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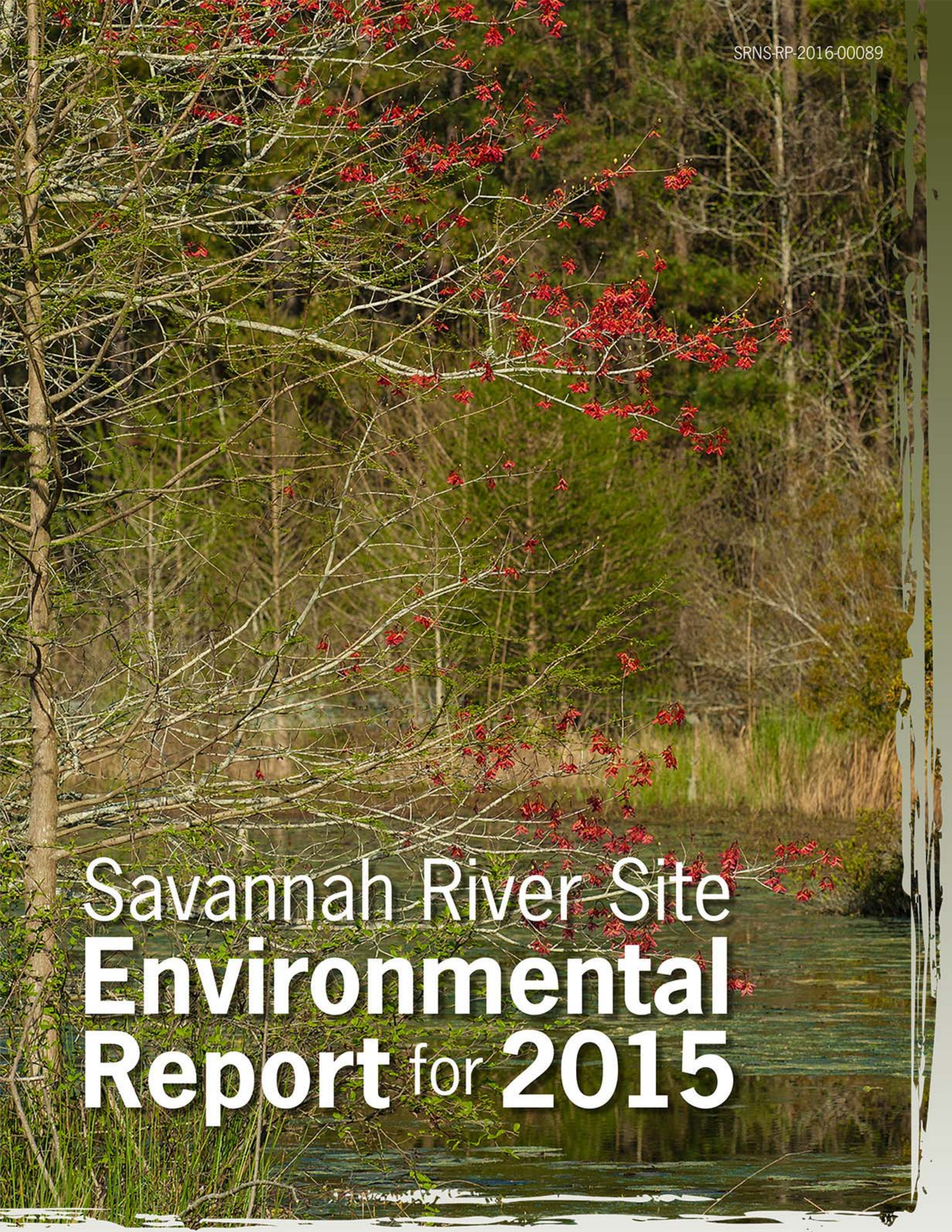

Savannah River Site Environmental Report for 2015

Front Cover – Steel Creek at L-Lake. Photograph provided by Steve Ashe, SRNS Corporate Communications.

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or go to the SRS Environmental Report webpage at
http://www.srs.gov/general/pubs/ERsum/index.html
and under the SRS Environmental Report for 2015, complete the electronic Customer Satisfaction Survey or Request a CD form.

SRNS-RP-2016-00089

Savannah River Site

Environmental Report for 2015

Prepared by
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(left to right) David Nasol, Kathryn Murphy, Kim Cauthen, Maatsi Ndingwan, Michele Wilson, Teresa Eddy, and Karen Vangelas. Absent from the photograph are Lori Coward, Sadika O'Quinn, and Tim Jannik.

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TO OUR READERS

Highlights

Annual Site Environmental Reports (ASERs) are required by U.S. Department of Energy (DOE) Order 231.1B (Environment, Safety, and Health Reporting) to assess field environmental program performance, site-wide environmental monitoring and surveillance effectiveness; and confirm compliance with environmental standards and requirements.

The ASERs are prepared in a manner that addresses likely public concerns and solicits feedback from the public and other stakeholders. Savannah River Site (SRS) began publishing the ASERs in 1959.

Readers can find the SRS Annual Environmental Report on the World Wide Web at the following address:

http://www.srs.gov/general/pubs/ERsum/index.html

The Savannah River Site Environmental Report for Calendar Year 2015 is an overview of environmental management activities conducted on and in the vicinity of the SRS from January 1 through December 31, 2015. This report includes:

- A summary of implemented environmental management systems designed to facilitate sound stewardship practices, as well as the compliance with applicable environmental regulations and laws intended to protect air, water, land, and other natural and cultural resources that have been impacted by SRS operations.
- The results of effluent monitoring and environmental surveillance of air, water, soil, vegetation, biota, and agricultural products to determine radioactivity in these media. The results are compared with historical data, background measurements, and/or applicable standards and requirements in order to verify that SRS does not adversely impact the environment or the health of humans or biota.
- Discussion of the potential doses to members of the public from radioactive releases from SRS operations compared to applicable standards and regulations; and from special case exposure scenarios.
- The quality assurance and quality control program which ensures that samples and data collected and analyzed are reported with utmost confidence.

The report addresses three general levels of reader interest:

- The first is a brief summary with a "take-home" conclusion. This is presented in the "Highlights" text box at the beginning of each chapter. There are no tables, figures, or graphs in the "Highlights".

