.04 | 2 | 6 |

#### Background Samples

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | ND | ND | ND | ND | ND | 0 | 1 |
| **Gross Beta** | 12.7 | NA | NA | NA | NA | 1 | 1 |
| **Cs-137** | ND | ND | ND | ND | ND | 0 | 1 |

ND is Not Detected, NA is Not Applicable

## SUMMARY STATISTICS

### 2022 DHEC Non-radiological (Metals) Data

### On-Site Streams

| Analyte | Average Concentration (mg/kg) | Standard Deviation | Median (mg/kg) | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Number of Detections | Number of Samples | ESV |
|---|---|---|---|---|---|---|---|---|
| **Barium** | 52.36 | 60.71 | 28.00 | 7.20 | 200.00 | 9 | 9 | 20 |
| **Beryllium** | 0.86 | 0.28 | 0.86 | 0.56 | 1.20 | 6 | 9 | 2.5* |
| **Cadmium** | ND | ND | ND | ND | ND | 0 | 9 | 1 |
| **Chromium** | 8.77 | 7.24 | 6.70 | 1.30 | 22.00 | 9 | 9 | 43.4 |
| **Copper** | 4.33 | 2.20 | 4.90 | 1.40 | 7.30 | 6 | 9 | 31.6 |
| **Lead** | 8.68 | 3.16 | 7.85 | 6.00 | 13.00 | 4 | 9 | 35.8 |
| **Manganese** | 108.00 | 85.02 | 100.00 | 28.00 | 310.00 | 9 | 9 | 460 |
| **Mercury** | 0.18 | NA | NA | NA | NA | 1 | 9 | 0.18 |
| **Nickel** | 5.38 | 2.19 | 5.00 | 2.90 | 8.40 | 6 | 9 | 22.7 |
| **Zinc** | 17.18 | 9.03 | 13.00 | 6.60 | 30.00 | 9 | 9 | 121 |

### Creek Mouth Locations

| Analyte | Average Concentration (mg/kg) | Standard Deviation | Median (mg/kg) | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Number of Detections | Number of Samples | ESV |
|---|---|---|---|---|---|---|---|---|
| **Barium** | 106.40 | 42.25 | 100.00 | 62.00 | 150.00 | 5 | 5 | 20 |
| **Beryllium** | 0.84 | 0.69 | 0.62 | 0.32 | 2.00 | 5 | 5 | 2.5* |
| **Cadmium** | 1.65 | 0.07 | 1.65 | 1.60 | 1.70 | 2 | 5 | 1 |
| **Chromium** | 19.48 | 12.16 | 17.00 | 7.40 | 37.00 | 5 | 5 | 43.4 |
| **Copper** | 6.73 | 5.63 | 5.75 | 1.40 | 14.00 | 4 | 5 | 31.6 |
| **Lead** | 11.97 | 7.25 | 10.00 | 5.90 | 20.00 | 3 | 5 | 35.8 |
| **Manganese** | 810.00 | 188.41 | 700.00 | 650.00 | 1,100.00 | 5 | 5 | 460 |
| **Mercury** | 0.12 | NA | NA | NA | NA | 1 | 5 | 0.18 |
| **Nickel** | 7.86 | 4.75 | 6.70 | 3.40 | 15.00 | 5 | 5 | 22.7 |
| **Zinc** | 39.80 | 21.28 | 38.00 | 17.00 | 67.00 | 5 | 5 | 121 |

### Stormwater Basins

| Analyte | Average Concentration (mg/kg) | Standard Deviation | Median (mg/kg) | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Number of Detections | Number of Samples | ESV |
|---|---|---|---|---|---|---|---|---|
| **Barium** | 59.33 | 15.31 | 51.00 | 50.00 | 77.00 | 3 | 3 | 20 |
| **Beryllium** | 0.75 | 0.22 | 0.77 | 0.52 | 0.95 | 3 | 3 | 2.5* |
| **Cadmium** | 1.65 | 0.78 | 1.65 | 1.10 | 2.20 | 2 | 3 | 1 |
| **Chromium** | 33.00 | 8.00 | 33.00 | 25.00 | 41.00 | 3 | 3 | 43.4 |
| **Copper** | 7.57 | 1.36 | 8.30 | 6.00 | 8.40 | 3 | 3 | 31.6 |
| **Lead** | 12.70 | 4.00 | 12.00 | 9.10 | 17.00 | 3 | 3 | 35.8 |
| **Manganese** | 119.33 | 79.43 | 86.00 | 62.00 | 210.00 | 3 | 3 | 460 |
| **Mercury** | ND | ND | ND | ND | ND | 0 | 3 | 0.18 |
| **Nickel** | 9.30 | 1.93 | 9.70 | 7.20 | 11.00 | 3 | 3 | 22.7 |
| **Zinc** | 67.00 | 26.63 | 64.00 | 42.00 | 95.00 | 3 | 3 | 121 |

### Boat Landings

| Analyte | Average Concentration (mg/kg) | Standard Deviation | Median (mg/kg) | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Number of Detections | Number of Samples | ESV |
|---|---|---|---|---|---|---|---|---|
| **Barium** | 72.13 | 69.67 | 40.00 | 5.80 | 170.00 | 6 | 6 | 20 |
| **Beryllium** | 0.71 | 0.34 | 0.79 | 0.34 | 1.00 | 3 | 6 | 2.5* |
| **Cadmium** | 2.10 | 0.28 | 2.10 | 1.90 | 2.30 | 2 | 6 | 1 |
| **Chromium** | 11.23 | 11.35 | 6.70 | 1.20 | 32.00 | 6 | 6 | 43.4 |
| **Copper** | 8.30 | 8.50 | 3.20 | 1.00 | 19.00 | 5 | 6 | 31.6 |
| **Lead** | 19.50 | 6.36 | 19.50 | 15.00 | 24.00 | 2 | 6 | 35.8 |
| **Manganese** | 549.67 | 457.94 | 420.00 | 18.00 | 1,300.00 | 6 | 6 | 460 |
| **Mercury** | ND | ND | ND | ND | ND | 0 | 6 | 0.18 |
| **Nickel** | 6.62 | 5.51 | 3.80 | 2.10 | 14.00 | 5 | 6 | 22.7 |
| **Zinc** | 32.50 | 24.43 | 20.50 | 11.00 | 71.00 | 6 | 6 | 121 |

**Chapter 7 Monitoring of Surface Soil Adjacent to SRS**



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### 7.1.0 PROJECT SUMMARY

DHEC independently evaluates surface soil adjacent to SRS from ground surface to a 12-inch depth for gross alpha, gross non-volatile beta, and select gamma-emitting radionuclides, as well as specific metals of concern. Soil samples are collected to determine if SRS activities have had an impact on areas outside the site boundary. Radionuclide detections in soil are the result of accumulation over many years.

A 50-mile area from the center of SRS was chosen for the comparison of DHEC and DOE-SR SRS perimeter radiological data averages. DOE-SR does not collect metals for surface soil; therefore, no direct data comparisons can be made.

DHEC collected samples from 12 SRS perimeter locations and 1 background location in 2022 (Section 7.5.0, Table 1). SRS perimeter sampling locations are depicted on the Map in Section 7.4.0.

### 7.2.0 RESULTS AND DISCUSSION

Soil Monitoring Summary Statistics for radionuclides and metals can be found in Section 7.6.0, and all Soil Monitoring Data can be found in the **2022** DHEC Data File.

#### 7.2.1 Radiological Parameter Results

Collecting soil samples which will be analyzed for radiological material and metals

Most samples had detectable amounts of Cs-137, an anthropogenic radionuclide that may be present due to a legacy of releases by SRS and atmospheric fallout from past nuclear weapons testing (SRNS, 2022). Cs-137 activity in **2022** is comparable to levels detected by DHEC in the past. There were no surface soil samples collected in **2022** that were above the EPA Preliminary Remediation Goals (PRGs), which can be found in Section 7.5.0, Table 2 (EPA, 2022).

Cesium-137 was the only gamma-emitting radionuclide that DHEC and DOE-SR shared in analytical results. Both DHEC and DOE-SR resulted in similar findings. DHEC had a perimeter average Cs-137 concentration of **0.13** pCi/g, which was slightly lower than DOE-SR's findings of 0.18 pCi/g. The PRG for C-137 is 28 pCi/g and all sample results were well below that level. Trending data for Cs-137 in SRS perimeter samples is in Section 7.5.0, Figures 1 and 2.

The results found by both DHEC and DOE-SR are influenced by the number of samples used to determine the average and by collecting samples from different locations. The average level of Cs-137 in surface soil can vary due to the highly variable nature of soils. Radiocesium

bioavailability in soil is influenced by soil properties such as clay content, pH, organic matter, and soil microflora (Absalom et al., 2001).

The only other gamma-emitting radionuclides detected in DHEC surface soil samples were potassium-40, lead-212, lead-214, radium-226, actinium-228, europium-155, and thallium-234. These are NORM decay products (2022 DHEC Data File).

### 7.2.2 Non-radiological Parameter Results

DOE-SR did not analyze for metals; therefore, no comparisons could be made. DHEC saw no exceedances of the EPA Regional Screening Levels (RSLs) in any of the surface soil samples in 2022 (EPA, 2021). A complete list of all DHEC non-radiological analytes and RSLs can be found in Section 7.5.0, Table 3.

Clearing away debris to expose soil

Barium has been a constituent of the H-Area Hazardous Waste Management Facility (WSRC, 1993). Barium was detected in 12 SRS perimeter samples.

Beryllium is a strong, lightweight metal used in nuclear weapons work as a shield for radiation and as a neutron source (Till et al., 2001). Beryllium was not detected in the SRS perimeter samples in 2022.

Cadmium enters the atmosphere through fuel and coal combustion (Till et al. 2001). None of the perimeter surface soil samples yielded detections.

Chromium solutions were used at SRS as corrosive inhibitors. Chromium was a part of wastewater solutions resulting from dissolving stainless steel. It was also used in cleaning solutions in the separations areas (Till et al., 2001). The legal disposal of fly ash on land as a result of burning coal is a contributor of both chromium and nickel to soils. Chromium was detected in all 12 of the SRS perimeter samples.

D-Area and the other coal combustion powerhouses emitted copper and other heavy metals (Till et al., 2001). These mechanisms are possible sources of elevated copper levels in surface soils. Copper was detected in 8 of the SRS perimeter samples.

Atmospheric emissions of lead from SRS occurred through coal and fuel combustion (Till et al., 2001). Lead can deposit in soil and due to its immobility can have a long residence time when compared to other pollutants. Lead can accumulate in soils where its bioavailability can persist long-term (Alloway, 1995). Lead was detected in **7** of the SRS perimeter samples.

Samples being prepared for lab analysis

Manganese has been released in the separations areas' processes and discharged to liquid waste tanks (Till et al., 2001). It is also a byproduct of coal burning. Manganese was detected in all 12 of the SRS perimeter samples.

The largest anthropogenic source of nickel globally is the burning of fuels and coal combustion (Alloway, 1995). At SRS, nickel was directly released through M-Area effluent from the plating rinse tanks and through site use of diesel generators (Till et al., 2001). Nickel was detected in **7** SRS perimeter samples.

Zinc was released in relatively small amounts to the separations areas' seepage basins as well as the M-Area seepage basin (Till et al., 2001). Zinc was detected in all 12 of the SRS perimeter samples.

SRS facilities, such as F- and H- Area, tritium facilities, waste tanks, and the coal-fired power plants have emitted mercury to the atmosphere (Till et al., 2001). Atmospheric fallout contributes to mercury findings in surface soil. There were no mercury detections in surface soil samples collected in 2022.

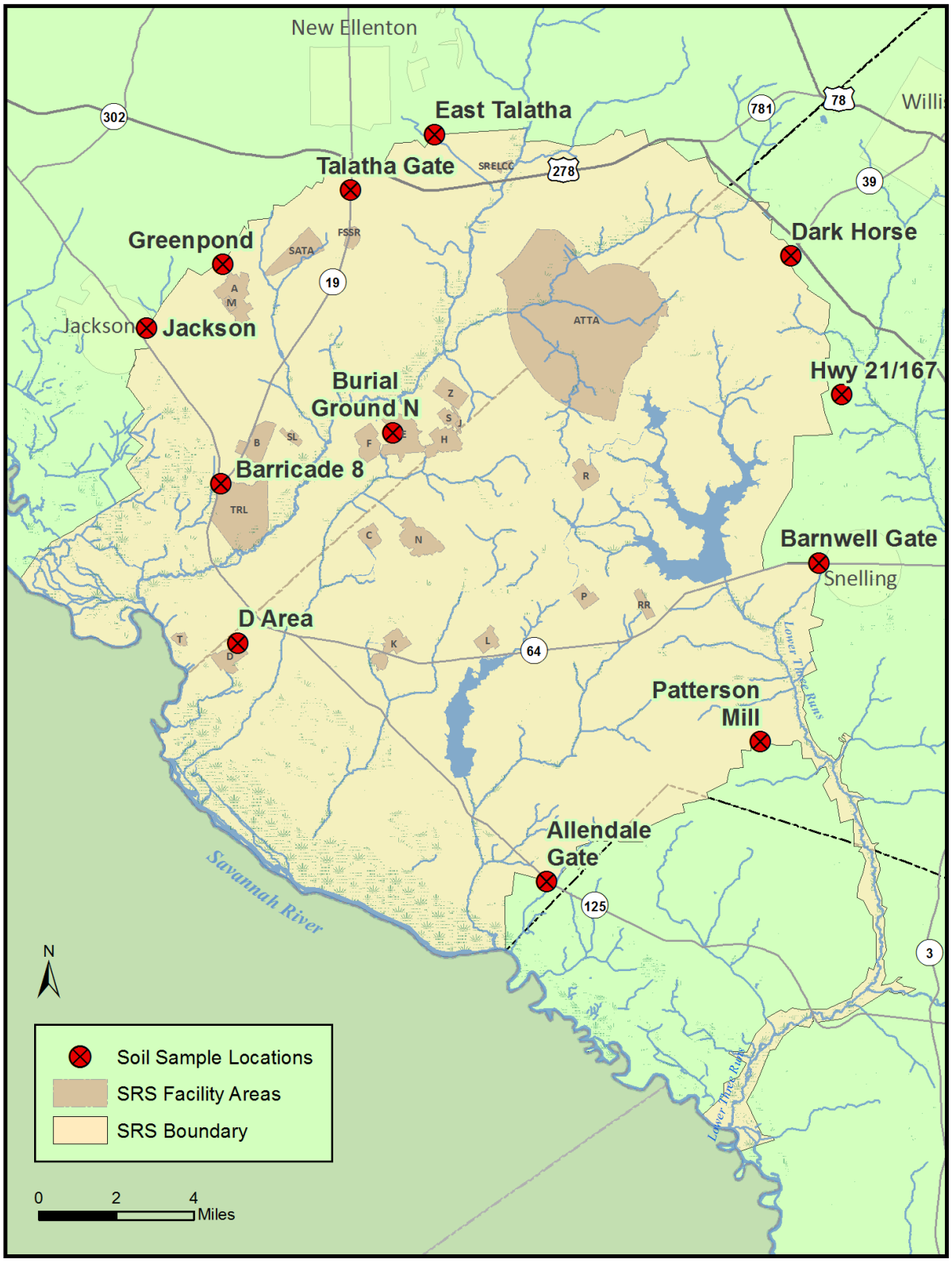
### 7.3.0 CONCLUSIONS AND RECOMMENDATIONS

Soil samples from DHEC and DOE-SR programs varied by location and in number. When interpreting data, it should be taken into consideration that samples were collected from a variety of soil types and locations.

DHEC will continue to monitor independently the SRS perimeter surface soil and will periodically evaluate modification of the monitoring activities to better accomplish project goals and objectives. Monitoring will continue as long as there are activities at SRS that create the potential for contamination to enter the environment. Continued monitoring will provide an improved understanding of radionuclide and non-radionuclide activity in SRS perimeter surface soils and the surrounding areas. Additional monitoring will impart valuable information to human health exposure pathways. Trending of data over multiple years will give a more definitive answer as to whether radionuclide concentrations in the SRS area are declining due to radioactive decay or possibly increasing due to flooding, soil disturbances, and prescribed burns on SRS. The comparison of data allows for independent data verification of DOE-SR monitoring activities. Cooperation between DOE-SR and DHEC provides credibility and confidence in the information being provided to the public.

### 7.4.0 MAP

## SRS Perimeter Surface Soil Monitoring



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## 7.5.0 TABLES AND FIGURES

**Table 1. Soil Sample Locations for in 2022**

| Perimeter Soil Samples | | |
|---|---|---|
| **Sample ID** | **Location** | **County** |
| East Talatha | New Ellenton | Aiken |
| Talatha Gate | New Ellenton | Aiken |
| Burial Ground N | SRS | Aiken |
| Barricade 8 | Hwy 125 | Aiken |
| Jackson | Jackson | Aiken |
| Greenpond | Near SRS Air Station at Green Pond | Aiken |
| D Area | SRS | Aiken |
| Allendale Gate | Air Station | Allendale |
| Barnwell Gate | Snelling | Barnwell |
| Hwy 21/167 | Seven Pines Air Station | Barnwell |
| Dark Horse | Hwy 278 | Barnwell |
| Patterson Mill | Patterson Mill Air Station | Barnwell |
| **Background Soil Samples** | | |
| **Sample ID** | **Location** | **County** |
| Pinckney | Pinckney Island National Refuge | Beaufort |

**Table 2. Soil Ingestion Preliminary Remediation Goals of Select Anthropogenic Radionuclides (EPA, 2022)**

| Radionuclide | Peak PRG for Exposure through Ingestion (pCi/g) |
|---|---|
| Americium-241 | 4.95 |
| Cesium-137 | 27.9 |
| Cobalt – 60 | 82.8 |
| Iodine-131 | 5980 |
| Plutonium-238 | 4.40 |
| Plutonium-239/240 | 3.92 |

See note for Table 2 in Section 6.5.0

**Table 3. Regional Screening Levels of Metals (EPA, 2021)**

| Analyte | RSL (mg/kg) |
|---|---|
| Barium | 15,000 |
| Beryllium | 160 |
| Cadmium | 71 |
| Total Chromium | 23** |
| Copper | 3,100 |
| Lead | 400 |
| Manganese | 1,800 |
| Mercury | 11 |
| Nickel | 1,500 |
| Zinc | 23,000 |

**The DHEC lab analyzes soil samples for total chromium; however, a RSL is not established for total chromium. The value provided in the table above is the ecological screening value for total chromium in soil.



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## TABLES AND FIGURES

**Figure 1. 2018-2022 DHEC and DOE-SR Trending Averages for Cesium-137 (SRNS, 2019-2023; DHEC, 2020a-2022**

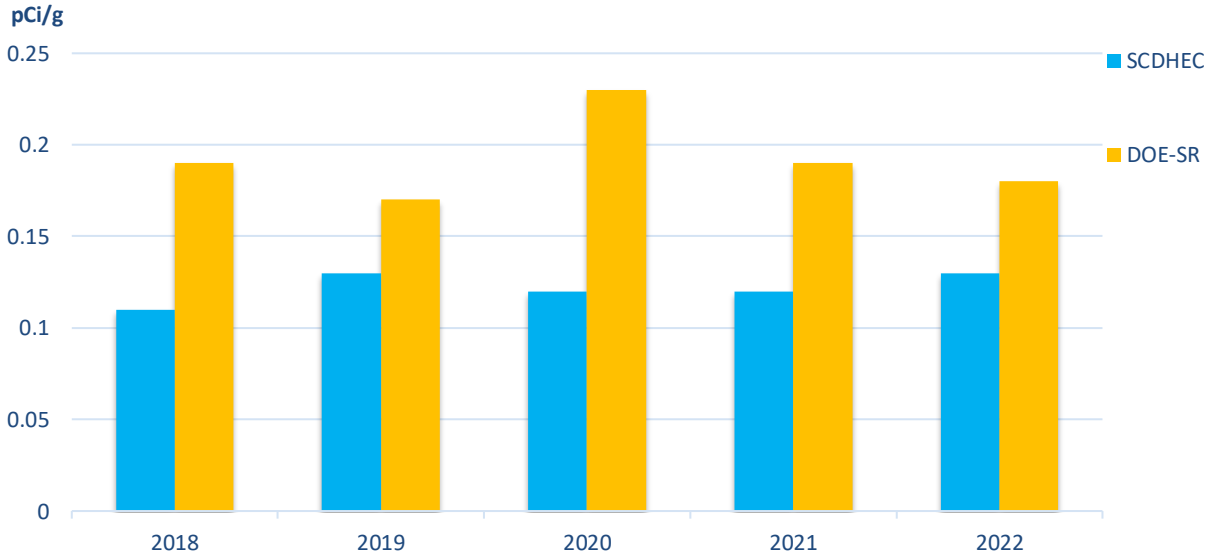
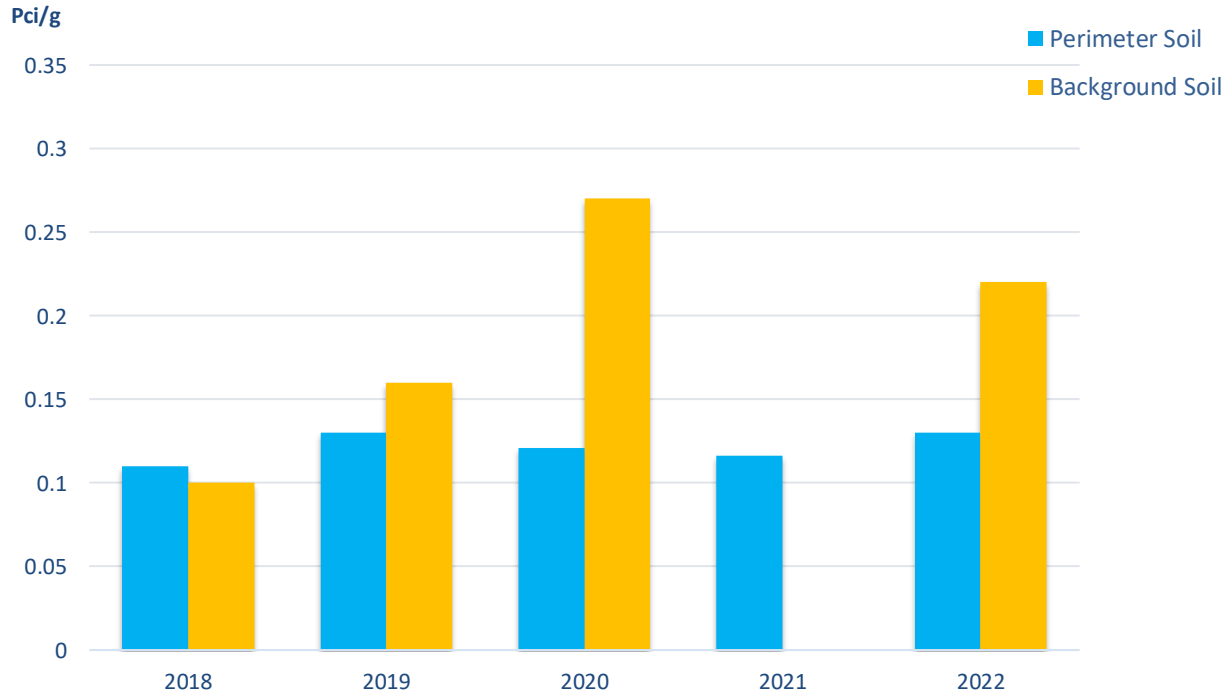



**Figure 2. 2018-2022 Perimeter and Background Trending Averages for Cesium-137 (DHEC 2020a – 2022)**




Background samples were not collected in 2021.



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### 7.6.0 SUMMARY STATISTICS

**2022 DHEC Radiological Statistics -- SRS Perimeter Samples**

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | 8.84 | NA | NA | NA | NA | 1 | 12 |
| **Gross Beta** | ND | ND | ND | ND | ND | 0 | 12 |
| **Cs-137** | 0.13 | 0.11 | 0.12 | 0.02 | 0.44 | 11 | 12 |

**2022 DHEC Radiological Statistics – Background Sample**

| Analyte | Average Concentration (pCi/g) | Standard Deviation | Median (pCi/g) | Minimum Detect (pCi/g) | Maximum Detect (pCi/g) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Gross Alpha** | ND | ND | ND | ND | ND | 0 | 1 |
| **Gross Beta** | 8.99 | NA | NA | NA | NA | 1 | 1 |
| **Cs-137** | 0.22 | NA | NA | NA | NA | 1 | 1 |

**2022 DHEC Non-radiological (Metals) Statistics -- SRS Perimeter Samples**

| Analyte | Average Concentration (mg/kg) | Standard Deviation | Median (mg/kg) | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Barium** | 22.46 | 11.92 | 24 | 5.20 | 44.00 | 12 | 12 |
| **Beryllium** | ND | ND | ND | ND | ND | 0 | 12 |
| **Cadmium** | ND | ND | ND | ND | ND | 0 | 12 |
| **Chromium** | 5.52 | 2.47 | 4.90 | 1.70 | 11.00 | 12 | 12 |
| **Copper** | 3.50 | 2.45 | 2.80 | 1.40 | 8.40 | 8 | 12 |
| **Lead** | 40.49 | 87.99 | 8.40 | 5.10 | 240.00 | 7 | 12 |
| **Manganese** | 94.92 | 75.60 | 83 | 9.00 | 240.00 | 12 | 12 |
| **Mercury** | ND | ND | ND | ND | ND | 0 | 12 |
| **Nickel** | 3.03 | 0.71 | 3.00 | 2.00 | 4.30 | 7 | 12 |
| **Zinc** | 21.64 | 15.71 | 18 | 4.40 | 59.00 | 12 | 12 |

### 7.6.0 SUMMARY STATISTICS continued

**2022 DHEC Non-radiological (Metals) Statistics – Background Samples**

| Analyte | Average Concentration (mg/kg) | Standard Deviation | Median (mg/kg) | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Barium** | 16 | NA | NA | NA | NA | 1 | 1 |
| **Beryllium** | ND | ND | ND | ND | ND | 0 | 1 |
| **Cadmium** | ND | ND | ND | ND | ND | 0 | 1 |
| **Chromium** | 4 | NA | NA | NA | NA | 1 | 1 |
| **Copper** | ND | ND | ND | ND | ND | 0 | 1 |
| **Lead** | 12 | NA | NA | NA | NA | 1 | 1 |
| **Manganese** | 57 | NA | NA | NA | NA | 1 | 1 |
| **Mercury** | ND | ND | ND | ND | ND | 0 | 1 |
| **Nickel** | ND | ND | ND | ND | ND | 0 | 1 |
| **Zinc** | 21 | NA | NA | NA | NA | 1 | 1 |

NA is Not Applicable and ND is Not Detected

**Chapter 8 Radiological Monitoring of Terrestrial Vegetation Adjacent to SRS**

### 8.1.0 PROJECT SUMMARY

DOE-SR collects and analyzes terrestrial vegetation, primarily Bermuda grass, to determine concentrations of radionuclides (SRNS, 2023). In 2019, DHEC began sampling Bermuda grass (*cynodon dactylon*) to align with DOE's methodology. If grass is unavailable, DHEC and DOE will revert to collecting leaves from broad-leafed evergreen trees and shrubs. DHEC and DOE-SR locations are collocated with samples being obtained from 12 locations at the SRS perimeter and 1 on-site location at the burial grounds. DHEC joinss DOE-SR personnel in the field to collect and split grass samples. DHEC also has a background location at Pinckney Island National Wildlife Refuge. DHEC and DOE-SR perimeter stations sampled in 2022 are shown in Section 8.4.0, Map.


Preparing vegetation samples for analysis

### 8.2.0 RESULTS AND DISCUSSION

#### Terrestrial Vegetation Data

Terrestrial Vegetation Monitoring Data can be found in the 2022 DHEC Data File.

In 2022, DHEC detected tritium at its center location (Burial Ground North – 3.61 pCi/g) and 1 perimeter location (Barricade 8 – 0.19 pCi/g) (Section 8.5.0). DOE-SR had tritium detects in 3 perimeter locations (Jackson – 0.05 pCi/g, East Talatha. – 0.10 pCi/g, and Barnwell Gate – 0.09 pCi/g), and at the center location (Burial Ground North at 0.05 pCi/g) (SRNS, 2023).

Bermuda grass samples

Tritium analysis results from DHEC and DOE-SR sampling are presented in Section 8.5.0, Table 1.

Gamma

In 2022, DHEC detected actinium-228, beryllium-7, and potassium-40. These isotopes are NORM; therefore, the results will not be discussed further but are presented in the 2022 DHEC Data File. A list of radionuclides in the gamma spectroscopy analysis are in List of Analytes, Table 1, page ix.

Gamma analysis results for Cs-137 from DHEC and DOE-SR sampling in 2022 are presented in Section 8.5.0, Table 2. The man-made isotopes Co-60 and Am-241 were not detected in the DHEC 2022 samples.


Prepared vegetation samples ready for analysis

### 8.3.0 CONCLUSIONS AND RECOMMENDATIONS

In 2020, DHEC discontinued sampling at the three 25-mile radius locations (Hwy 301 Welcome Center, Augusta Loc and Dam, and the Aiken Airport). 2 of these locations are in found in Georgia, whereas DHEC's background sample is collected from Pinckney Island National Wildlife Refuge in Beaufort County, SC.

DHEC's revision of beginning to sample Bermuda grass on an annual basis in 2019 allows for a more direct comparison with the data collected by DOE-SR. By having parallel sampling techniques with DOE-SR, DHEC will potentially observe less differences in the data.



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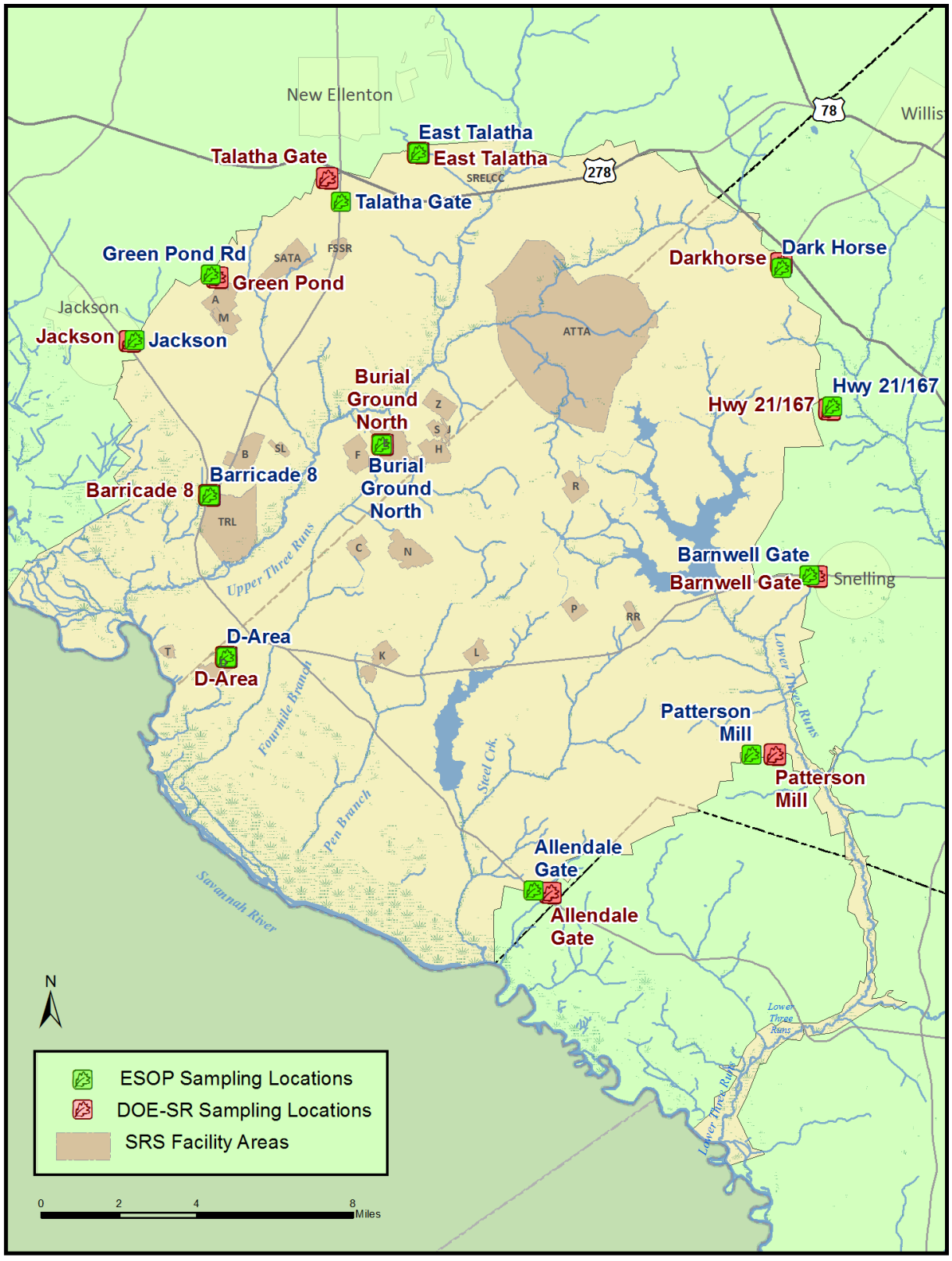
### 8.4.0 MAP

## Terrestrial Vegetation Sampling Locations




2022 ESOP Terestrial Vegetation Monitoring Map www.scdhec.gov



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### 8.5.0 SUMMARY STATISTICS

**Table 1. 2022 Tritium Data Comparison for DHEC and DOE-SR Sampling Locations (SRNS, 2023)**

| Stations | DHEC Result (pCi/g) | DOE-SR Result (pCi/g) |
|---|---|---|
| **Burial Ground North** | 3.61 | 0.05 |
| **Sample Perimeter Locations** | | |
| **Talatha Gate** | ND | ND |
| **Green Pond Rd** | ND | ND |
| **Jackson** | ND | 0.05 |
| **East Talatha** | ND | 0.10 |
| **Dark Horse** | ND | ND |
| **Patterson Mill** | ND | ND |
| **Barnwell Gate** | ND | 0.09 |
| **Barricade 8** | 0.19 | ND |
| **Highway 21/167** | ND | ND |
| **Allendale Gate** | ND | ND |
| **D-Area** | ND | ND |
| **Perimeter Locations' Summary Statistics – Tritium** | | |
| **Average** | **NA** | **0.08** |
| **Standard Deviation** | **NA** | **0.02** |
| **Median** | **NA** | **0.09** |

NA is Not Applicable
ND is Not Detected
DHEC's background location at Pinckney did not detect tritium in 2022. No background sample was collected at Pinckney for DOE-SR.
No summary statistics for each location were shown due to only one sample being taken per location.
DHEC perimeter summary statistics were NA due to only having one detect at Barricade 8 in 2022.