  A lay person with little scientific background may comfortably read the "Highlights" and key terms.

- The second level is a more in-depth discussion with figures, summary tables, and summary graphs accompanying the text. The chapters of the annual report represent this level, which requires some familiarity with scientific data and graphs.

  A person with some scientific background can read and understand this report.

- The third level includes links to supplemental and technical reports and websites that support the annual report. The links to these reports may be found in the chapters or on the SRS Annual Environmental Report webpage.

  This level is directed toward scientists who would like to see original data and more in-depth discussions of the methods used and results.

The SRS Environmental Report webpage contains reports from multiple years with the 2015 report being the latest. The report folders feature:

1) The full report with hyperlinks to all supplemental information or reports.
2) A folder titled "Maps" contains figures with environmental sampling locations for the various media samples. These figures are identified as "Maps Figure" within the text of the report.
3) Annual reports from other SRS organizations.

The Savannah River Nuclear Solutions (SRNS), LLC develops this report as the Management & Operations contractor to the Department of Energy for the SRS. In addition to SRNS, the contributors to the annual report include Savannah River Remediation (SRR), LLC, Parsons Government Services, Department of Energy, Savannah River Operations Office (DOE-SR), Chicago Bridge & Iron Areva MOX Services, LLC, Centerra-SRS, Ameresco Federal Solutions, Inc.; Savannah River Ecology Laboratory (SREL) and U.S. Department of Agriculture Forest Service (USFS). Links to their websites may be found on pages 1-3 through 1-6 of this report.

The SRS Annual Environmental Report is available on the World Wide Web at the following address:

http://www.srs.gov/general/pubs/ERsum/index.html

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ACRONYMS AND ABBREVIATIONS

A

ARP	Actinide Removal Process

B

BJWSA	Beaufort-Jasper Water and Sewer Authority
BLLDF	Barnwell Low-Level Disposal Facility

C

C&D	Construction and Demolition
CA	Composite Analysis
CAA	Clean Air Act
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curie
CMP	Chemicals, Metals, and Pesticides
COC	Contaminant of Concern
CWA	Clean Water Act

D

DCS	Derived Concentration Standard
DOE	United States Department of Energy
DOE-SR	United States Department of Energy - Savannah River Operations Office
DOECAP	DOE Consolidated Audit Program

DWPF	Defense Waste Processing Facility

E

EA	Environmental Assessment
ECHO	Enforcement and Compliance History Online
EDAM	Environmental Dose Assessment Manual
EEC	Environmental Evaluation Checklist
EIS	Environmental Impact Statement
EM	Environmental Management
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ERPP	Environmental Radiological Protection Program
ESA	Endangered Species Act
ETP	Effluent Treatment Project

F

FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FTF	F-Tank Farm
FY	Fiscal Year

G

GA	Georgia
GHG	Greenhouse Gas

H

HVAC	Heating, Ventilation, and Air Conditioning
HWMF	Hazardous Waste Management Facility

I

I&D	Industrial and Domestic
ISO	International Organization for Standardization

M

MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act
MCL	Maximum Contaminant Level
MCU	Modular Caustic Side Solvent Extraction Unit
MDC	Minimum Detectable Concentration
MDN	Mercury Deposition Network
MEI	Maximally Exposed Individual
MFFF	Mixed Oxide Fuel Fabrication Facility
MOX	Mixed Oxide
MWMF	Mixed Waste Management Facility

N

NADP	National Atmospheric Deposition Program
NA-MRF	North Augusta, SC Material Recovery Facility
NDAA	National Defense Authorization Act
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act

NNSA	National Nuclear Security Administration
NOAV	Notices of Alleged Violation
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NTN	National Trends Network
NWP	Nationwide Permit

O

ODS	Ozone-Depleting Substances
ORPS	Occurrence Reporting and Processing System

P

P2	Pollution Prevention
PA	Performance Assessment
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene

Q

QA	Quality Assurance
QC	Quality Control

R

RCRA	Resource Conservation and Recovery Act
REMP	Radiological Environmental Monitoring Program
RHA	Rivers and Harbors Act
RICE	Reciprocating Internal Combustion Engine
RM	River Mile

RQ	Reportable Quantity
RSL	Regional Screening Levels

S

SA	Supplement Analysis
SARA	Superfund Amendment and Reauthorization Act of 1986
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SDWA	Safe Drinking Water Act
SPOFOA	Sustainability Performance Office Funding Opportunity Announcement
SRARP	Savannah River Archaeological Research Program
SREL	Savannah River Ecology Laboratory
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SSP	Site Sustainability Plan
std dev	standard deviation
STP	Site Treatment Plan
SWDF	Solid Waste Disposal Facility
SWPF	Salt Waste Processing Facility
SWPPP	Stormwater Pollution Prevention Plan

T

TCE	Trichloroethylene
TLD	Thermoluminescent Dosimeter

TRI	Toxic Release Inventory
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids

U

U.S.	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFS-SR	United States Forest Service-Savannah River
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
UST	Underground Storage Tank

V

VEGP	Vogtle Electric Generating Plant
VOC	Volatile Organic Compound

W

WIPP	Waste Isolation Pilot Plant
WTP	Water Treatment Plant

SAMPLING LOCATION INFORMATION

Note: This section contains sampling location abbreviations used in the text and/or on the sampling location maps. It also contains a list of sampling locations known by more than one name (see next page).