### 8.5.0 TABLES AND FIGURES

**Table 2. 2022 Cesium-137 Data Comparison for DHEC and DOE-SR Sampling Locations (SRNS, 2023)**

| Stations | DHEC Result (pCi/g) | DOE-SR Result (pCi/g) |
|---|---|---|
| **Burial Ground North** | ND | ND |
| **Sample Perimeter Locations** | | |
| **Talatha Gate** | ND | ND |
| **Green Pond Rd** | ND | 0.12 |
| **Jackson** | ND | ND |
| **East Talatha** | 0.026 | 0.16 |
| **Dark Horse** | ND | 0.16 |
| **Patterson Mill** | 0.047 | 0.15 |
| **Barnwell Gate** | 0.076 | 0.47 |
| **Barricade 8** | ND | ND |
| **Highway 21/167** | 0.116 | 0.32 |
| **Allendale Gate** | 0.128 | 0.44 |
| **D-Area** | ND | ND |
| **25-Mile Radius Locations** | | |
| **Aiken Airport** | ND | 0.23 |
| **Perimeter Locations' Summary Statistics – Cs-137** | | |
| **Average** | **0.079** | **0.259** |
| **Standard Deviation** | **0.043** | **0.145** |
| **Median** | **0.076** | **0.163** |

ND is Not Detected
DHEC's background location at Pinckney had a Cs-137 detection of 0.036 pCi/g. No background sample was collected at Pinckney for DOE-SR.
No summary statistics for each location were shown due to only one sample being taken per location.



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## Chapter 9 Radiological Monitoring of Edible Vegetation Adjacent to SRS



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### 9.1.0 PROJECT SUMMARY

The Radiological Monitoring of Edible Vegetation Project is a component of the DHEC's ESOP that monitors edible vegetation from SRS perimeter and background locations.


Foraging for wild plums

DHEC defined a study area comprised of grids radiating out to 25 miles from the SRS center point, 25 miles to 50 miles, and background locations greater than 50 miles from the SRS center point (Map in Section 9.4.0). DOE-SR, as compared to DHEC, has 5 defined quadrants where samples are collected annually: 4 quadrants are within 10 miles of SRS in each direction (NE, NW, SE, SW), along with 1 quadrant located within 25 miles SE. Direct comparisons between DOE-SR and DHEC could not be made due to variation in sampling and analysis methodologies.

Edible vegetation is collected based solely on availability and is directly dependent upon the growing season. Certain farmers, gardeners, and/or businesses surrounding the perimeter of SRS contribute domestically grown crops. Wild, edible vegetation, such as muscadines and plums, are also collected. References to vegetation in this section pertain to the edible parts of plants.

DHEC background sampling helps to separate atomic test fallout contamination levels and other sources (e.g., ongoing permitted releases at other nuclear facilities) from SRS source potential contamination. However, fallout dispersion patterns and concentrations are weather related and not uniform, and no assignment of a specific source can be made.

### 9.2.0 RESULTS AND DISCUSSION

Edible Vegetation Monitoring Data can be found in the 2022 DHEC Data File.

Blended samples to be sent to the Columbia lab for analysis

The U.S. Food and Drug Administration (FDA) has guidance levels for specific radionuclides called Derived Intervention Levels (DILs). The FDA adopted DILs to help determine whether domestic food in interstate commerce or food offered for import into the United States presents a safety concern (FDA, 2020).

Blending squash for analysis

DHEC detected tritium in 1 sample of fruit from NE-1 quadrant (0.200 pCi/L) and 2 fruits from E-1 quadrant had an average detection of 0.200 pCi/L) in 2022. DOE-SR had 1 detection of tritium in its greens/vegetable samples in SE-1 quadrant (0.030 pCi/L) in 2022 (SRNS, 2023).

In 2022, DOE-SR edible vegetation exhibited radiological detections of gross beta, plutonium-238/9, strontium-89/90, neptunium-237, americium-241, curium-244 uranium-234, uranium-235, and uranium-238 (SRNS, 2022). Potassium-40 and lead-214 were the only gamma analyte detected in 2022 in DHEC samples. All the detected gamma radionuclides, except Cs-137, are NORM and are the source of most detections in edible vegetation; therefore, they are not discussed further.

The FDA-derived Guidance Level for Cs-137 is 32.4 pCi/g (FDA, 2020). DHEC detected Cs-137 in 1 sample of fungi from W-1 quadrant at 0.14 pCi/g and in 1 sample of fruit from NE-1 quadrant at 0.04 pCi/g. DOE-SR had detections of Cs-137 in 8 of the 19 samples collected in 2022 at an average of 0.029 pCi/g (the highest detection being in rotational in the SE quadrant 25 Miles at 0.048 pCi/g) (SRNS, 2023).

### 9.3.0 CONCLUSIONS AND RECOMMENDATIONS

DHEC and DOE-SR have different edible vegetation sampling schemes. DOE-SR samples primarily domestic plants collected from annual contributors in quadrants at zero to 10 miles from the perimeter of the SRS border and one quadrant at 25 miles. DHEC accepts domestic plants as donations from citizens and collects perennial, wild, edible vegetation and fungi found within 50 miles of the SRS center and background locations (Section 9.4.0).

In the future, DHEC will explore opportunities to split samples with DOE-SR and attempt to establish collocated sampling locations for better comparisons between the two. In addition, DHEC will continue to collect wild fungi due to its inherent ability to bioconcentrate Cs-137.

Collecting zucchini in a garden



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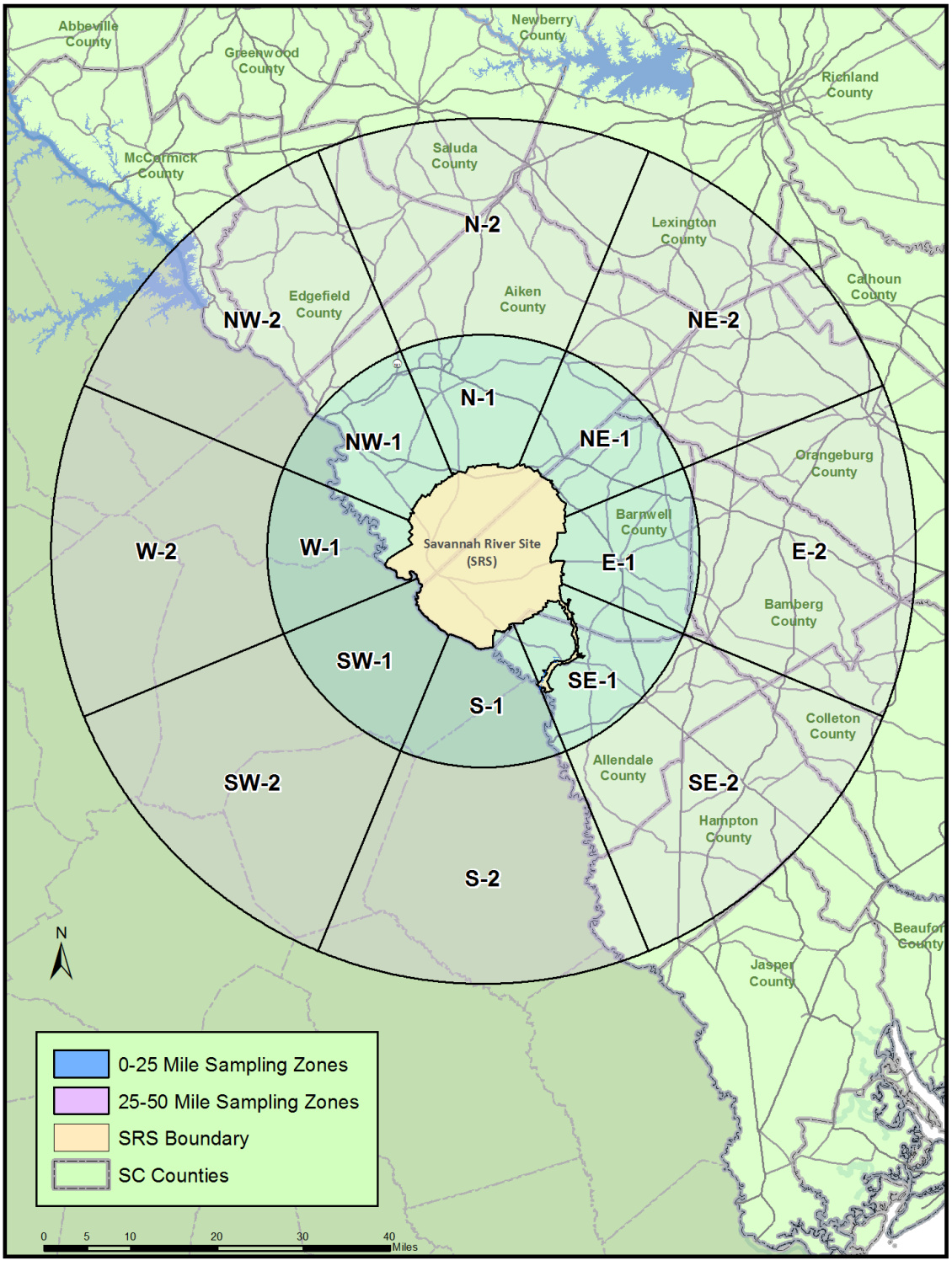
### 9.4.0 MAP

## DHEC Edible Vegetation Monitoring




Note: Though zones are highlighted in Georgia, samples are only collected in South Carolina.



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## Chapter 10 Radiological Monitoring of Dairy Milk



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### 10.1.0 PROJECT SUMMARY

Operations at SRS have resulted in the potential for radiological constituents to be released to the surrounding environment (Till et al., 2001). Consumption of milk products containing radioactive materials can be a human exposure pathway. When an atmospheric release occurs, radionuclides can be deposited on pastures and ingested by grazing dairy animals. The animals may release a portion of the radionuclides into their milk that could be consumed by humans (CDC, 2001). Radionuclides could also enter milk through the irrigation of a pasture using groundwater containing radioactive materials and through uptake by plants from soil containing radioactive materials.

In 2022, DHEC collected milk from three dairies within South Carolina (Section 10.4.0, Map). All three of these locations are within a 50-mile radius to the center of SRS. This project provides analytical data for trending and comparison to published DOE-SR data.

DHEC personnel collected unpasteurized milk samples on a quarterly basis in 2022. All milk samples from each quarter were analyzed for tritium, Sr-89/90, and gamma-emitting radionuclides. While a select group of gamma-emitting radionuclides (iodine-131 (I-131), Cs-137, and cobalt-60 (Co-60)) are analytes of concern in dairy milk for this project, all other detections such as Potassium-40 (K-40) are considered NORM. Naturally occurring radionuclides are the source of most public exposure; however, they are not discussed in this report unless detections are significantly greater than those of the background location detections. In 2022, DHEC did not sample any background dairy locations. DHEC analyzes samples for total strontium (Sr-89/90) instead of only Sr-90. This is done to provide a more conservative result, and it is assumed the total strontium detected is in the form of Sr-90.

### 10.2.0 RESULTS AND DISCUSSION

None of the 12 DHEC milk samples collected in 2022 exhibited tritium activity above the LLD (2022 DHEC Data File). DOE-SR did not detect tritium in any of the samples collected in 2022 from the South Carolina dairies (SRNS, 2023).

DHEC analyzed for gamma-emitting radionuclides (K-40, I-131, Cs-137, and Co-60) in 12 milk samples collected in 2022. All analytical results for these radionuclides were below the sample MDA except for naturally occurring K-40. These results can be found in the 2022 DHEC Data File. These results are consistent with past gamma results and no summary statistics were calculated for these radionuclides due to a lack of numerical data. DOE-SR had 3 detections of Cs-137 in their 16 cow milk samples from South Carolina dairies (SRNS, 2023).

2 of the 12 DHEC milk samples collected in 2022 exhibited strontium activity above the MDA with an average of 0.35 pCi/L. Section 10.5.0, Figure 1 shows the trend for DHEC strontium detections for the last five years. All strontium averages have been below the EPA established MCL of 8 pCi/L for Sr-90 in drinking water since testing initiated in 1998 (EPA, 2020). DOE-SR had 2 detections of Sr-89/90 in their 16 cow milk samples collected in 2022 in South Carolina (SRNS, 2023).

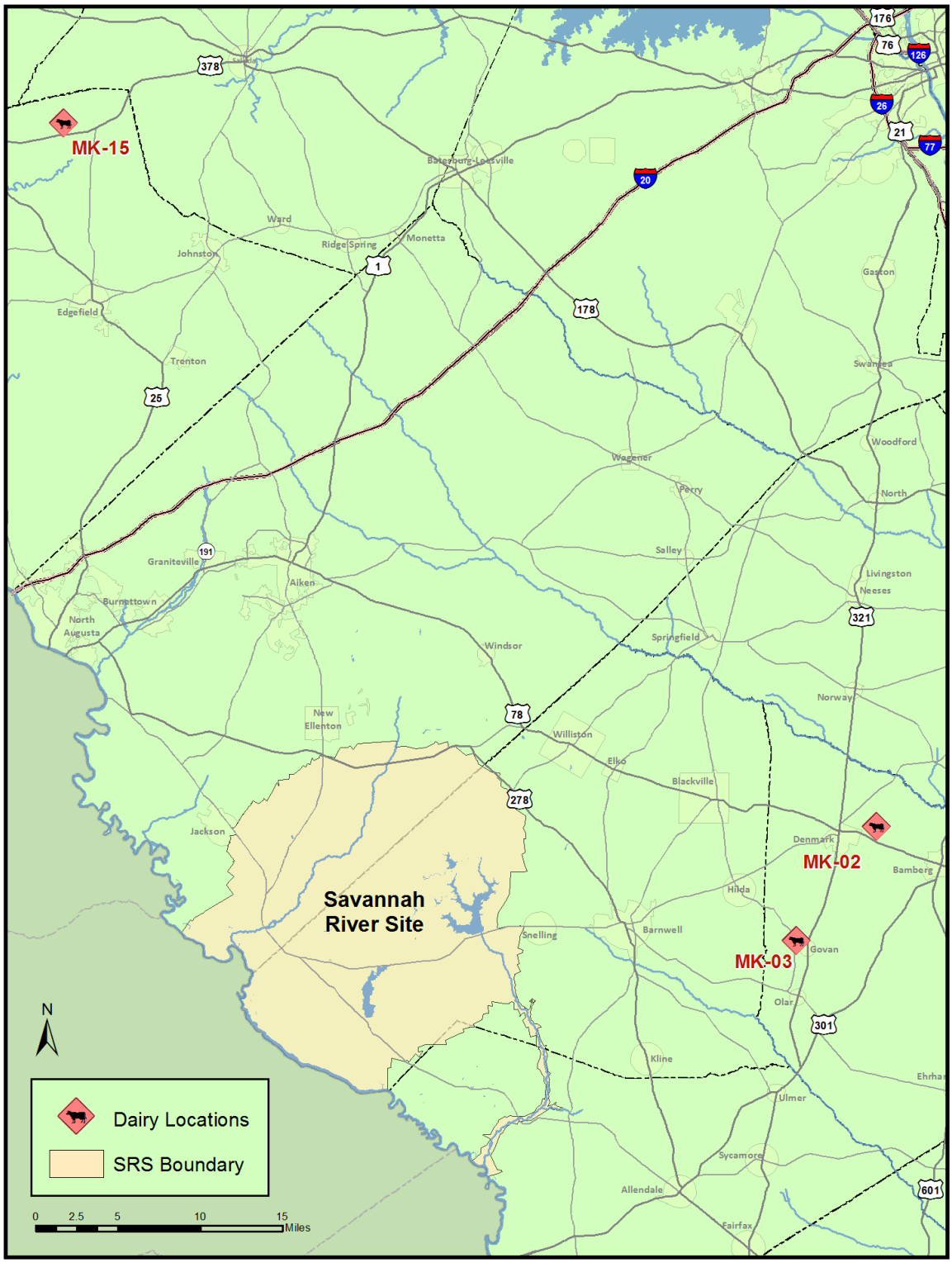
### 10.3.0 CONCLUSIONS AND RECOMMENDATIONS

A large portion of the radiological activity observed in milk samples can be attributed to fallout from past nuclear testing (Kathren, 1984). Also, radionuclides within soil and plants can potentially be redistributed because of farming practices and fires. Due to strontium's ability to be stored in bones and cesium building up in muscles, DHEC will continue to monitor tritium, gamma-emitting radionuclides, and strontium in milk to ensure the safety of milk consumption by the public.

The remaining dairies in DHEC's study area appear to be stable with no indication of closing in the foreseeable future. DHEC will continue to seek opportunities to add additional dairies to the sampling program for better coverage of the study area.

### 10.4.0 MAP

# Radiological Dairy Milk Monitoring Sampling Locations




2022 ESOP Dairy Milk Monitoring Map www.scdhec.gov



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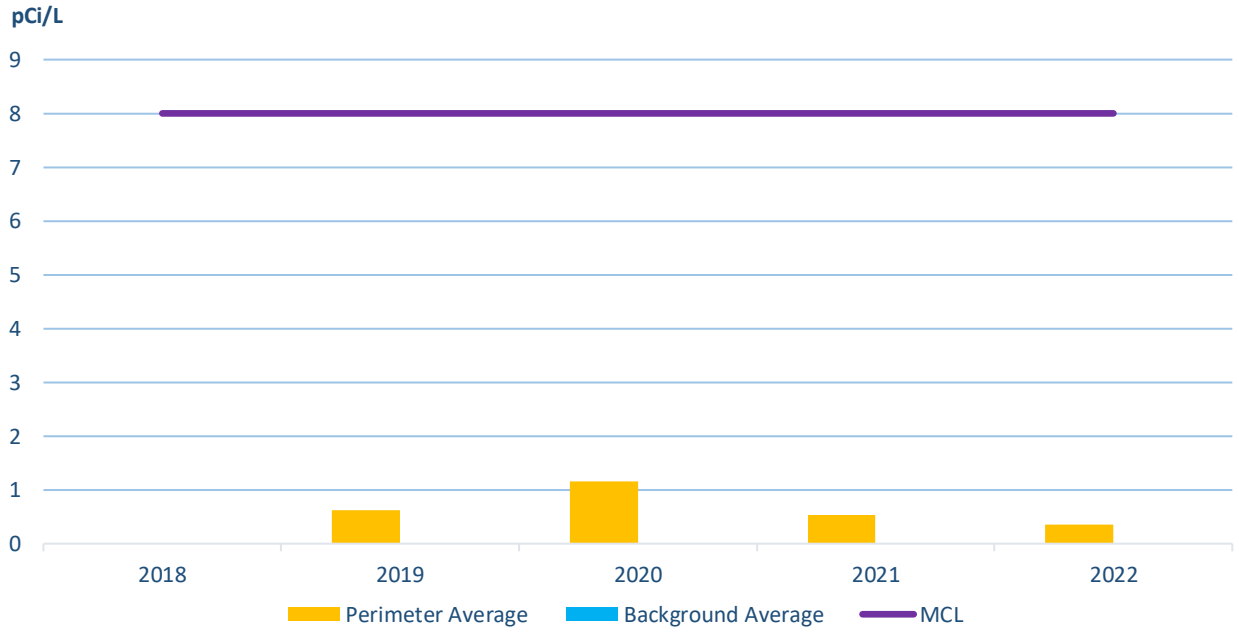
## 10.5.0 TABLES AND FIGURES

**Figure 1. DHEC Average Strontium-89/90 Data Trends for 2018-2022 (DHEC, 2020a-2022a)**




No bar indicates <MDA
No background location was collected in 2018, 2019, 2020, 2021, and 2022

## 10.6.0 SUMMARY STATISTICS

**2022 Strontium-89/90 All Sample Detections**

| Sample Location | Average (pCi/L) | Standard Deviation | Median (pCi/L) | Minimum Detect (pCi/L) | Maximum Detect (pCi/L) | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **MK-02** | ND | NA | NA | ND | ND | 0 | 4 |
| **MK-03** | 0.354 | 0.010 | 0.354 | 0.347 | 0.361 | 2 | 4 |
| **MK-15** | ND | NA | NA | ND | ND | 0 | 4 |

NA is Not Applicable
ND is Not Detected
No background sample was taken



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## Chapter 11 Monitoring of Fish Associated with SRS

### 11.1.0 PROJECT SUMMARY

DHEC ESOP conducts non-regulatory, independent monitoring and surveillance of fish to determine the magnitude, extent, and trend levels for radionuclides and selected metals.

Electroshocking boat on the Savannah River

In 2022, DHEC collected largemouth bass (*Micropterus salmoides)*, channel catfish (*Ictalurus punctatus*), and flathead catfish (*Pylodictis olivaris*) from four stations where creeks from SRS meet the Savannah River: Upper Three Runs Creek (SV-2011), Fourmile Branch (SV-2015), Steel Creek (SV-2017), and Lower Three Runs Creek (SV-2020). Samples of largemouth bass and channel catfish were also collected from the background station on the Combahee River between Beaufort and Colleton counties (MD-119), one Savannah River station upstream of SRS (New Savannah Bluff Lock and Dam (NSBLD SV-2028)), and two stations downstream of SRS (Highway 301 (SV-118) and Highway 17 saltwater (SV-2091 – the only area where striped mullet (*Mugil cephalus*) and red drum (*Sciaenopsocellatus*) are caught)). Flathead catfish were also collected at SV-118 and SV-2028. Stations sampled in 2022 are shown in Section 11.4.0, Map. These stations are accessible to the public.

A total of 6 largemouth bass and 6 channel catfish were collected from all Savannah River stations and the Combahee River background site. 1 red drum and 1 striped mullet were collected from the saltwater station (SV-2091) along with 1 largemouth bass collected from the background sampling location. Non-edible portions (bone) were tested for Sr-89/90. Edible portions (muscle tissue) were analyzed for mercury and other selected metals and gamma-emitting isotopes. 6 flathead catfish were composited and tested for gamma-emitting radionuclides in muscle tissue and strontium in bone tissue. Beginning in 2021, in addition to the composited flathead sample, an individual, large (greater than 24 inches) flathead catfish was also collected and analyzed for selected metals, mercury, and gamma-emitting radionuclides. DHEC was able to continue this for 2022 but DOE did not collect an individual large flathead catfish. Recently, tritium was found to contribute to “less than 1% of the estimated total fisherman dose” (SRNS, 2016). This is due to tritium’s ability to reach concentration equilibrium (the ability of a chemical to balance out) in both water and fish flesh resulting in no bioaccumulation (build up) in fish muscle (SRNS, 2016). With this discovery, DOE-SR and DHEC have at this time discontinued its testing of tritium in fish flesh.

Catching a largemouth bass



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### 11.2.0 RESULTS AND DISCUSSION

Fish Monitoring Summary Statistics can be found in Section 11.6.0 and all Fish Monitoring Data can be found in the 2022 DHEC Data File.

#### 11.2.1 Radiological Data Comparison

DHEC bass and catfish data collected in 2022 were compared to DOE-SR data (Section 11.5.0) (SRNS, 2023). One difference between the two programs is that DHEC analyzes one composite from each species for each station, whereas the DOE-SR program analyzes three composites per station for Cs-137. Therefore, a single composite for a DHEC station was compared to the average of the three DOE-SR composites reported. DHEC and DOE-SR have differences in how results from the single, large flathead catfish were calculated and reported. For Sr-89/90, DOE-SR reports individual sample results. To compare Sr-89/90 data, the average of these individual DOE-SR samples for each location are compared to the one composite sample of DHEC.

Trending graphs for 2022 activity levels of Cs-137 and Sr-89/90 are reported in Section 11.5.0, Figures 1 and 2.


Blending fish samples for sample preparation

#### 11.2.2 Non-radiological Data Comparison

DHEC and DOE-SR analyzed fish for antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc. DHEC did have detections of chromium, copper, manganese, mercury, and zinc in some of its edible fish samples. Due to differences in sampling methodology, direct comparisons were not made between DHEC and DOE-SR for these non-radiological constituents; however, since mercury tends to be a public health focus with fish consumption, a comparison was made for bass and both catfish species (Section 11.5.0, Table 9, 10, 11, and 12). Mercury trends for 2022 are reported in Section 11.5.0, Figure 3.

### 11.3.0 CONCLUSIONS AND RECOMMENDATIONS

Higher levels of radionuclides are found in Savannah River fish collected adjacent to and downstream of SRS compared to upstream. Therefore, independent monitoring of radionuclide levels in Savannah River fish will continue along with evaluating the DOE-SR Radiological Fish Monitoring Program. Continued monitoring will provide a better understanding of actual radionuclides, their extent, and trends. This data will allow DHEC to advise and inform the public. Data comparison



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will also be part of the further evaluation of the DOE-SR program. This independent evaluation will provide credibility and confidence in the DOE-SR data and its uses.

Future analyses of the target species will continue to include mercury and selected metals. This will augment the existing data on Savannah River fish, provide information for human health assessment, and provide another basis for comparison of results with DOE-SR data.

Flathead Catfish



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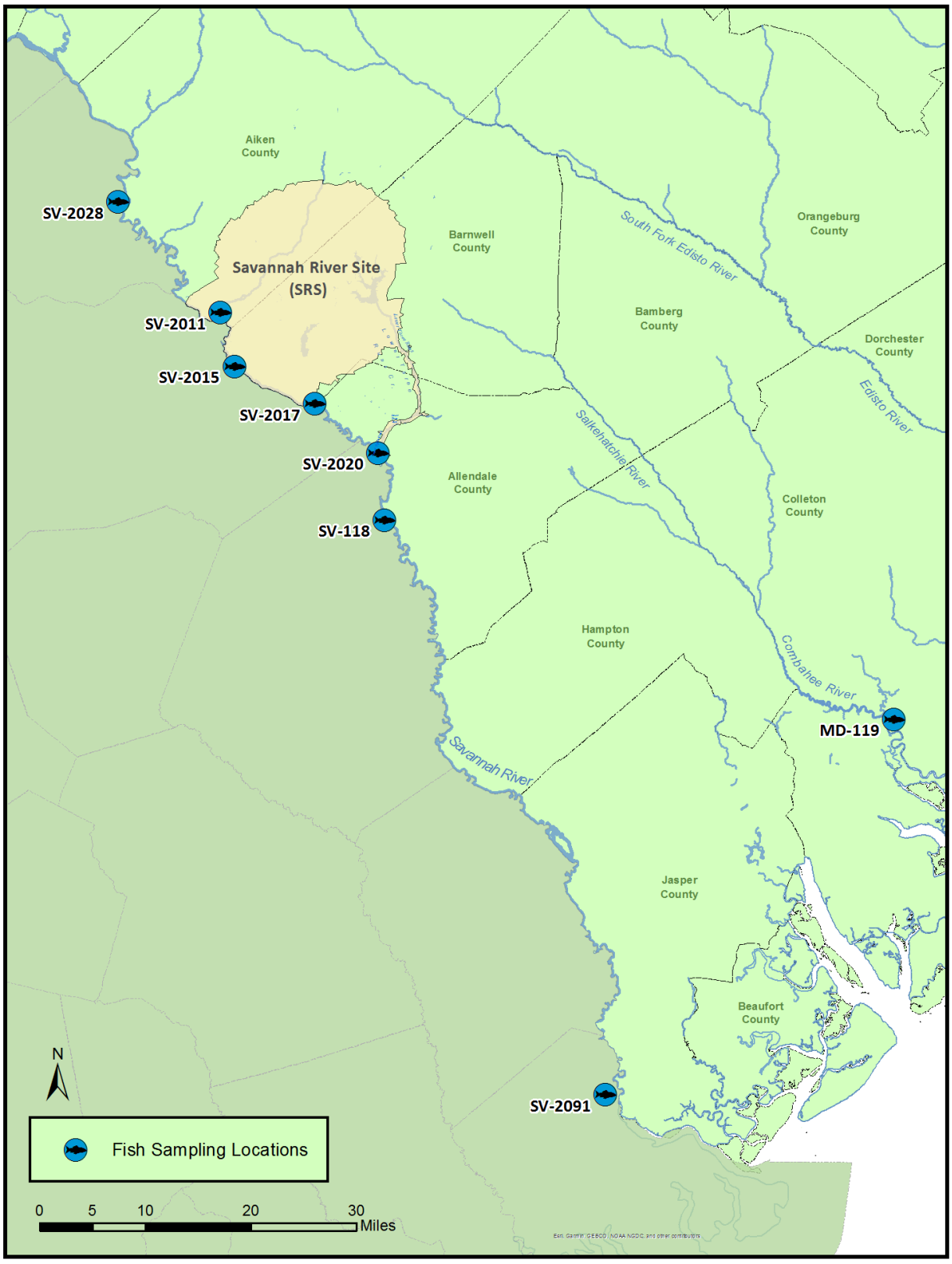
### 11.4.0 MAP

# Fish Monitoring Sampling Locations




2022 ESOP Fish Monitoring Map www.scdhec.gov



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## 11.5.0 TABLES AND FIGURES

### 2022 DHEC and DOE-SR Data Comparison (SRNS, 2023)

**Notes for Table 1-13:**
ND is Not Detected
NS is Not Sampled
DOE-SR data are averages
DHEC submits one composite sample for each location, whereas DOE-SR typically submits three composite samples for Cs-137, six composite samples for Sr-89/90, and seven composite samples for Mercury at each location (however, there may be variation within each year)

**Table 1. Cesium-137 in Edible Bass**

| Location | Agency | Number of Detects | Result (pCi/g) |
|---|---|---|---|
| NSBLD | DHEC | 0 | <MDA |
| | DOE-SR | 3 | 0.029 |
| Upper Three Runs | DHEC | 1 | 0.069 |
| | DOE-SR | 3 | 0.037 |
| Fourmile Branch | DHEC | 1 | 0.097 |
| | DOE-SR | 3 | 0.082 |
| Steel Creek | DHEC | 1 | 0.251 |
| | DOE-SR | 3 | 0.135 |
| Lower Three Runs | DHEC | 0 | <MDA |
| | DOE-SR | 2 | 0.030 |
| Hwy. 301 | DHEC | 0 | <MDA |
| | DOE-SR | 3 | 0.016 |

**Table 2. Cesium-137 in Edible Channel Catfish**

| Location | Agency | Number of Detects | Result (pCi/g) |
|---|---|---|---|
| NSBLD | DHEC | 0 | <MDA |
| | DOE-SR | 2 | 0.016 |
| Upper Three Runs | DHEC | 0 | <MDA |
| | DOE-SR | 0 | ND |
| Fourmile Branch | DHEC | 1 | 0.057 |
| | DOE-SR | 3 | 0.043 |
| Steel Creek | DHEC | 1 | 0.196 |
| | DOE-SR | 3 | 0.077 |
| Lower Three Runs | DHEC | 1 | 0.038 |
| | DOE-SR | 3 | 0.478 |
| Hwy. 301 | DHEC | 0 | <MDA |
| | DOE-SR | 3 | 0.018 |



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### 11.5.0 TABLES AND FIGURES continued

**2022 DHEC and DOE-SR Data Comparison (SRNS, 2023)**

**Table 3. Cesium-137 in Edible Composite Flathead Catfish**

| Location | Agency | Number of Detects | Result (pCi/g) |
|---|---|---|---|
| NSBLD | DHEC | 0 | <MDA |
| | DOE-SR | NS | NS |
| Upper Three Runs | DHEC | 0 | <MDA |
| | DOE-SR | 1 | 0.034 |
| Fourmile Branch | DHEC | 1 | 0.045 |
| | DOE-SR | 2 | 0.039 |
| Steel Creek | DHEC | 1 | 0.044 |
| | DOE-SR | 3 | 0.076 |
| Lower Three Runs | DHEC | 1 | 0.026 |
| | DOE-SR | 3 | 0.061 |
| Hwy. 301 | DHEC | 1 | 0.024 |
| | DOE-SR | 3 | 0.021 |

**Table 4. Cesium-137 in Edible Individual LARGE Flathead Catfish**

| Location | Agency | Number of Detects | Result (pCi/g) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 0.026 |
| | DOE-SR | NS | NS |
| Upper Three Runs | DHEC | 1 | 0.094 |
| | DOE-SR | NS | NS |
| Fourmile Branch | DHEC | 1 | 0.152 |
| | DOE-SR | NS | NS |
| Steel Creek | DHEC | 1 | 0.114 |
| | DOE-SR | NS | NS |
| Lower Three Runs | DHEC | 1 | 0.028 |
| | DOE-SR | NS | NS |
| Hwy. 301 | DHEC | 0 | <MDA |
| | DOE-SR | NS | NS |

**Table 5. Strontium-89/90 in Non-Edible Bass**

| Location | Agency | Number of Detects | Result (mg/kg) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 0.044 |
| | DOE-SR | 0 | ND |
| Upper Three Runs | DHEC | 0 | <MDA |
| | DOE-SR | 1 | 0.004 |
| Fourmile Branch | DHEC | 1 | 0.020 |
| | DOE-SR | 1 | 0.003 |
| Steel Creek | DHEC | 0 | <MDA |
| | DOE-SR | 0 | ND |
| Lower Three Runs | DHEC | 1 | 0.034 |
| | DOE-SR | 0 | ND |
| Hwy. 301 | DHEC | 1 | 0.013 |
| | DOE-SR | 0 | ND |

**Table 6. Stronium-89/90 in Non-Edible Channel Catfish**

| Location | Agency | Number of Detects | Result (pCi/g) |
|---|---|---|---|
| NSBLD | DHEC | 0 | <MDA |
| | DOE-SR | 0 | ND |
| Upper Three Runs | DHEC | 1 | 0.067 |
| | DOE-SR | 0 | ND |
| Fourmile Branch | DHEC | 1 | 0.031 |
| | DOE-SR | 1 | 0.006 |
| Steel Creek | DHEC | 1 | 0.003 |
| | DOE-SR | 0 | ND |
| Lower Three Runs | DHEC | 1 | 0.029 |
| | DOE-SR | 0 | ND |
| Hwy. 301 | DHEC | 0 | <MDA |
| | DOE-SR | 0 | ND |



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### 11.5.0 TABLES AND FIGURES continued

**2022 DHEC and DOE-SR Data Comparison (SRNS, 2023)**

**Table 7. Strontium-89/90 in Non-Edible Composite Flathead Catfish**

| Location | Agency | Number of Detects | Result (mg/kg) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 0.022 |
| | DOE-SR | NS | NS |
| Upper Three Runs | DHEC | 1 | 0.042 |
| | DOE-SR | 0 | ND |
| Fourmile Branch | DHEC | 1 | 0.070 |
| | DOE-SR | 1 | 0.004 |
| Steel Creek | DHEC | 1 | 0.045 |
| | DOE-SR | 0 | ND |
| Lower Three Runs | DHEC | 1 | 0.025 |
| | DOE-SR | 0 | ND |
| Hwy. 301 | DHEC | 1 | 0.083 |
| | DOE-SR | 0 | ND |

**Table 8. Stronium-89/90 in Non-Edible Individual LARGE Flathead Catfish**

| Location | Agency | Number of Detects | Result (mg/kg) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 0.028 |
| | DOE-SR | NS | NS |
| Upper Three Runs | DHEC | 1 | 0.001 |
| | DOE-SR | NS | NS |
| Fourmile Branch | DHEC | 1 | 0.043 |
| | DOE-SR | NS | NS |
| Steel Creek | DHEC | 0 | <MDA |
| | DOE-SR | NS | NS |
| Lower Three Runs | DHEC | 1 | 0.062 |
| | DOE-SR | NS | NS |
| Hwy. 301 | DHEC | 1 | 0.058 |
| | DOE-SR | NS | NS |