Location Abbreviations	Location Name/Other Applicable Information
4M	Fourmile
4MB	Fourmile Branch (Fourmile Creek)
4MC	Fourmile Creek
BDC	Beaver Dam Creek
BG	Burial Ground
BLTW	Burke and Screven Counties Wells (Georgia)
EAV	E-Area Vaults
FM	Four Mile
FMB	Fourmile Branch (Fourmile Creek)
GSTW	Burke and Screven Counties Wells (Georgia)
HP	HP (sampling location designation only; not an actual abbreviation)
HWY	Highway
JAX	SRS Boundary Wells
KP	Kennedy Pond
L3R	Lower Three Runs
MCQBR	McQueens Branch
MHTW	Burke and Screven Counties Wells (Georgia)
MPTW	Burke and Screven Counties Wells (Georgia)
MSB	SRS Boundary Wells
NSB L&D	New Savannah Bluff Lock & Dam (Augusta Lock and Dam)
PAR	"P" and "R" Pond
PB	Pen Branch
RM	River Mile
SC	Steel Creek
SWDF	Solid Waste Disposal Facility
TB	Tims Branch
TC	Tinker Creek
TNX	Multipurpose Pilot Plant Campus
TR	Burke and Screven Counties Wells (Georgia)
U3R	Upper Three Runs
VEGP	Vogtle Electric Generating Plan (Plant Vogtle)

Sampling Locations Known by More Than One Name
Augusta Lock and Dam; New Savannah River Lock & Dam
Beaver Dam Creek; 400-D
Fourmile Creek–2B; Fourmile Creek at Road C
Fourmile Creek–3A; Fourmile Creek at Road C
Lower Three Runs–2; Lower Three Runs at Patterson Mill Road
Lower Three Runs–3; Lower Three Runs at Highway 125
Pen Branch–3; Pen Branch at Road A-13-2
R-Area downstream of R–1; 100-R
River Mile 118.8; U.S. Highway 301 Bridge Area; Highway 301, US 301, Georgia Welcome Center at Highway 301
River Mile 129.1; Lower Three Runs Mouth
River Mile 141.5; Steel Creek Boat Ramp
River Mile 150.4; Vogtle Discharge
River Mile 152.1; Beaver Dam Creek Mouth
River Mile 157.2; Upper Three Runs Mouth
River Mile 160.0; Dernier Landing
Steel Creek at Road A; Steel Creek–4; Steel Creek–4 at Road A; Steel Creek at Highway 125
Tims Branch at Road C; Tims Branch–5
Tinker Creek at Kennedy Pond; Tinker Creek–1
Upper Three Runs–4; Upper Three Runs–4 at Road A; Upper Three Runs at Road A; Upper Three Runs at Hwy 125
Upper Three Runs–1A; Upper Three Runs–1A at Road 8-1
Upper Three Runs–3; Upper Three Runs–3 at Road C
Highway 17 Bridge; Houlihan Bridge

1 INTRODUCTION

This report was prepared to meet the U.S. Department of Energy (DOE) Order 231.1B "Environment, Safety, and Health Reporting." It also is the principal document that demonstrates compliance with the requirements of DOE Order 458.1, "Radiation Protection of the Public and the Environment," and is a key component to DOE's effort to keep the public informed of environmental conditions at the Savannah River Site (SRS).

This document presents summary environmental information and data for the SRS to:

- Highlight significant Site programs and efforts,
- Summarize environmental occurrences and responses reported during the calendar year,
- Describe compliance status with respect to environmental standards and requirements,
- Document the Site's environmental management performance, and
- Show the results of radiological monitoring and the results from monitoring property for release from SRS.

This chapter (i.e. Introduction) will discuss a brief history of the SRS, and the current missions the Site holds. This section will also highlight various organizations on site and their prime responsibilities, as well as physical characteristics and attributes in and around the SRS. This chapter introduces the Site's primary mission via programmatic activities and provides the annual update for each program (i.e. Nuclear Materials Stabilization, Waste Management, Environmental Monitoring, etc.).

1.1 HISTORY

SRS is a DOE site located in the western region of South Carolina along the Savannah River. SRS was built in the early 1950s to produce materials used to create nuclear weapons. Five nuclear reactors were built to produce these materials. Reactor operations continued until 1988. A number of support facilities were also built. Several of these facilities continue to operate. The main activities on Site today are waste processing and treatment, environmental cleanup and remediation, tritium processing, and protection of nuclear material.

1.2 MISSIONS

The mission of SRS is to operate safely and efficiently and to protect public health and the environment, while supporting the nation's nuclear deterrent programs. SRS missions fall under the DOE Environmental Management (EM) program or the National Nuclear Security Administration (NNSA).

SRS has three main mission areas:

Environmental Stewardship – SRS is focused on reducing the environmental legacy of nuclear materials and radioactive waste at SRS through initiatives such as groundwater restoration, deactivation and decommissioning of excess contaminated facilities, and radioactive waste disposition.

National Security – SRS is focused on enhancing national security by creating safe, innovative solutions to manage nuclear materials. Activities include surplus nuclear materials disposition, tritium supply management, and nuclear stockpile maintenance and evaluation.

Clean Energy – Through public and private research and development partnerships, SRS is focused on accelerating technological development to provide sustainable energy.

You will find more information on SRS's website.

1.3 ORGANIZATION

Two DOE Program Offices (Office of Environmental Management (EM) and National Nuclear Security Administration (NNSA)) provide direction to the Savannah River Operations Office. To execute SRS's missions, two federal agencies, two state universities, and several contractors participate in various supporting roles. Figure 1-1 shows the relationship of these contractors with DOE. You will find a description of each entity on the following pages.