**Table 9. Mercury in Edible Bass**

| Location | Agency | Number of Detects | Result (mg/kg) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 1.100 |
| | DOE-SR | 7 | 0.434 |
| Upper Three Runs | DHEC | 1 | 0.750 |
| | DOE-SR | 7 | 0.315 |
| Fourmile Branch | DHEC | 1 | 0.620 |
| | DOE-SR | 7 | 0.532 |
| Steel Creek | DHEC | 1 | 0.680 |
| | DOE-SR | 7 | 0.604 |
| Lower Three Runs | DHEC | 1 | 0.440 |
| | DOE-SR | 7 | 0.524 |
| Hwy. 301 | DHEC | 1 | 0.510 |
| | DOE-SR | 7 | 0.558 |

**Table 10. Mercury in Edible Channel Catfish**

| Location | Agency | Number of Detects | Result (pCi/g) |
|---|---|---|---|
| NSBLD | DHEC | 0 | <LLD |
| | DOE-SR | 7 | 0.186 |
| Upper Three Runs | DHEC | 1 | 0.100 |
| | DOE-SR | 7 | 0.125 |
| Fourmile Branch | DHEC | 1 | 0.170 |
| | DOE-SR | 7 | 0.219 |
| Steel Creek | DHEC | 1 | 0.230 |
| | DOE-SR | 7 | 0.438 |
| Lower Three Runs | DHEC | 0 | <LLD |
| | DOE-SR | 7 | 0.327 |
| Hwy. 301 | DHEC | 1 | 0.130 |
| | DOE-SR | 7 | 0.231 |



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### 11.5.0 TABLES AND FIGURES continued

**2022 DHEC and DOE-SR Data Comparison (SRNS, 2023)**

**Table 11. Mercury in Edible Composite Flathead Catfish**

| Location | Agency | Number of Detects | Result (mg/kg) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 0.140 |
| | DOE-SR | NS | NS |
| Upper Three Runs | DHEC | 1 | 0.220 |
| | DOE-SR | 8 | 0.296 |
| Fourmile Branch | DHEC | 1 | 0.180 |
| | DOE-SR | 8 | 0.232 |
| Steel Creek | DHEC | 1 | 0.290 |
| | DOE-SR | 8 | 0.297 |
| Lower Three Runs | DHEC | 1 | 0.160 |
| | DOE-SR | 8 | 0.352 |
| Hwy. 301 | DHEC | 1 | 0.230 |
| | DOE-SR | 8 | 0.240 |

**Table 12. Mercury in Edible Individual LARGE Flathead Catfish**

| Location | Agency | Number of Detects | Result (mg/kg) |
|---|---|---|---|
| NSBLD | DHEC | 1 | 0.310 |
| | DOE-SR | NS | NS |
| Upper Three Runs | DHEC | 1 | 0.780 |
| | DOE-SR | NS | NS |
| Fourmile Branch | DHEC | 1 | 0.690 |
| | DOE-SR | NS | NS |
| Steel Creek | DHEC | 1 | 1.400 |
| | DOE-SR | NS | NS |
| Lower Three Runs | DHEC | 1 | 0.470 |
| | DOE-SR | NS | NS |
| Hwy. 301 | DHEC | 1 | 0.430 |
| | DOE-SR | NS | NS |



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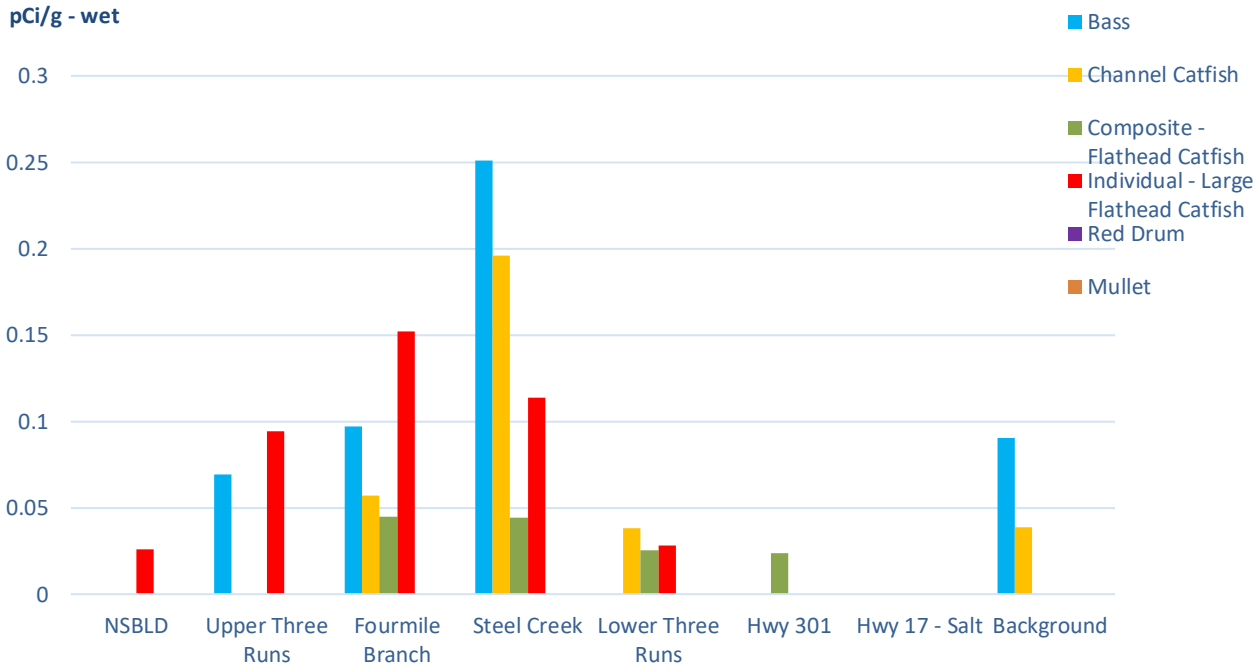
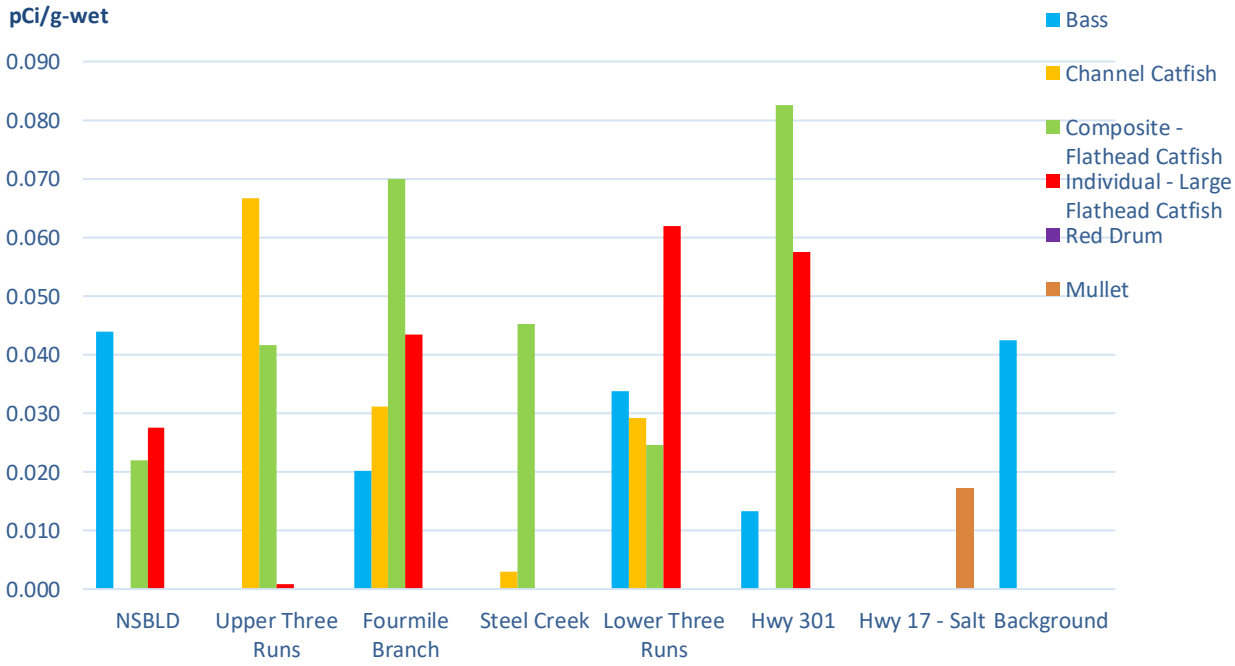
### 11.5.0 TABLES AND FIGURES continued

**Figure 1. 2022 DHEC Cesium-137 in Fish Composites**




Missing bars indicate <MDA.

**Figure 2. 2022 DHEC Strontium-89/90 in Fish Bone Composites**




Missing bars indicate <MDA.



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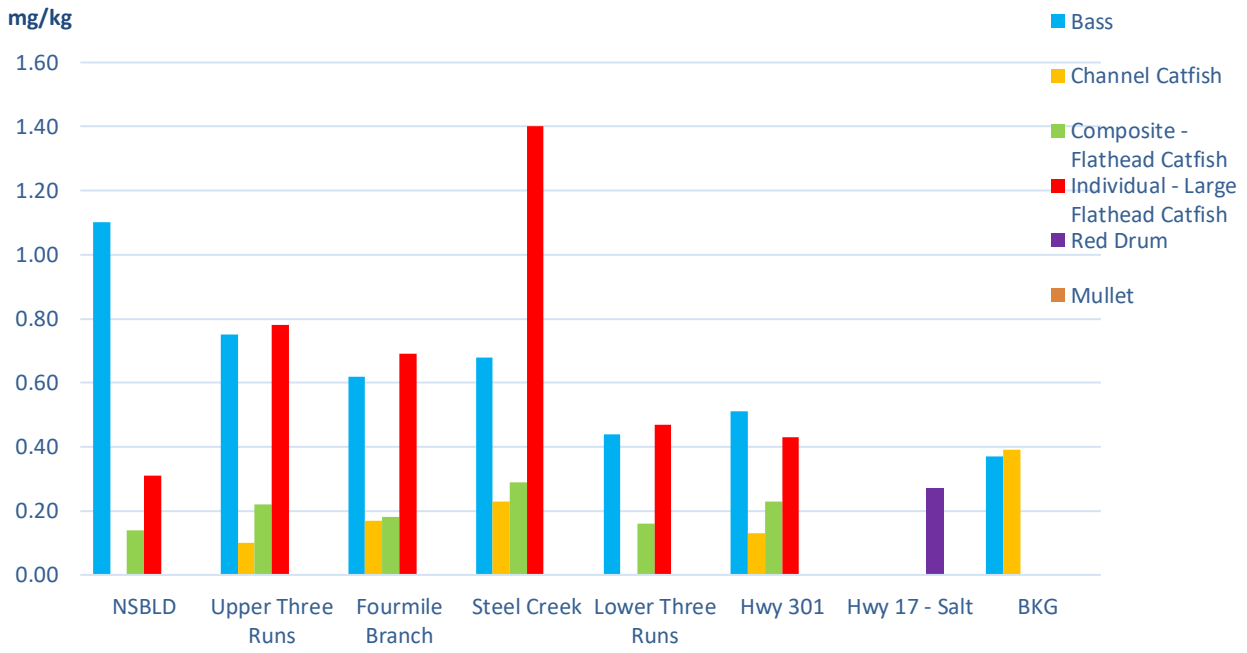
### 11.5.0 TABLES AND FIGURES continued

**Figure 3. 2022 DHEC Mercury in Fish**




Missing bars indicate <LLD.



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## 11.6.0 SUMMARY STATISTICS

### 2022 DHEC Cesium-137 Levels in Savannah River Fish (pCi/g–wet)

| Edible | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Bass** | 0.14 | 0.10 | 0.10 | 0.07 | 0.25 | 3 | 6 |
| **Channel Catfish** | 0.10 | 0.09 | 0.06 | 0.04 | 0.02 | 3 | 6 |
| **Composite - Flathead Catfish** | 0.03 | 0.01 | 0.03 | 0.02 | 0.04 | 4 | 6 |
| **Individual - Large Flathead Catfish** | 0.08 | 0.05 | 0.09 | 0.03 | 0.15 | 5 | 6 |

### 2022 DHEC Strontium-89/90 Levels in Savannah River Fish (pCi/g–wet)

| Edible | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Bass** | 0.03 | 0.01 | 0.03 | 0.01 | 0.04 | 4 | 6 |
| **Channel Catfish** | 0.03 | 0.03 | 0.03 | 0.00 | 0.07 | 4 | 6 |
| **Composite - Flathead Catfish** | 0.05 | 0.02 | 0.04 | 0.02 | 0.08 | 6 | 6 |
| **Individual - Large Flathead Catfish** | 0.04 | 0.02 | 0.04 | 0.00 | 0.06 | 5 | 6 |

### 2022 DHEC Mercury Levels in Savannah River Fish (mg/kg)

| Edible | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detects | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Bass** | 0.68 | 0.23 | 0.65 | 0.44 | 1.10 | 6 | 6 |
| **Channel Catfish** | 0.16 | 0.06 | 0.15 | 0.10 | 0.23 | 4 | 6 |
| **Composite - Flathead Catfish** | 0.20 | 0.06 | 0.20 | 0.14 | 0.29 | 6 | 6 |
| **Individual - Large Flathead Catfish** | 0.68 | 0.39 | 0.58 | 0.31 | 1.40 | 6 | 6 |

NA means Not Applicable
Cs-137 and mercury results represent the activity level in fish tissue
Sr-89/90 results represent the activity level in an aliquot of fish bone
* Indicates a single detection



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## Chapter 12 Monitoring of Game Animal Adjacent to SRS

### 12.1.0 PROJECT SUMMARY

DHEC conducts game animal monitoring activities around SRS due to white-tailed deer and feral hogs having the highest potential of mammalian species for human exposure pathway from Cs-137 (Haselow, 1991). The game animal project addresses concerns of potentially contaminated white-tailed deer and feral hogs migrating off SRS. It also provides valuable information concerning potential exposure to Cs-137 from consuming game animals harvested around SRS.

White-tailed deer and feral hogs have access to several contaminated areas on and off SRS which allows them to be a vector for the redistribution of contaminants (primarily Cs-137). A five-mile study area was established based on a typical white-tailed deer upper limit home range to ensure that potentially contaminated deer residing at or near the SRS boundary would be included in the sample set.

Cesium-137 is the isotope of focus for game due to its ability to accumulate in an animal's skeletal muscles (Brisbin & Smith, 1975). When contaminated game is eaten by hunters, Cs-137 is readily incorporated into the human body because of its similarity to K-40 in physiological processes (Davis, 1963).

### 12.2.0 RESULTS AND DISCUSSION

Game Monitoring Summary Statistics can be found in Section 12.6.0 and all Game Monitoring Data can be found in the 2022 DHEC Data File.

DHEC analyzed muscle tissue collected in 2022 for Cs-137 from 33 deer and 6 hogs collected from area hunters via hunting clubs, plantations, and Crackerneck Wildlife Management Area within a five-mile study area adjacent to SRS (Section 12.4.0, Map). Additionally, 5 deer tissue samples were collected and analyzed from a background location at Pinckney Island National Refuge. Sample size, location, and collection dates were dependent on the participating hunters.

Cesium-137 and the naturally occurring K-40 were the only isotopes detected in game samples collected in 2022**.** Naturally occurring isotopes will not be discussed in this report. Cesium-137 concentrations from deer and hogs collected in the SRS perimeter study area are shown in Section 12.5.0, Figure 1.

DOE-SR does not collect game animal samples within the DHEC study area, and off-site hunter doses are based on DOE-SR models.

### 12.3.0 CONCLUSIONS AND RECOMMENDATIONS

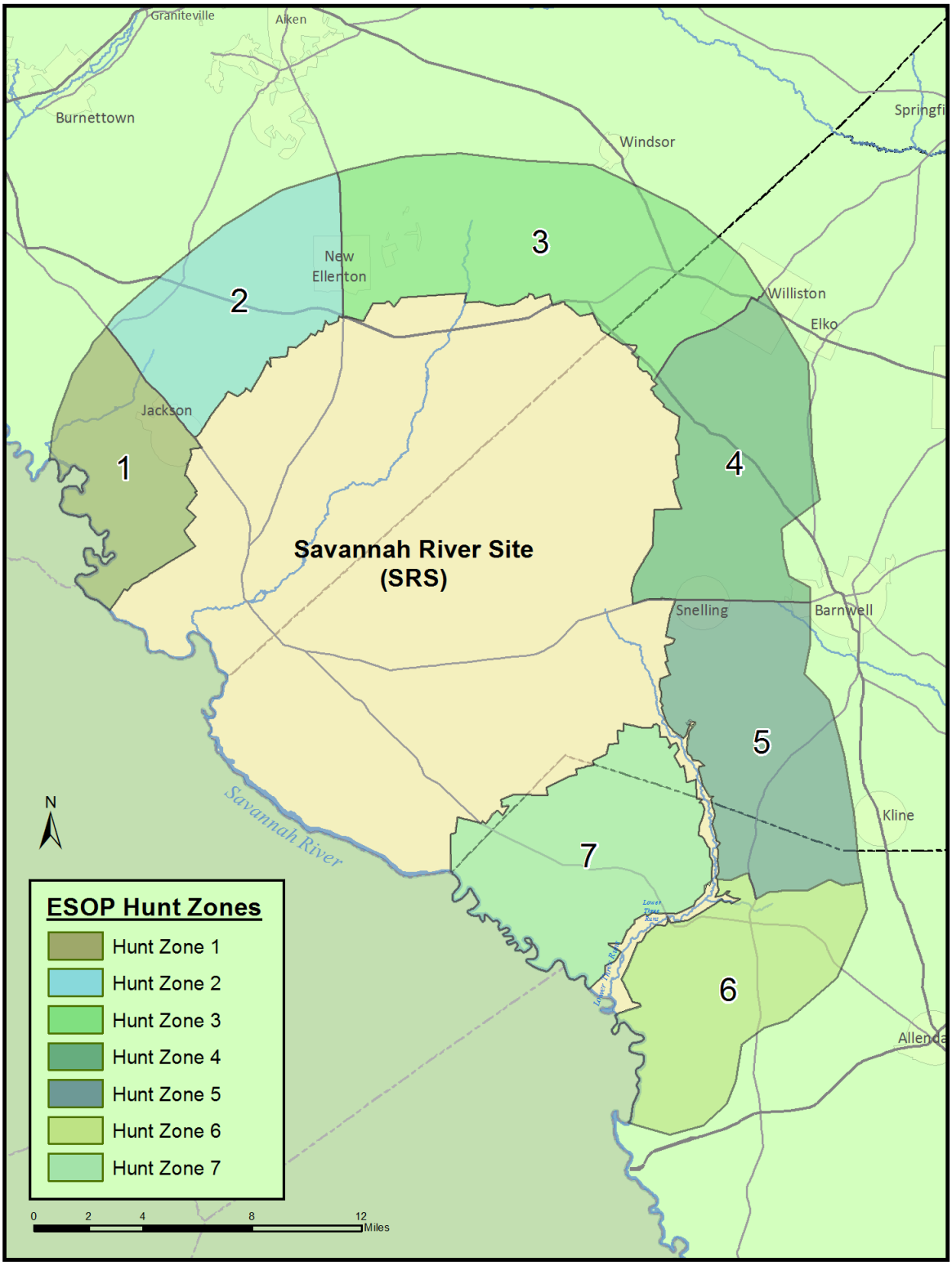
Historic SRS operations released known Cs-137 contamination to Steel Creek, Par Pond, Lower Three Runs, their floodplains, and the Savannah River swamp (Till et al., 2001) all of which impact hunt zones 4, 5, 6, and 7 (Section 12.4.0, Map). Although a portion of Cs-137 was deposited on SRS from site operations, levels found in the study area and background location are likely results of above ground nuclear weapons testing (Haselow, 1991).

Age, sex, body weight, soil type, diet, and collection location may affect the Cs-137 activities found in white-tailed deer and hogs (Haselow, 1991). A hunter consuming deer from SRS, the study area, or background locations would most likely ingest a portion of the activity associated with these animals. Refer to the 2022 DHEC Critical Pathway Dose section of this report for a better understanding of the contamination found in game versus other food sources.

DHEC will continue to monitor Cs-137 levels in deer and hogs within the established study area and background locations to assess trends. DHEC will continue to pursue new hunters within the five-mile study area to ensure adequate sample numbers can be achieved each year. DHEC will also put additional efforts into trapping wild hogs within the study area.

### 12.4.0 MAP

## Game Monitoring Sampling Locations




2022 ESOP Game Animal Monitoring www.scdhec.gov



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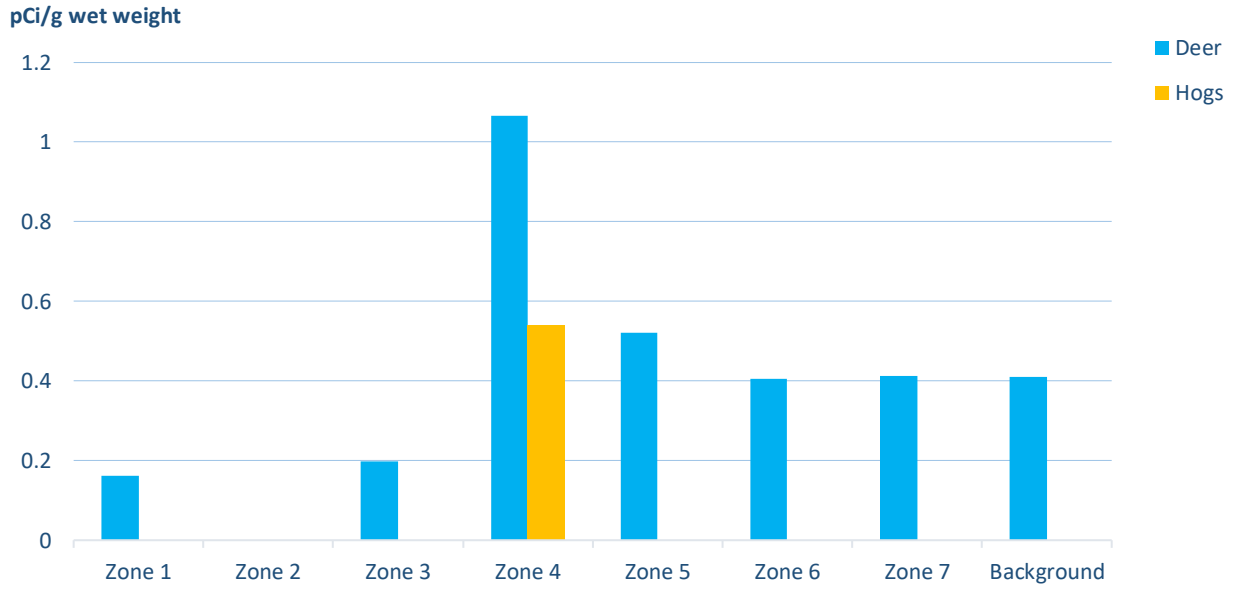
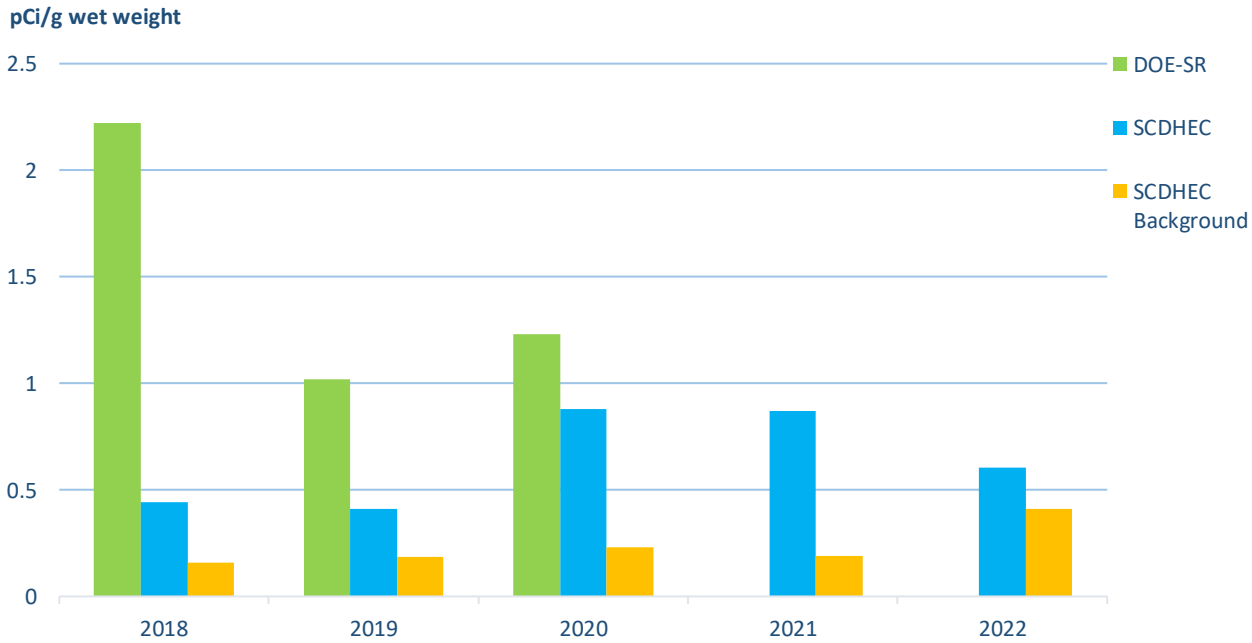
## 12.5.0 TABLES AND FIGURES

**Figure 1. 2022 DHEC Hunt Zone Average Cs-137 Concentration in Game**




Hogs were also collected by DHEC in Zone 7 and resulted in no detects for 2022.

**Figure 2. 2018-2022 Average Cs-137 Concentration in Deer (SRNS, 2019-2023; DHEC, 2020a-2023)**




2018-2022 background location was Pinckney Island National Wildlife Refuge.
DOE-SR data is from on-site deer only and DHEC data is from SRS 5-mile perimeter only.
DOE-SR data is the gross average concentration of Cs-137 calculated from field averages, which is used in an algorithm to provide a comparable dose to DHEC (SRNS, 2023).



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### 12.6.0 SUMMARY STATISTICS

**2022 Cs-137 Concentration (pCi/g wet weight) in Deer**

| | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Study Area Deer** | 0.605 | 0.632 | 0.419 | 0.044 | 2.687 | 28 | 33 |
| **Background Deer** | 0.410 | 0.125 | 0.381 | 0.301 | 0.624 | 5 | 5 |

**2022 Cs-137 Concentration (pCi/g wet weight) in Deer DHEC Hunt Zones**

| Hunt Zone | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Zone 1 Deer** | 0.163 | 0.197 | 0.079 | 0.063 | 0.514 | 5 | 5 |
| **Zone 2 Deer** | ND | NA | NA | ND | ND | 0 | 4 |
| **Zone 3 Deer** | 0.198 | 0.122 | 0.209 | 0.044 | 0.332 | 4 | 4 |
| **Zone 4 Deer** | 1.066 | 0.794 | 0.802 | 0.287 | 2.687 | 11 | 11 |
| **Zone 5 Deer** | 0.522 | 0.220 | 0.515 | 0.306 | 0.746 | 3 | 4 |
| **Zone 6 Deer** | 0.406 | 0.038 | 0.414 | 0.365 | 0.439 | 3 | 3 |
| **Zone 7 Deer** | 0.412 | 0.061 | 0.412 | 0.369 | 0.456 | 2 | 2 |

**2022 Cs-137 Concentration (pCi/g wet weight) in Hogs DHEC Hunt Zones**

| Hunt Zone | Average | Standard Deviation | Median | Minimum Detect | Maximum Detect | Number of Detections | Number of Samples |
|---|---|---|---|---|---|---|---|
| **Zone 4 Hogs** | 0.54 | NA | 0.54 | 0.054 | 0.054 | 1 | 1 |
| **Zone 7 Hogs** | ND | NA | NA | ND | ND | 0 | 5 |

Zones 1, 2, 3, 5, and 6 the background did not have hog samples in 2022.

**Chapter 13 Critical Pathway and Dose**

### 13.1.0 PROJECT SUMMARY

DHEC implemented a Radionuclide Dose Calculation Project/Critical Pathway Project to calculate the potential exposure or dose to the public within 50-miles of an SRS center point. This study area was chosen for comparison to the DOE-SR 80-km (50-mile) radius dose results. Individual project managers chose differing sample locations/schemes within this study area to establish trends in media radionuclide concentrations.

DHEC and DOE-SR programs were evaluated based on media potential exposure in mrem (Section 13.2.4). The figures in Section 13.4.0 illustrate the trends and central tendencies in the critical pathway potential dose exposures. The annual dose is calculated on average exposed individual (AEI) and maximum exposed individual (MEI) bases which are summarized in Section 13.4.0, Table 1.

### 13.2.0 RESULTS AND DISCUSSION

All 2022 Dose Data can be found in Section 13.5.0.

The DHEC MEI is a hypothetical subsistence and survivalist type of individual who resides downriver in the area below all SRS contributions to the Savannah River, visits the entire 50-mile perimeter study area, and receives the MEI dose based on the single highest detection per radionuclide per media detected in the environment. The 2022 data and dose results are discussed under the following headings in this section: 2022 AEI and MEI Dose, Critical Pathways 2022 Summary, and DOE-SR/DHEC 2022 Comparisons. Total AEI Dose covers the 2013-2022 period, whereas other headings discuss only 2022 data. Not all media were collected for all years during this summary period (2013-2022).

The critical pathways were analyzed both on a millirem (mrem) basis and percentage of dose basis (Section 13.4.0, Table 4). Percentages denote relative importance, whereas mrem denotes potential exposure levels. The dose critique attempts to point out the limits of this dose estimate and why any DOE-SR and DHEC estimates may or may not be similar.

#### 13.2.1 2022 AEI and MEI Dose

The basis for dose calculations is not limited to any particular pathway of dose exposure based on lifestyle or media encountered, but is simply a tabulation of detected dose found in media sampled regardless of applicability to an individual. Only the highest contributor for the AEI and the MEI is used for groundwater derived drinking water and Savannah River derived drinking water, the various types of fish that are sampled, sediment at creek mouths and boat landings, and swimming at creek mouths and boat landings. Table 1 in Section 13.4.0 summarizes all DHEC detections by media on an AEI and MEI detection basis. With the exception of wild game, background readings are not subtracted before dose calculations are performed.

The AEI dose is a conservative estimate based on consumption rates, represented by the consumption rate column in the data tables, average dose per media (Section 13.5.0), and is based on sample results only with no modeling. In 2022, the calculated AEI dose was 1.097 mrem (Section 13.4.0, Table 1), with 1.085 mrem from food dose. If wild game is not consumed,

the AEI dose falls to 0.278 mrem. The AEI dose skews high, as only detections are used in the dose calculations. For a typical person in the study area, the dose they receive should be lower than the AEI dose.

In 2022, the total calculated MEI dose was 5.184 mrem, of which 5.151 mrem was attributable to food consumption. If wild game is not consumed, the MEI dose falls to 1.077 mrem. The MEI basis column uses the single highest detection for a media radionuclide and calculates dose as if the high dose occurrence was somehow stored and the exposure continued throughout the year. If the individual did not store the media at the location, date, and time of DHEC sample collection and achieve a full year's exposure to that media, then the MEI estimate represents a sizable overestimate.

Only speciated doses for specific radionuclides were included in the estimated doses for 2022. The use of detections only in determining AEI dose per radionuclide per media, the calculation of dose based on the MEI detection for each radionuclide/media, and conservative consumption rates provided a protective dose estimate. Each media radionuclide dose, excluding Naturally Occurring Radioactive Material (NORM), was considered as part of a critical pathway with contributions through the inhalation, ingestion, and direct exposure routes.

The MEI dose can be received by only one individual since that individual had to consume the specific dose basis animals. Two elevated dose bases (AEI and MEI) were used because they were measured and protective without the inclusion of screening value assumptions for alpha and beta. The assumption of all alpha as plutonium-239 (Pu-239) and all beta as strontium-90 (Sr-90) may double the calculated dose without evidence for that assumption in speciated data. Unspeciated dose assignments were discontinued in 2011 and replaced by calculating a MEI dose potential from the single highest detection per radionuclide per media.

### 13.2.2 Critical Pathways 2022 Summary

Atmospheric Pathway 2022 Summary

The DHEC 2022 atmospheric pathway contributed dose to the individual through the inhalation of tritium (H-3) in air, the consumption of food, predominantly from wild game but also including milk, edible vegetation, and fungi, as well as direct exposure from soil and the incidental consumption of soil with edible vegetation. Section 13.4.0, Table 2 illustrates the dominance of the atmospheric pathway, which accounted for 1.056 mrem, at 96.26 percent, of dose to the AEI and 4.746 mrem, at 91.55 percent, of dose to the MEI. The primary contributor to the atmospheric pathway was Cs-137 in wild game.

Liquid Pathway 2022 Summary

The DHEC 2022 liquid pathway estimated AEI dose to the individual was from the consumption of fish, drinking water from the Savannah River, and ingestion from swimming (Section 13.4.0, Table 2). The liquid pathway contributions to dose exposure were secondary to those contributed by the atmospheric pathway. In 2022, the liquid pathway contribution to the AEI was 0.041 mrem, accounting for 3.74 percent of dose. The contribution to the MEI dose was 0.438 mrem, at 8.45 percent. The primary contributor to dose in the liquid pathway was Cs-137 in fish.

Food Sub-pathway 2022 Summary

The food sub-pathway was covered under the atmospheric and liquid pathways except for these additional observations. The annual 2022 DHEC AEI food sub-pathway dose order, highest to lowest for averages, was wild game-deer (0.652 mrem), vegetation (0.204 mrem), wild game-hog (0.167 mrem), fish (0.034 mrem), fungi (0.026 mrem), and cow milk (0.002 mrem). Incidental soil ingestion did not contribute any quantifiable dose.

The 2022 MEI food sub-pathway order was wild game-deer (3.940 mrem), vegetation (0.551 mrem), fish (0.412 mrem), wild game-hog (0.167 mrem), fungi (0.071 mrem), and cow milk (0.010 mrem). Incidental soil ingestion did not contribute any quantifiable dose.

Cs-137 was the predominant dose contributor to food through the consumption of deer for the AEI and the MEI. It should be noted that deer and hog consumption rates are based on the edible portions of the relevant harvested animals and they vary from year to year. In 2022 the relevant consumption rates were 122.14 pounds for the deer AEI and 132.75 pounds for the deer MEI. The hog dose AEI and MEI were both based on 56.25 pounds as only one animal was sampled. Cs-137 also contributed to dose from fish, edible vegetation, and fungi and Sr-89/90 contributed to dose from fish and from milk. Tritium contributed a small amount of dose through fruits and vegetables (edible vegetation).

Isotopic Contribution Summary

Most of the AEI dose exposure in 2022 was due to Cs-137: 1.076 mrem (98.09 percent) of the 1.097 mrem total. The primary contributor to the Cs-137 AEI dose was wild game (deer, 0.652 mrem). Tritium was the second highest dose contributor in 2022 at 0.011 mrem while SR-89/90 accounted for 0.010 mrem. Cesium-137, H-3, and Sr-89/90 were each detected in the atmospheric and the liquid pathways.