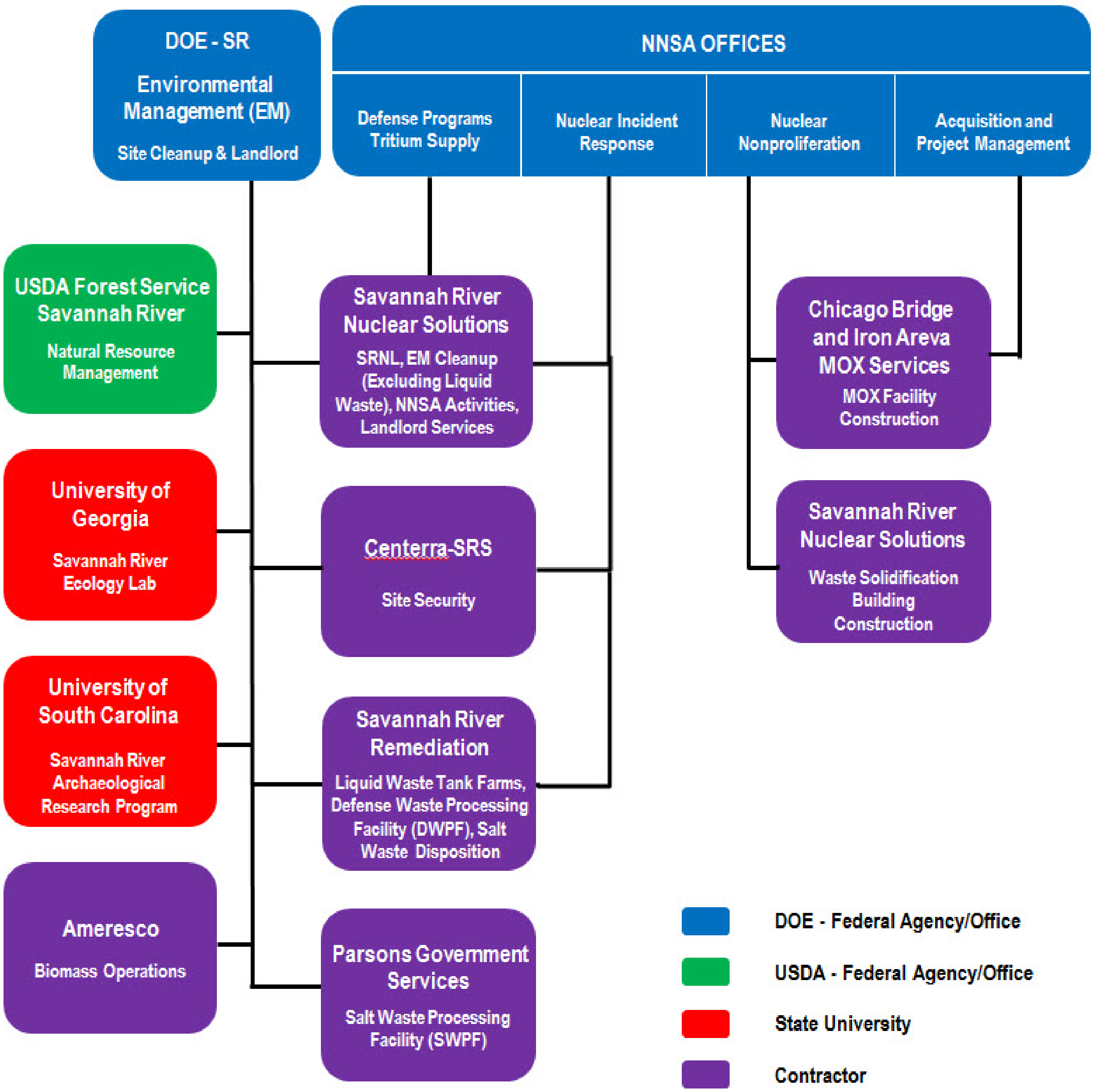


Figure 1-1 SRS Organization

The mission of Office of EM is to complete the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development and government-sponsored research. The DOE Savannah River Operations Office (DOE-SR) is responsible for oversight of EM operations and landlord services supporting all mission areas at SRS. You will find more information on the DOE-SR website.

NNSA is responsible for the defense programs and nuclear nonproliferation elements of the national security mission. NNSA is also responsible for emergency operations related to SRS tritium facility functions and DOE/NNSA radiological emergency response assistance program. You will find more information on the NNSA website.

Savannah River Nuclear Solutions, LLC (SRNS), a joint venture of Fluor Corporation, Newport News Nuclear, and Honeywell International, Inc., is the SRS management and operations contractor. SRNS is responsible for nuclear materials facilities, solid waste management facilities, tritium programs, Site infrastructure, and waste site remediation and closure projects. You will find more information on the SRNS website.

SRNL, operated by SRNS, is the only EM applied research and development laboratory. SRNL creates practical, high-value, cost-effective technological solutions in all three SRS mission areas as well as throughout the DOE weapons complex. SRNL also provides technical leadership and key support for future SRS missions. You will find more information on the SRNL website.

Savannah River Remediation LLC (SRR) is responsible for treating and disposing of radioactive liquid waste and operationally closing waste tanks. SRR is composed of a team of companies led by AECOM with partners Bechtel National, CH2M, and BWX Technologies. Critical subcontractors for the contract are AREVA, Energy Solutions, and URS Professional Solutions. You will find more information on the SRR website.

Parsons Government Services, Inc. is responsible for the design, construction, startup, and operation of the Salt Waste Processing Facility (SWPF). The SWPF will separate radioactive salt solutions currently stored in below ground tanks at SRS. SWPF will then transfer separated solutions to the Defense Waste Processing Facility (DWPF) or the Saltstone Facility for more processing. You will find more information on the Parsons website.

Chicago Bridge & Iron Areva MOX Services, LLC is responsible for the design, construction, startup, and operation of the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF). The MFFF will convert plutonium that could be used to make weapons to a form that can be used in a commercial nuclear power plant. You will find more information on the Chicago Bridge & Iron Areva MOX Services website.

Centerra-SRS is responsible for the protective force that focuses on ensuring Site operations are not disrupted by criminal or terrorist acts, while protecting sites employees, sensitive information and nuclear materials in a safe manner. You will find more information on the Centerra website.

Ameresco Federal Solutions, Inc. constructed and now operates biomass steam generating plants in K and L Areas and the steam and electricity cogeneration plant located near F Area. Ameresco currently supplies steam to SRS. Ameresco does not provide compliance data for the *SRS Environmental Report for 2015.* You will find more information on the Ameresco website.

The Savannah River Ecology Laboratory (SREL) is a research unit of the University of Georgia that has been conducting ecological research at SRS for more than 60 years. SREL's mission is to provide an independent, university-based perspective on the environmental risks associated with past, present, and future DOE missions. SREL's mission includes training future generations of scientists on how to evaluate such risks and to provide local communities with data on how SRS addresses environmental issues of importance to environmental protection and human health. You will find more information on the SREL website.

Under an Interagency Agreement with DOE-SR, the U.S. Department of Agriculture (USDA) Forest Service-Savannah River (USFS-SR) contributes to environmental stewardship at SRS by managing the Site's natural resources, including timber; maintaining and improving habitat for threatened, endangered, and sensitive species; maintaining secondary roads and Site boundaries; performing prescribed burns and protecting the Site from wildland fires; and evaluating the effects of its management practices on the environment. You will find more information on the USFS-SR website.