Cs-137 was also the primary contributor to the MEI, at 5.034 mrem (97.05 percent) of the 5.187 (this number varies slightly from the number presented in Table 1 because of rounding error) mrem total, with Sr-89/90 second, at 0.118 mrem, and H-3 third at 0.035 mrem. Cs-137 in wild game (deer, 3.940 mrem) was the single largest dose contributor to the MEI.

### 13.2.3 2013-2022 Total AEI Dose

Section 13.4.0, Table 4 summarizes dose associated with all media on an AEI basis from 2013-2022. The critical pathway basis of comparison for DHEC detected dose comes from releases of radionuclides that were deposited outside of SRS during 2013-2022 and within 50 miles of the SRS center point although animals that are harvested off-site may have migrated from on-site. Additionally, the Chelsea and Purrysburg drinking water locations are located outside of the 50 mile zone.

Table 4 illustrates the dominance of the atmospheric pathway accumulated dose which accounted for 96.32 percent, over the liquid pathway, at 3.68 percent. The food sub-pathway was the dominant route, accounting for 99.50 percent of accumulated exposure. The AEI received a 2.601 mrem average dose per year during the 2013-2022 period.

Section 13.4.0, Figures 1-3 and Table 4 illustrate the various pathways of dose exposure. The AEI basis critical pathway dose for 2022, 1.097 mrem, is less than the 7.00 mrem dose an individual typically receives from living in a brick house for one year (Wahl, 2011). Section 13.4.0, Figures 1-3 illustrate the media exposure trends via line graphs.

The predominant source of AEI exposure from 2013-2022 was wild game (deer and hog). In total it accounted for 20.523 mrem, which amounts to 78.90 percent of the total accumulated AEI exposure (26.011 mrem) during that time period. Following wild game were fungi (3.831 mrem; 14.73 percent), fish (0.864 mrem; 3.32 percent), and edible vegetation (0.646 mrem; 2.48 percent). Furthermore, wild game accounted for 81.92 percent of the accumulated dose from the atmospheric pathway and 79.29 percent of the food sub-pathway.

The predominant route of accumulated exposure from 2013-2022 for water sources was public system water from the Savannah River (0.093 mrem). Groundwater derived drinking water accounted for 0.020 mrem although this was not added into the total (only the highest source of drinking water is used). The primary routes for minor sources of accumulated dose were from the inhalation of tritium in air (0.021 mrem) and from direct exposure to soil (0.005 mrem).

### 13.2.4 DOE-SR and DHEC 2022 Comparisons

DOE-SR calculates potential doses to members of the public from atmospheric and liquid releases, as well as from special-case exposure scenarios, on an annual basis (SRNS, 2023). These include liquid pathway and air pathway doses, an all-pathway dose, a sportsman dose, on-site and off-site hunter doses, and an off-site fisherman dose. The DOE-SR dose estimates are analogous to DHEC dose estimates as follows, although it must be taken into account that there are differences between DOE-SR and DHEC sampling and dose estimation protocols:

1. The DOE-SR all-pathway dose and the sum of the DHEC fish, wading, swimming, public system drinking water from the Savannah River, vegetation, milk, and inhalation doses, serve as a means of comparison of the dose a member of the public in the study area (an individual who doesn't consume wild game or gather edible mushrooms) could receive from SRS activities during a given year (The DHEC All-Pathway Approximation).

2. The DOE-SR off-site hog consumption, off-site deer consumption, and creek fisherman doses and the DHEC hog dose, deer dose, and fish dose at the mouth of creeks that empty into the Savannah River serve as a means of comparison of the dose a survivalist type of individual who consumes fish from the Savannah River and wild game could receive.

3. The DOE-SR creek mouth fisherman dose being derived from fish caught at the mouths of creeks that empty into the Savannah River: DHEC uses the highest creek mouth location, typically Steel Creek, to calculate a comparable creek fisherman dose. In 2022 the highest DOE-SR fish dose applicable to the general public was from the Lower Three Runs location and this was used for the DOE-SR's creek mouth fisherman. DHEC's creek mouth fisherman is based on Steel Creek, where the highest fish results were obtained, for 2022.

The DOE-SR all-pathways representative person dose and the DHEC all-pathway approximation were the most relevant dose estimates that represent the potential dose exposure for the general public in 2022. The DOE-SR all-pathways representative person dose for 2022 was 0.18 mrem (Section 13.4.0, Table 3). The DHEC All-Pathway Approximation was 0.896 mrem in 2022 which is 0.90 percent of the DOE all-pathway dose standard of 100 mrem/yr (SRNS, 2023).

In 2022, the DOE-SR creek mouth fisherman dose (0.57 mrem), which used bass caught from the mouth of Lower Three Runs, was higher than DHEC's estimate from Steel Creek (0.304 mrem; DHEC's highest creek mouth fish location in 2022). The DOE-SR off-site deer hunter dose estimate of 3.06 mrem was lower than DHEC's 3.940 mrem estimate while the off-site hog hunter estimate of 3.22 mrem was higher than DHEC's estimate of 0.167 mrem (Section 13.4.0, Table 3; SRNS, 2023).

### 13.2.5 Dose Critique

In 2022, most sampling resulted in less than minimum detectable activity (MDA) determinations and was not included in the DHEC summary statistics, which used detections only. The use of detections only in calculations was protective and biases the measures of central tendency higher (Gilbert, 1987).

The NORM averages and maximums were not included in the dose estimates as this dose was considered to be part of the background dose for the study area. The yearly dose averages were based on DHEC detections only and are inflated since most sample results were less than MDA. The justification for using detections only was to allow for undetected radionuclides and media. The justification for selecting higher source consumption levels was due to the conceptualization of the DHEC MEI as a survivalist type who consumed natural media at a greater than typical use rate. The basis for both considerations was to be protective of the public and environment.

The inclusion of alpha and beta assumed dose in the past provided an excessively high dose estimate and was not supported by media radionuclide species detections. The inclusion of calculations based on a single highest maximum detection for each radionuclide/media was a more definable basis for establishing an upper bound rather than the dose assumption of unknown alpha as Pu-239 and unknown beta as Sr-90. This upper bound is not practically achievable by the MEI due to the unlikely probability of exposure to all maximums at a constant rate throughout the year (via storage of media). However, since most of the dose was due to wild-type food consumption containing Cs-137, then a single individual who ate all of the worst-case deer, hog, and edible plant and mushrooms could approach the MEI dose if these media were stored and consumed over the entire year.

The DHEC 2007 Critical Pathway Dose Report noted that 38.50 percent of the dose was assigned and represented a potential dose overestimate that may in fact be NORM detections (alpha and beta). The DHEC dose calculations since then were still protective due to the use of detections only in determining dose, the calculation of a maximum dose for the MEI based on a single maximum detection for each radionuclide/media, and the use of conservative consumption rates.

The AEI was given prominence as protective for general dose considerations, and the reader should be aware that the AEI dose estimate was conservative or biased high due to the use of detections only for dose calculation. For example, the omission of less than MDA assignments from calculations would raise any calculated number to a higher value. Alternatively, less than MDA actually represents an undetermined low number that may be zero or any number up to the given MDA value for that analysis.

This project used dose instead of risk so that direct comparisons of dose could be made with similar media data published in the SRS Environmental Reports. It should also be recognized that DHEC uses sampling methods for various media that are similar to, but not necessarily the same, as DOE-SR's. Additionally, DOE-SR uses modeled radionuclide releases for some dose estimates while DHEC uses only sample results.

### 13.3.0 CONCLUSIONS AND RECOMMENDATIONS

The 2022 results indicated that monitoring of the primary inhalation, ingestion, and direct exposure routes from the atmospheric and liquid pathways should continue. Groundwater, surface water, sediments, plants, and animals should be monitored for contaminants that are associated with past and present SRS operations. Early detection is paramount to protecting the public and the environment if a release to off-site streams or groundwater occurs. DHEC will continue to monitor SRS and adjacent areas for the primary radionuclide contributors to dose potentially associated with DOE-SR operations.

### 13.4.0 TABLES AND FIGURES

**Table 1. DHEC Dose Estimates (mrem) for all Media: AEI and MEI**

| Pathway | Route | Source of Exposure | AEI | MEI |
|---|---|---|---|---|
| Atmospheric | Inhalation | Surface Soil Resuspension | 0.000 | 0.000 |
| Atmospheric | Inhalation | Inhalation of H-3 in Air | 0.003 | 0.005 |
| **Air Inhalation Total** | | | **0.003** | **0.005** |
| Liquid | Ingestion | Fish | 0.034 | 0.412 |
| Atmospheric | Ingestion | Cow Milk | 0.002 | 0.010 |
| Atmospheric | Ingestion | Wild Game (Deer) | 0.652 | 3.940 |
| Atmospheric | Ingestion | Wild Game (Hog) | 0.167 | 0.167 |
| Atmospheric | Ingestion | Vegetation (Fruit and Vegetables) | 0.204 | 0.551 |
| Atmospheric | Ingestion | Fungi | 0.026 | 0.071 |
| Atmospheric | Ingestion | Soil Ingestion with Food | 0.000 | 0.000 |
| **Food Ingestion Total** | | | **1.085** | **5.151** |
| Liquid | Ingestion | Public System Drinking Water - Savannah River | 0.007 | 0.025 |
| Liquid | Ingestion | Drinking Water - Groundwater | ND | ND |
| Liquid | Ingestion | Ingestion from Swimming | 0.000 | 0.001 |
| **Drinking Water Total** | | | **0.007** | **0.026** |
| Liquid | Direct | Exposure from Wading at Boat Landings | 0.000 | 0.000 |
| Liquid | Direct | Exposure from Wading at SRS Creek Mouths | 0.000 | 0.000 |
| Atmospheric | Direct | Exposure from Soil | 0.002 | 0.002 |
| **Direct Exposure Total** | | | **0.002** | **0.002** |
| **Overall Total Dose** | | | **1.097** | **5.184** |

Note:
1. ND is sampled but No Detections in 2022
2. Drinking Water - Groundwater includes aquifers that supply both public and private wells.
3. Drinking Water Total is the sum of the Savannah River/Groundwater dose, whichever is higher, and the Ingestion from Swimming dose.

**Table 2. DHEC Dose Estimates (mrem) for the Atmospheric and Liquid Pathways: AEI and MEI**

| Critical Pathway Summary | AEI | MEI |
|---|---|---|
| The Atmospheric Pathway Totals | 1.056 | 4.746 |
| The Liquid Pathway Totals | 0.041 | 0.438 |
| **Combined Dose** | **1.097** | **5.184** |

## TABLES AND FIGURES

### Table 3. DOE-SR/DHEC Dose Comparisons

| Pathway | Comparison Basis | DOE-SR[1] | DHEC[2] |
|---|---|---|---|
| **All-Pathway** | DHEC All-Pathway Approximation[3] | 0.18 | 0.896 |
| **Sportsman** | On-site Hunter[4] | 8.76 | NS |
| **Sportsman** | On-site Turkey[5] | ND | NS |
| | Creek Mouth Fisherman[6] | 0.57 | 0.304 |
| | Off-site Hunter Deer | 3.06 | 3.940 |
| | Off-site Hunter Hog | 3.22 | 0.167 |
| | Edible Fungi | NS | 0.071 |
| | | | |

Notes:
1. DOE-SR data from Table 6-5 and Table 6-7 (SRNS, 2023).
2. Based on DHEC maximums or single highest detection basis for all media per route of exposure unless otherwise specified (Table 1).
3. Sum of DHEC highest Steel Creek fish, wading exposure, swimming ingestion, Savannah River derived drinking water (treated only), vegetation, milk, and atmospheric inhalation.
4. SCDHEC does not sample onsite game.
5. SRS did sample turkeys in 2022 but none were greater than background.
6. Compares DOE-SR and DHEC bass results from the mouth of Steel Creek. (Location can vary from year to year based on results; in 2022 SRS' highest creek mouth detection was at Lower Three Runs while DHEC's highest detection was at Steel Creek).

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### Table 4. 2013-2022 AEI Exposure: Total AEI Dose (mrem) and Percentage

| Pathway | AEI Media Categories | 2022[1] | 2013-2022[2] | 2013-2022 % AEI[3] |
|---|---|---|---|---|
| Atmospheric | Surface Soil Resuspension Inhalation | 0.000 | 0.009 | 0.03 |
| Atmospheric | H-3 Inhalation | 0.003 | 0.021 | 0.08 |
| Liquid | Fish | 0.034 | 0.864 | 3.32 |
| Atmospheric | Cow Milk | 0.002 | 0.018 | 0.07 |
| Atmospheric | Wild Game (Deer and Hog) | 0.819 | 20.523 | 78.90 |
| Atmospheric | Vegetation (Fruit and Vegetables) | 0.204 | 0.646 | 2.48 |
| Atmospheric | Fungi | 0.026 | 3.831 | 14.73 |
| Atmospheric | Soil Ingestion with Food | 0.000 | 0.000 | 0.00 |
| Liquid | Drinking Water from the Savannah River | 0.007 | 0.093 | 0.36 |
| Liquid | Drinking Water from Groundwater[4] | ND | 0.020 | NA |
| Liquid | Ingestion from Swimming | 0.000 | 0.001 | 0.00 |
| Liquid | Exposure from Wading at Boat Landings | 0.000 | 0.000 | 0.00 |
| Liquid | Exposure from Wading at Creek Mouths[5] | 0.000 | 0.000 | 0.00 |
| Atmospheric | Exposure from Soil | 0.002 | 0.005 | 0.02 |
| Totals[6,7] | | 1.097 | 26.011 | 100% |

Notes:
1. The 2022 column is average dose in mrem during 2022.
2. The 2013-2022 column is total dose in mrem over the 2013-2022 ten-year period.
3. The AEI % basis column is the percentage of the 2013-2022 total dose from a given media.
4. Only the highest drinking water source is used for the ten-year total and percentages.
5. Only the highest wading dose is used for wading.
6. Percentages may not equal 100 percent due to rounding.
7. The average dose received per year is 2.601 mrem.



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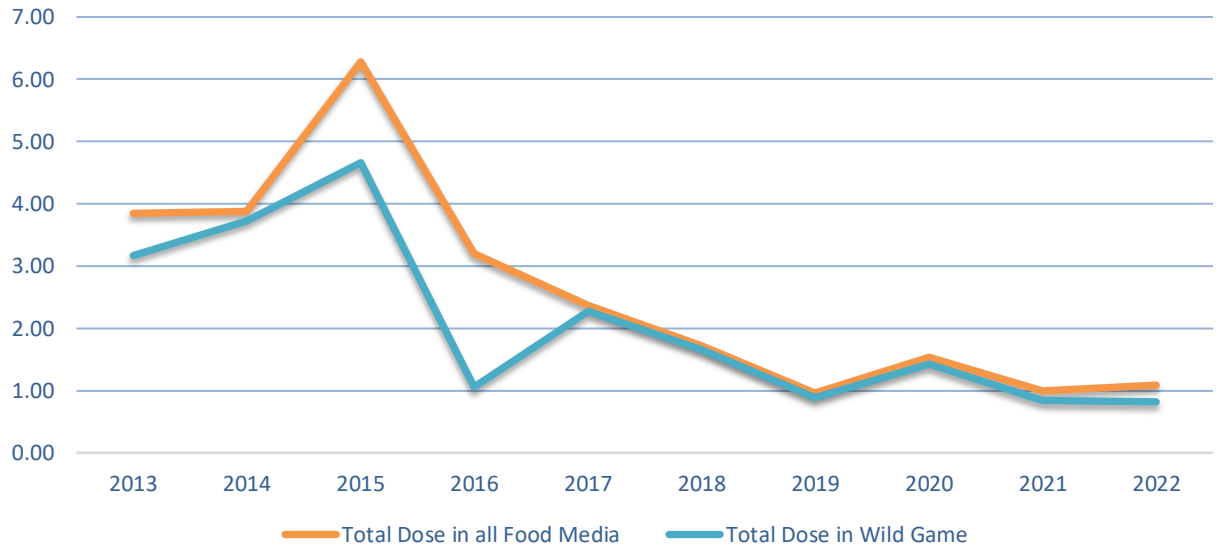
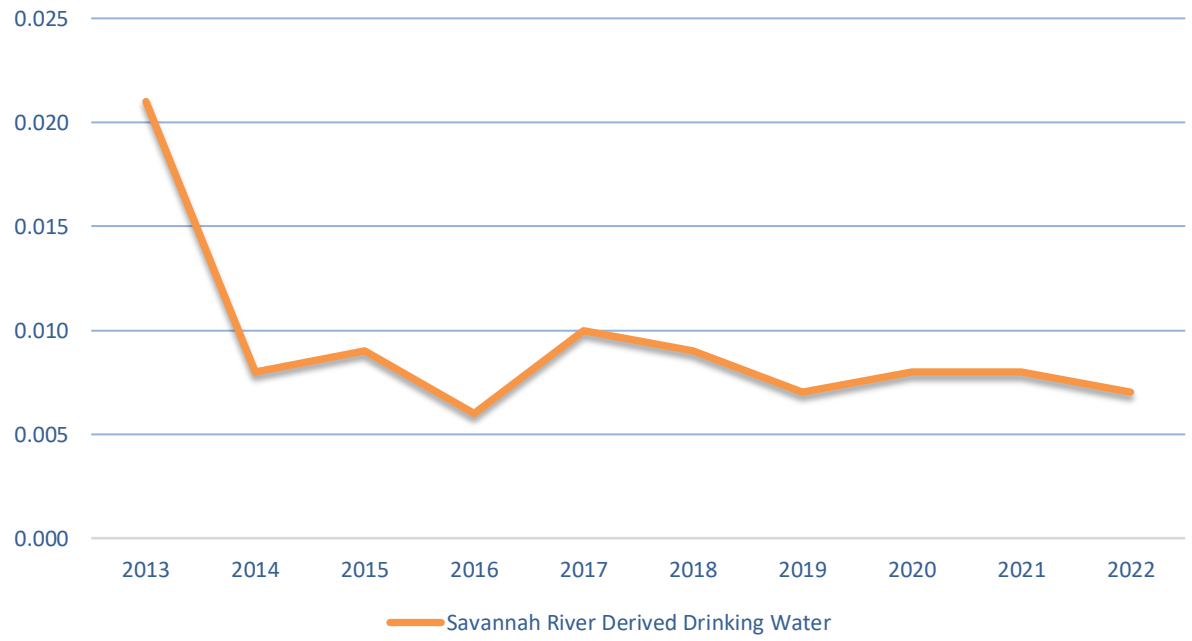
## TABLES AND FIGURES

**Figure 1. 2013-2022 DHEC AEI Food Dose**




Note: This graph shows the total food AEI dose trend and the trend for the primary contributor to that dose for 2022 in mrem.