The Savannah River Archaeological Research Program (SRARP) is a research unit of the University of South Carolina that provides the technical expertise to support management of SRS cultural resources. SRARP responsibilities include identifying, evaluating, and protecting SRS archaeological sites and artifacts, conducting compliance based research, offering public outreach programs, and preparing documents and reports for state and federal regulators. You will find more information on the SRARP website.

1.4 SITE LOCATION, DEMOGRAPHICS, AND ENVIRONMENT

SRS borders the Savannah River, and covers about 310 square miles in the South Carolina counties of Aiken, Allendale, and Barnwell. SRS is about 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia (Figure 1-2). The Savannah River flows along the Site's southwestern border. On Figure 1-2, the capital letters within the SRS borders identify operational areas referenced throughout this report.

Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of the center of SRS is about 781,060 people. This translates to an average population density of about 104 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area.

1.4.1 Water Resources

The Savannah River bounds SRS on the southwest for 35 river miles. The upriver boundary of SRS is about 160 river miles from the Atlantic Ocean. The nearest downriver municipal facility that uses the river as a drinking water source (Beaufort-Jasper Water and Sewer Authority's Purrysburg Water Treatment Plant) is about 90 river miles from the Site. Commercial fishermen, sport fishermen, and boaters also use the river. The river is not currently used for any large-scale irrigation projects downriver of the Site.

The groundwater flow system at SRS consists of four major aquifers. Groundwater migrates through the subsurface, eventually either discharging into the Savannah River and its tributaries or migrating vertically downward into the deeper regional flow systems. SRS uses groundwater for both industrial processes and drinking water.

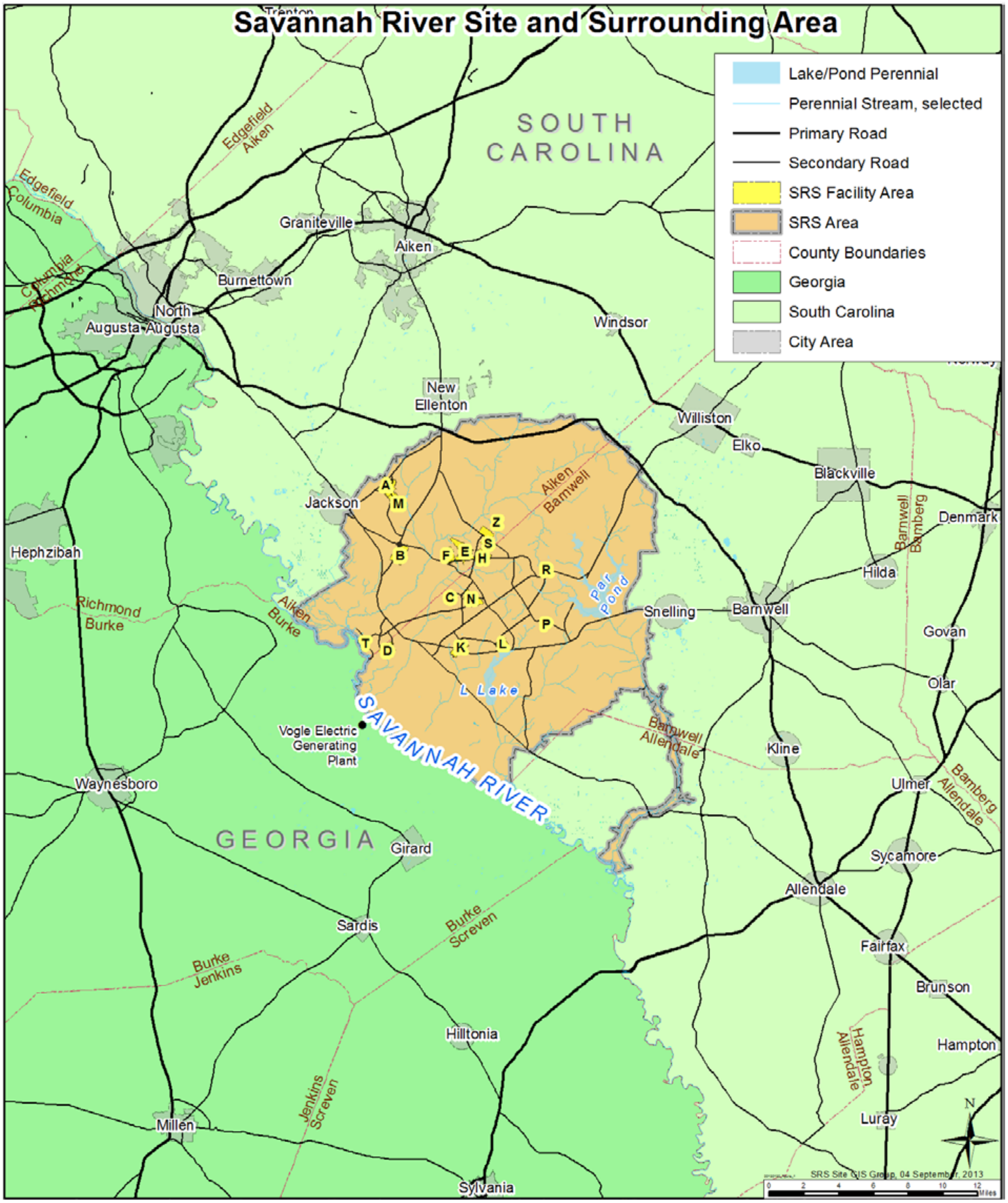


Figure 1-2 The Savannah River Site and Surrounding Area

1.4.2 Geology

SRS is on the southeastern Atlantic Coastal Plain, part of the larger Atlantic Plain that extends south from New Jersey to Florida. The center of SRS is about 25 miles southeast of the geological fall line that separates the Coastal Plain from the Piedmont.

With nearly three centuries of available historic and contemporary seismic data, the Charleston/ Summerville area remains the most seismically active region of South Carolina and the most significant seismogenic region affecting SRS. Levels of seismic activity within this region are very low, with magnitudes generally less than or equal to 3.0 on the Richter Scale.

1.4.3 Land and Forest Resources

SRS uses only about 10% of the total land area of the Site for industrial activities and the remaining 90% consists of natural and managed forests planted, maintained, and harvested by the USFS-SR. Four major forest types are found on SRS: mixed pine-hardwoods, sandhills pine savanna, bottomland hardwoods, and swamp floodplain forests. More than 345 Carolina Bays exist on SRS. Carolina Bays are relatively shallow depressions that provide important wetland habitat and refuge for many plants and animals.

1.4.4 Animal and Plant Life

SRS is home to about 1,500 species of plants, more than 100 species of reptiles and amphibians, some 50 species of mammals, nearly 100 species of fish, and provides habitat for more than 250 species of birds. Nearly 600 species of aquatic insects can be found in SRS streams and wetlands. The Site also provides habitat for a number of protected species including the wood stork, the red-cockaded woodpecker, the pondberry, the gopher tortoise, and the smooth purple coneflower (all federally-listed as threatened or endangered species) and at least 40 plant species of state or regional concern.

1.5 DOE EM PRIMARY SITE ACTIVITIES

1.5.1 Nuclear Materials Stabilization

In the past, separations facilities located in F and H Areas processed special nuclear materials and spent fuel from Site reactors to produce materials for nuclear weapons and isotopes for both medical and National Aeronautics and Space Administration applications. The end of the Cold War in 1991 brought a shift in the mission of these facilities to stabilization of nuclear materials from onsite and offsite sources for safe storage or disposition.

H Canyon

H Canyon is a multi-purpose facility supporting both DOE-EM and NNSA missions. Its unique design and capability allows it to disposition surplus uranium and plutonium materials. One of the most important missions of H Canyon since 2003 has been to recover and disposition highly enriched uranium from various spent and un-irradiated nuclear fuels as well as from uranium bearing materials from across the DOE complex. In H Canyon, the highly enriched uranium is purified through a separations process and then diluted into a low-enriched uranium product using natural uranium. The low-enriched product is shipped offsite and used in the manufacture of commercial reactor fuel.

H Canyon also dissolves plutonium materials into a solution that is converted into a purified oxide product. DOE has forecasted the plutonium oxide product as feed for the MFFF. In 2015, H Canyon marked 60 years of service to the nation. You will find more information on the H-Area Nuclear Materials Disposition page on SRS's website.

1.5.2 Nuclear Materials Consolidation and Storage

SRS handles and provides interim storage of our nation's surplus plutonium and other special nuclear materials and fulfills the United States' commitment to international nonproliferation efforts in a safe and environmentally sound manner.

K-Area Complex

The K-Area Complex is DOE's only special nuclear materials storage facility designated for interim safe storage of plutonium. The principal operations building formerly housed K Reactor, which produced nuclear materials to support the United States during the Cold War for nearly four decades. DOE has revitalized this very safe and robust structure to store nuclear materials. The stored materials have various proposed disposition paths including Waste Isolation Pilot Plant (WIPP), the Defense Waste Processing Facility (DWPF), H Area facilities, and the MFFF.

You will find more information on the Nuclear Materials Management page on SRS's website.

Spent Fuel Storage in the L-Area Complex

1.5.3 Spent Nuclear Fuel Storage

SRS supports the DOE National Security mission by safely receiving and storing spent fuel elements from foreign and domestic research reactors, pending disposition. Currently, spent nuclear fuel is stored at the L-Area Complex. You will find more information in the L-Area Complex fact sheet on SRS's website.

1.5.4 Waste Management

SRS manages radiological and nonradiological waste created by previous operations, as well as newly generated waste created by ongoing Site operations.

1.5.4.1 Radioactive Liquid Waste Management

The processing of nuclear materials for national defense, research, and medical programs generates radioactive liquid waste. Approximately 36 million gallons of radioactive liquid waste are safely stored underground in waste tanks located in the F- and H-Area Tank Farms. SRS waste tanks have provided more than 50 years of safe storage for radioactive liquid waste. The primary activities of this program are waste removal, treatment, and disposal followed by closure of the tanks. Removing waste from the tanks will allow for permanent closure of the Site's radioactive liquid waste storage tanks, a high priority for DOE. In 2015, SRS completed closure of the seventh radioactive liquid waste storage tank at the Site (Tank 16H), and the fifth tank closed since 2012. Through 2015, seven tanks have been closed.

SRS uses cylindrical Saltstone Disposal Units (SDUs) for disposal operations. In 2015 SRS continued construction of a new design for the cylindrical SDUs and processed and disposed of over 750,000 gallons of waste through the Saltstone facilities.

High activity waste from the Tank Farms is processed at DWPF. Since operations began in March 1996, over 15 million pounds of glass have been produced, 57.4 million curies have been immobilized, and 4,000 canisters poured. In FY 2015, the DWPF produced 93 canisters with approximately 350,000 pounds of glass, immobilizing approximately 1.8 million curies of radioactivity.

You will find more information in the Radioactive Liquid Waste: Operational Tank Closure and Liquid Waste Facilities fact sheets on SRS's website.

E-Area Waste Storage and Disposal Facilities

1.5.4.2 Solid Waste Management

Solid wastes managed at SRS include the following types:

- Low-level radioactive solid waste includes ordinary items that have become contaminated with small amounts of radioactive material;
- Transuranic (TRU) waste, which contains alpha-emitting isotopes with an atomic number greater than that of uranium;
- Hazardous waste (nonradiological), which is any toxic, corrosive, reactive, or ignitable material that could affect human health or the environment;
- Mixed waste, which contains both hazardous and radioactive components; and
- Sanitary waste, like ordinary municipal waste, is neither radioactive nor hazardous.

All low-level radioactive and hazardous wastes generated at SRS are treated, stored, and disposed of to meet environmental and regulatory requirements. The Site also emphasizes waste minimization and recycling as a way to reduce the volume of waste that SRS must manage.

TRU waste is packaged and transported by DOT approved caskets to WIPP for disposal. SRS did not make any TRU shipments in 2015. This was a result of the WIPP being shut down. WIPP is the disposal location for SRS TRU waste.

Annual reviews are conducted to ensure that Site Operations are within the performance standards established by DOE. The 2015 annual reviews for the E-Area Low-Level Waste Facility Performance Assessment (PA) and the Saltstone Disposal Facility PA, showed that operations in FY 2015 were within the performance standards established by DOE Orders, and that the public and the environment were protected.