**Figure 2. 2013-2022 DHEC AEI Water Dose**




Note: This graph shows the water AEI dose trend for drinking water obtained from the Savannah River in mrem. Only groundwater derived or Savannah River derived drinking water is used, whichever is higher.



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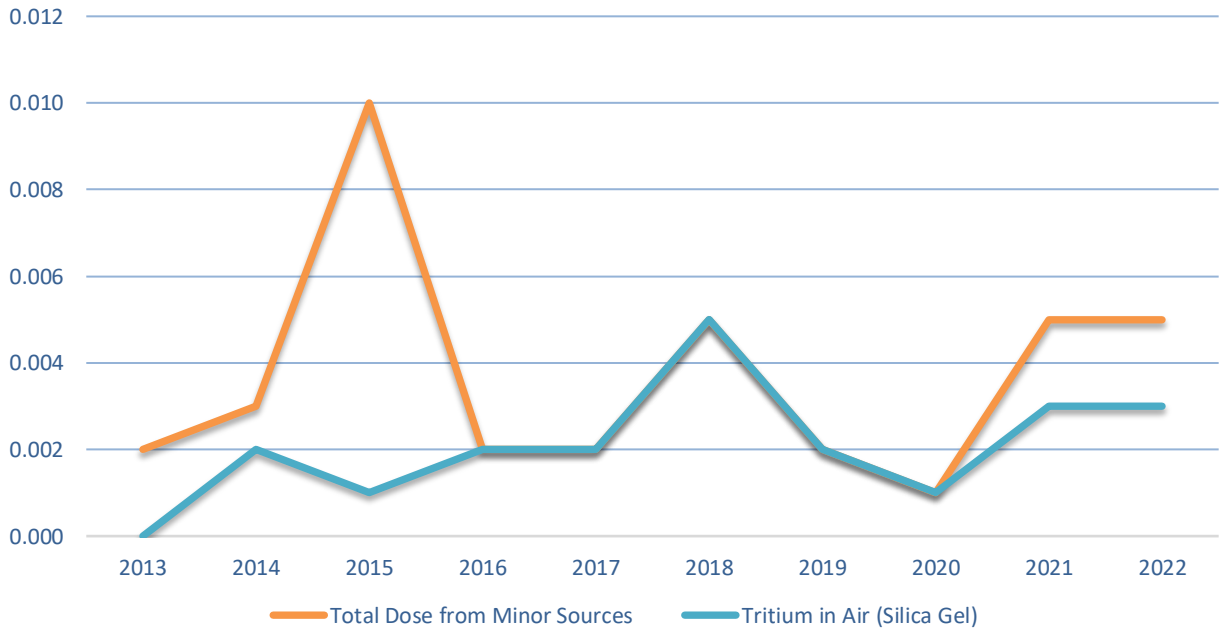
## TABLES AND FIGURES

**Figure 3. 2013-2022 DHEC AEI Dose from Minor Sources**




Note: This graph shows the total minor sources AEI dose trend and the trend for the primary contributor to that dose from 2022 in mrem.



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### 13.5.0 2022 DOSE DATA

Notes apply to all data tables:

1. ND is No Detects
2. NA is Not Applicable
3. NS is Not Sampled
4. All consumption rates are from Aranceta et al., 2006; Botsch et al., 2000; EPA, 2011; and SRNS, 2023.
5. Dose in the following tables may be presented slightly differently from the text or in the above tables and graphs due to rounding error.

### AEI Fish Dose

| Dose from Fish Ingestion (AEI) | | | | |
|---|---|---|---|---|
| **Media** | **Radionuclide** | **Activity (pCi/g)** | **Consumption Rate (kg/yr)** | **Dose (mrem)** |
| Bass | Cs-137 | 0.139 | 3.7 | 0.026 |
| Bass | Sr-89/90 | 0.022 | 3.7 | 0.008 |
| Channel Catfish | Cs-137 | 0.097 | 3.7 | 0.018 |
| Channel Catfish | Sr-89/90 | 0.033 | 3.7 | 0.012 |
| Flathead Catfish | Cs-137 | 0.035 | 3.7 | 0.007 |
| Flathead Catfish | Sr-89/90 | 0.048 | 3.7 | 0.018 |
| Large Flathead | Cs-137 | 0.083 | 3.7 | 0.015 |
| Large Flathead | Sr-89/90 | 0.038 | 3.7 | 0.014 |
| Drum | Cs-137 | ND | 3.7 | ND |
| Drum | Sr-89/90 | ND | 3.7 | ND |
| Mullet | Cs-137 | ND | 3.7 | ND |
| Mullet | Sr-89/90 | 0.017 | 3.7 | 0.006 |
| **Fish Total** | | | | **0.034** |

### MEI Fish Dose

| Dose from Fish Ingestion (MEI) | | | | |
|---|---|---|---|---|
| **Media** | **Radionuclide** | **Activity (pCi/g)** | **Consumption Rate (kg/yr)** | **Dose (mrem)** |
| Bass | Cs-137 | 0.251 | 24.0 | 0.304 |
| Bass | Sr-89/90 | 0.044 | 24.0 | 0.108 |
| Channel Catfish | Cs-137 | 0.196 | 24.0 | 0.237 |
| Channel Catfish | Sr-89/90 | 0.067 | 24.0 | 0.164 |
| Flathead Catfish | Cs-137 | 0.045 | 24.0 | 0.054 |
| Flathead Catfish | Sr-89/90 | 0.083 | 24.0 | 0.204 |
| Large Flathead | Cs-137 | 0.152 | 24.0 | 0.184 |
| Large Flathead | Sr-89/90 | 0.062 | 24.0 | 0.152 |
| Drum | Cs-137 | ND | 24.0 | ND |
| Drum | Sr-89/90 | ND | 24.0 | ND |
| Mullet | Cs-137 | ND | 24.0 | ND |
| Mullet | Sr-89/90 | 0.017 | 24.0 | 0.042 |
| **Fish Total** | | | | **0.412** |

## 2022 DOSE DATA

### AEI Milk Dose

| Dose from Milk (AEI) | | | | |
|---|---|---|---|---|
| **Media** | **Radionuclide** | **Activity (pCi/L)** | **Consumption Rate (kg/yr)** | **Dose (mrem)** |
| Milk | H-3 | ND | 69.0 | ND |
| | Cs-137 | ND | 69.0 | ND |
| | Sr-89/90 | 0.354 | 69.0 | 0.002 |
| | I-131 | ND | 69.0 | ND |
| **Milk Total** | | | | **0.002** |

### MEI Milk Dose

| Dose from Milk (MEI) | | | | |
|---|---|---|---|---|
| Media | Radionuclide | **Activity (pCi/L)** | **Consumption Rate (kg/yr)** | **Dose (mrem)** |
| Milk | H-3 | ND | 260.0 | ND |
| | Cs-137 | ND | 260.0 | ND |
| | Sr-89/90 | 0.361 | 260.0 | 0.010 |
| | I-131 | ND | 260.0 | ND |
| **Milk Total** | | | | **0.010** |

### AEI Wild Game Dose

| Dose from Wild Game (AEI) | | |
|---|---|---|
| **Media** | **Radionuclide** | **Dose** |
| Deer | Cs-137 | 0.652 |
| Hog | Cs-137 | 0.167 |
| **Game Total** | | **0.819** |

Note: Deer AEI is based on an edible portion of 122.14 lbs.; Hog is based 56.25 lbs.

### MEI Wild Game Dose

| Dose from Wild Game (MEI) | | |
|---|---|---|
| **Media** | **Radionuclide** | **Dose** |
| Deer | Cs-137 | 3.94 |
| Hog | Cs-137 | 0.167 |
| **Game Total** | | **4.11** |

Note: Deer MEI is based on an edible portion of 132.75 lbs.; Hog is based on 56.25 lbs. (only one hog was harvested in 2022)

## 2022 DOSE DATA

### AEI Edible Vegetation Dose

| Dose in Edible Vegetation (AEI) | | | | |
|---|---|---|---|---|
| **Media** | **Radionuclide** | **Activity (pCi/g)** | **Consumption Rate (kg/yr)** | **Dose (mrem)** |
| Fruit and Vegetables | H-3 | 0.200 | 92 | 0.001 |
| | Cs-137 | 0.044 | 92 | 0.203 |
| **Fruit and Vegetable Total** | | | | **0.204** |
| Nuts | H-3 | NS | NA | NA |
| | Cs-137 | NS | NA | NA |
| **Nuts Total** | | | | **NA** |
| Fungi | H-3 | ND | 3.65 | ND |
| | Cs-137 | 0.140 | 3.65 | 0.026 |
| **Fungi Total** | | | | **0.026** |
| **Combined Vegetation Total** | | | | **0.230** |

### MEI Edible Vegetation Dose

| Dose in Edible Vegetation (MEI) | | | | |
|---|---|---|---|---|
| **Media** | **Radionuclide** | **Activity (pCi/g)** | **Consumption Rate (kg/yr)** | **Dose (mrem)** |
| Fruit and Vegetables | H-3 | 0.213 | 248 | 0.004 |
| | Cs-137 | 0.044 | 248 | 0.547 |
| **Fruit and Vegetable Total** | | | | **0.551** |
| Nuts | H-3 | NS | NA | NA |
| | Cs-137 | NS | NA | NA |
| **Nuts Total** | | | | **NA** |
| Fungi | H-3 | ND | 10 | ND |
| | Cs-137 | 0.140 | 10 | 0.071 |
| **Fungi Total** | | | | **0.071** |
| **Combined Vegetation Total** | | | | **0.621** |

## 2022 DOSE DATA

### AEI Ingestion from Surface Water and Wells Dose

| Ingestion from Surface Water and Wells (AEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Savannah River Sourced Drinking Water | | pCi/L | L/yr | mrem |
| **Surface Water** | **H-3** | **321** | **300** | **0.007** |
| Groundwater Sourced Drinking Water | | pCi/L | L/yr | mrem |
| **Groundwater** | **H-3** | **ND** | **300** | **ND** |
| **Ingestion from Surface Water and Wells Total** | | | | **0.007** |

- Notes: Groundwater aquifers that are known to be used for drinking water were used and samples were collected as part of the groundwater project. Individual groundwater sourced drinking water taps were not sampled.
- Only the highest dose is used for the total.

### MEI Ingestion from Surface Water and Wells Dose

| Ingestion from Surface Water and Wells (MEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Savannah River Sourced Drinking Water | | pCi/L | L/yr | mrem |
| **Surface Water** | **H-3** | **450** | **800** | **0.025** |
| Groundwater Sourced Drinking Water | | pCi/L | L/yr | Mrem |
| **Groundwater** | **H-3** | **ND** | **800** | **ND** |
| **Ingestion from Surface Water and Wells Total** | | | | **0.025** |

- Notes: Groundwater aquifers that are known to be used for drinking water were used and samples were collected as part of the groundwater project. Individual groundwater sourced drinking water taps were not sampled.
- Only the highest dose is used for the total.

## 2022 DOSE DATA

### AEI Incidental Water Ingestion and Direct Exposure from Water Dose

| Incidental Water Ingestion and Direct Exposure from Water (AEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Swimming at Savannah River Creek Mouths | | | | |
| Surface Water Swimming | H-3 | pCi/L | L/yr | mrem |
| **Ingestion** | | **447** | **0.189** | **0.000** |
| Surface Water Swimming | H-3 | pCi/L | hrs/yr | mrem |
| **Surface Water Immersion** | | **447** | **9** | **0.000** |
| **Savannah River Creek Mouth Total** | | | | **0.000** |

| Incidental Water Ingestion and Direct Exposure from Water (AEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Swimming at Savannah River Boat Landings | | | | |
| Surface Water Swimming | H-3 | pCi/L | L/yr | mrem |
| **Ingestion** | | **740** | **0.189** | **0.000** |
| Surface Water Swimming | H-3 | pCi/L | hrs/yr | mrem |
| **Surface Water Immersion** | | **740** | **9** | **0.000** |
| **Savannah River Boat Landing Total** | | | | **0.000** |

### MEI Incidental Water Ingestion and Direct Exposure from Water Dose

| Incidental Water Ingestion and Direct Exposure from Water (MEI) | | | | |
|---|---|---|---|---|
| **Source** | **Source** | **Source** | **Source** | **Source** |
| Swimming at Savannah River Boat Landings | | | | |
| Surface Water Swimming | H-3 | pCi/L | L/yr | mrem |
| **Ingestion** | | **1388** | **2.57** | **0.000** |
| Surface Water Swimming | H-3 | pCi/L | hrs/yr | mrem |
| **Surface Water Immersion** | | **1388** | **36** | **0.000** |
| **Savannah River Creek Mouth Total** | | | | **0.000** |

| Incidental Water Ingestion and Direct Exposure from Water (MEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Swimming at Savannah River Boat Landings | | | | |
| Surface Water Swimming | H-3 | pCi/L | L/yr | mrem |
| **Ingestion** | | **5643** | **2.57** | **0.001** |
| Surface Water Swimming | H-3 | pCi/L | hrs/yr | mrem |
| **Surface Water Immersion** | | **5643** | **36** | **0.000** |
| **Savannah River Boat Landing Total** | | | | **0.001** |

## 2022 DOSE DATA

### AEI Sediment at Creek Mouths and Boat Landings Dose

| Sediment at Creek Mouths and Boat Landings (AEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Sediment Dose | | pCi/g | hrs/yr | mrem |
| **Creek Mouths** | **Cs-137** | **0.646** | **9** | **0.000** |
| **Boat Landings** | **Cs-137** | **0.358** | **9** | **0.000** |
| **Sediment Total** | | | | **0.000** |

### MEI Sediment at Creek Mouths and Boat Landings Dose

| Sediment at Creek Mouths and Boat Landings (MEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Sediment Dose | | pCi/g | hrs/yr | mrem |
| **Creek Mouths** | **Cs-137** | **1.84** | **36** | **0.000** |
| **Boat Landings** | **Cs-137** | **0.994** | **36** | **0.000** |
| **Sediment Total** | | | | **0.000** |

### AEI Surface Soil Ingestion Dose

| Surface Soil Ingestion (AEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Surface Soil | | pCi/g | Mg/day | mrem |
| Ingestion | Cs-137 | 0.113 | 20 | 0.000 |
| **Soil Ingestion Total** | | | | **0.000** |

Note: This represents soil inadvertently consumed with plants.

### MEI Surface Soil Ingestion Dose

| Surface Soil Ingestion (MEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Surface Soil | | pCi/g | Mg/day | mrem |
| Ingestion | Cs-137 | 0.157 | 20 | 0.000 |
| **Soil Ingestion Total** | | | | **0.000** |

Note: This represents soil inadvertently consumed with plants.

## 2022 Dose Data

### AEI Soil Direct Dose

| Soil Direct (AEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Surface Soil | | pCi/g | hrs/yr | mrem |
| External Direct | Cs-137 | 0.113 | 4380 | 0.002 |
| **Direct Soil Total** | | | | **0.002** |

### MEI Soil Direct Dose

| Soil Direct (MEI) | | | | |
|---|---|---|---|---|
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| Surface Soil | | pCi/g | hrs/yr | mrem |
| External Direct | Cs-137 | 0.157 | 4380 | 0.002 |
| **Direct Soil Total** | | | | **0.002** |

## 2022 DOSE DATA

### AEI Atmospheric Inhalation Dose

| Atmospheric Inhalation (AEI) | | | | |
|---|---|---|---|---|
| Surface Soil Resuspension and Air Inhalation | | | | |
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| **Surface Soil Resuspension** | | **pCi/g** | **m3/yr** | **mrem** |
| Inhalation | Cs-137 | 0.113 | 5000 | 0.000 |
| **Surface Soil Resuspension Total** | | | | **0.000** |
| **Air Inhalation (Silica Gel)** | | **pCi/m$^3$** | **m3/yr** | **mrem** |
| Inhalation | H-3 | 3.53 | 5000 | 0.003 |
| **Atmospheric Inhalation Total** | | | | **0.003** |

### MEI Atmospheric Inhalation Dose

| Atmospheric Inhalation (MEI) | | | | |
|---|---|---|---|---|
| Surface Soil Resuspension and Air Inhalation | | | | |
| **Source** | **Radionuclide** | **Activity** | **Consumption Rate** | **Dose** |
| **Surface Soil Resuspension** | | **pCi/g** | **m3/yr** | **mrem** |
| Inhalation | Cs-137 | 0.157 | 6400 | 0.000 |
| **Surface Soil Resuspension Total** | | | | **0.000** |
| **Air Inhalation (Silica Gel)** | | **pCi/m$^3$** | **m3/yr** | **Mrem** |
| Inhalation | H-3 | 4.29 | 6400 | 0.005 |
| **Atmospheric Inhalation Total** | | | | **0.005** |

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