You will find more information on the Solid Waste Management page on SRS's website.

1.5.5 Waste Site Remediation and Closure

Past operations at SRS have resulted in the release of hazardous and radioactive substances to soil which subsequently have ended up in the groundwater. The Area Completion Projects is responsible for and focuses on reducing the footprint of legacy waste at SRS's contaminated waste sites and obsolete facilities. Area Completion Projects cleans up contamination in the environment by treating or immobilizing the source of the contamination; mitigating transport through soil and groundwater or slowing the movement of contamination that has already migrated from the source. Cleanup actions include capping inactive waste sites, installing and operating efficient groundwater treatment units, and using natural remedies, such as bioremediation (using naturally occurring microbes) and natural remediation (using natural processes) to reduce contaminants from reaching groundwater or the contaminants concentrations in groundwater.

SRS Employees Observe D-Area Coal Ash Basin Closure Activities

During 2015, SRS continued a five-year project to restore 90 acres located near the former coal-fired power plant in D Area. The restoration activities will include removal of ash, deposited over decades, and construction of an engineered cover system, resulting in two highly engineered grassy hills. You will find more information on the Area Completion Projects page on SRS's website.

1.5.6 Environmental Monitoring

SRS has an extensive environmental monitoring program that has been in place since 1951, prior to the start of Site operations. In the 1950s, onsite environmental monitoring program data were reported in Site documents. Beginning in 1959, SRS made offsite environmental surveillance data available to the public. SRS reported onsite and offsite environmental monitoring activities separately until 1985, when data from both programs were merged into one publicly available document.

SRS continues to conduct an extensive environmental monitoring program to determine impacts, if any, from SRS operations to the surrounding communities and the environment, both on and offsite. In addition to the environmental monitoring activities conducted on the Site, SRS also monitors a 2,000-square-mile area beyond the Site boundary. This area includes neighboring cities, towns, and counties in South Carolina and Georgia. SRS collects thousands of samples of air, rainwater, surface water, drinking water, groundwater, food products, wildlife, soil, sediment, and vegetation. These samples are checked for radionuclides, metals, and other chemicals that could be in the environment because of activities at SRS.

During 2015, the Site's radioactive and chemical discharges to air and water were well below regulatory standards for environmental and public health protection; its air and water quality results met applicable requirements; and the potential radiation dose to the public was well below the DOE public dose limit. You will find more information in the Environmental Monitoring fact sheet on SRS's website.

1.6 NNSA PRIMARY SITE ACTIVITIES

Tritium Facility

NNSA operates tritium facilities at SRS to supply and process tritium, a radioactive form of hydrogen gas that is a vital component of nuclear weapons. SRS also plays a critical role in NNSA's nonproliferation missions, helping the United States meet its commitments to plutonium and uranium disposition and security.

1.6.1 Tritium Processing

SRS has the nation's only facility for extracting, recycling, purifying, and reloading tritium. SRS replenishes tritium by recycling tritium from existing warheads and by extracting tritium from target rods irradiated in nuclear reactors operated by the Tennessee Valley Authority. Recycled and extracted gases are purified to produce tritium suitable for use. SRS tritium facilities are part of the NNSA's Defense Programs operations at SRS. You will find more information on the Defense Programs page on SRS's website.

MFFF Facility under Construction

1.6.2 Nuclear Nonproliferation

Currently under construction, the MFFF will convert surplus weapons-grade plutonium to a form used to generate electricity in commercial nuclear power reactors. Once irradiated, the plutonium in the MOX fuel cannot be used for nuclear weapons. You will find more information on the Chicago Bridge & Iron Areva MOX Services website.

2 ENVIRONMENTAL MANAGEMENT SYSTEM

The U.S. Department of Energy (DOE) is committed to implementing sound stewardship practices to protect the air, water, land, and other natural, archaeological, and cultural resources potentially affected by Savannah River Site (SRS) construction, operations, maintenance, and decommissioning activities. The Environmental Management System (EMS) provides for the systematic planning, integrated execution, and evaluation of SRS activities for: (1) public health and environmental protection, (2) pollution prevention and waste minimization, (3) compliance with applicable environmental and cultural resource protection requirements, and (4) continuous improvement. The SRS activities discussed in this chapter portray the EMS goals and objectives in the areas of waste minimization, water management, renewable energy, greenhouse gas reduction, sustainable acquisition, sustainable remediation and best management practices on site. The SRS Site Sustainability Plan contains more information on the goals and progress towards meeting those goals.

2015 Highlights

The Savannah River Nuclear Solutions (SRNS) – Savannah River Remediation (SRR) EMS program review confirmed that both organizations are compliant with the requirements of DOE Orders and International Organization for Standardization (ISO) 14001. Some of the most notable environmental sustainability goals met during the year include:

Pollution Prevention/Waste Minimization

SRS saved $3.6 million through initiatives that avoided or diverted hazardous and radioactive wastes from disposal.

Water Management

SRS has reduced potable water usage by 37% since 2000.

Renewable Energy Intensity

48% of electric energy used in 2015 came from renewable energy sources

Greenhouse Gas Reduction

SRS has reduced greenhouse gas emissions over 68% since 2008.

Transportation and Fleet Management

Over 90% of SRS light duty vehicles are hybrid, electric, or use E85 (ethanol) fuel.

Best Practices/Lessons Learned

SRS shipped $20.8 million in usable assets (equipment and supplies) for reuse and recovery.

2.1 SRS EMS IMPLEMENTATION

2.1.1 Introduction

DOE has chosen the ISO Standard 14001 (Environmental Management Systems) as the framework to employ EMS and sustainable practices. The ISO14001 standard specifies the actual requirements for an environmental management system. It applies to those environmental aspects of which the organization has control and over which the organization can be expected to have an influence. The standard involves a repetitive cycle of developing a management system, planning and implementation, operation of the management system; checking (evaluation), corrective action and management review. Ultimately, ISO14001 aims to continuously assure itself that it can implement, maintain and improve an environmental management system. EMS also meets the criteria of Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, and DOE Order 436.1, "Departmental Sustainability," that require federal facilities to use environmental management systems.

The EMS integrates environmental protection into daily activities throughout operations at SRS. Environmental protection is integrated with safety and health hazard identification, as well as quality management processes. It is an approach to planning, executing, evaluating, and modifying how SRS operates so that the Site has minimal impact on the environment. SRS uses the EMS as a platform for the Site Sustainability Plan (SSP) implementation, as well as to carry out programs with goals and measurable targets that contribute to SRS meeting its sustainability goals. The SRS EMS and SSP targets and goals, along with the status of the Site's progress toward meeting these goals, are available on the SRS website. These documents, combined with site policies and procedures, ensure SRS remains a leader in environmental protection and reduction in energy and water usage.

Chapter 2 - Key Terms

Environmental aspects *are elements of an organization's activities, products, or services that can interact with the environment causing potential impacts.*

Environmental impacts *are any change to the environment, whether adverse or beneficial, wholly or partly resulting from an organization's activities, products, or services.*

Environmental policy *is an organization's state of intentions and principles in relation to its overall environmental performance. It provides a framework for action and for setting objectives and targets.*

Environmental objectives *support the environmental policy. They define the organization's goals.*

Environmental targets *are the specific measures that must be met to achieve the objectives.*

Environmental sustainability *is the responsible interaction with the environment to avoid depletion or degradation of natural resources and allow for long-term environmental quality. It includes reducing the amount of waste produced, using less energy, and developing processes that maintain the quality of the environment on a long-term basis.*

The following contractors maintain ISO14001 credentials: SRNS, SRR, Centerra and CB&I Areva. A March 2015 audit of the SRNS-SRR EMS program found it conformed with the ISO14001 requirements. A copy of the audit report can be found on the SRS website. Centerra re-registered in 2015.

Ameresco, operator of three of the four biomass plants, provides information for use in the Site Sustainability Plan, and their contribution to greenhouse gas reduction is counted in the Site's reductions.

The SRS Integrated Safety Management System is a process to integrate safety into management and work practices at all levels so that the Site accomplishes missions, while protecting the public, the worker, and the environment. Integrated Safety Management System execution is comprised of five functions: (1) Define Scope of Work, (2) Analyze Hazards, (3) Develop and Implement Controls, (4) Perform Work, and (5) Feedback and Improvement.

Integrated Safety Management System Continual Improvement Framework

SRS organizations follow this ISMS approach in their programs and procedures.

2.1.2 Objectives, Targets, and Programs

Through the EMS, SRS identifies significant facility and operational activities (aspects) that interact with the environment, and sets targets and goals for continuous improvement and reduction in SRS environmental impacts. New targets and goals are set each year to meet these aspects and to support DOE's environmental objectives.

Table 2-1 shows some examples of environmental aspects and their potential impacts.

Table 2-1 Environmental Aspects (Cause) and Environmental Impacts (Effect)

Cause	Effect
Emissions of smoke particles	Air pollution; decreased visibility
Discharges to streams	Degradation of aquatic habitat and drinking water supplies
Spills and leaks	Soil and groundwater contamination
Electricity use	Air pollution; global climate change
Resource Use	Natural resource depletion
Waste generation	Resource depletion; landfill space depleted; potential land contamination

Through the EMS, SRS sets targets and goals on an annual basis in support of DOE environmental objectives, which include:

- Reduction in total energy usage
- Increase utilization of renewable energy
- Reduction in water usage
- Purchasing of "green" products and services
- Reduction in solid waste generation
- Reduction in chemical usage

- Increase in the number of sustainable buildings
- Reduction in fleet and petroleum usage
- Use of energy compliant electronic devices
- Maintenance of compliance with requirements

These goals cover the topic areas of Clean Energy Initiatives, Sustainability, and Environmental Protection. Appendix A presents the goals, identifies the strategies for implementation, and the status of SRS's progress towards achieving them. Additional information is contained in this chapter on how SRS is moving forward in supporting DOE environmental objectives.

2.2 SUSTAINABILITY ACCOMPLISHMENTS

The following topics summarize the major accomplishments discussed in the SSP.

2.2.1 Pollution Prevention/Waste Minimization

SRS uses the North Augusta, SC Material Recovery Facility (NA-MRF) for routine waste (typical office and municipal-type waste) and recycling services. For 2015, about 43% of this stream, (approximately 680 tons) was recycled at the facility. SRS worked with NA-MRF to support process and program improvements to strive for attainment of a 50% recovery rate. During 2015, NA-MRF added new front-end processing equipment to improve waste segregation and reduce labor that increased the recovery rate of recyclable materials. Other efforts at their facility included the initiation of a vendor contract to purchase plastic waste bags and operations procedure revisions to improve recovery rates. For the month of September 2015, the NA-MRF achieved an approximate 60% recovery rate.

SRS strives to prevent or reduce pollution and waste generation whenever possible. In 2015, 15 pollution prevention (P2) initiatives avoided or diverted 459 yd^3 of hazardous and radioactive wastes from disposal, saving the Site over $3.6 million annually.

Table 2-2 shows a summary of the pollution prevention and waste minimization projects.

North Augusta Material Recovery Facility

Table 2-2 Summary of SRS Pollution Prevention Activities

Waste Reduction Activity Description	Waste Minimized or Recycled (weight or volume)
Hazardous waste generation avoided due to pollution prevention projects	9 yd^3
Low level radioactive waste generation avoided due to pollution prevention projects	115 yd^3
Mixed hazardous and low level mixed waste generation avoided due to pollution prevention projects	21 yd^3
Light bulbs recycled	24,680 lbs
Used oil recycled	8,350 gals
Lead-acid batteries recycled	280,179 lbs
Used tires recycled	24,000 lbs
Metals recycled	1,045,300 lbs
Furniture recycled/reused	62,800 lbs
Scrap electronic devices recycled (Does not include computers returned to vendor for reissuance)	93,900 lbs
PCB Waste Oil Recycled	56,920 gals
Mixed papers (to the NA- MRF)	1,366,200 lbs

2.2.2 Water Management

Potable water consumption has been reduced by 36.9% since 2000. The intensity reduction (gallons per gross square foot) is 22% since 2007, meeting the interim goal of a 16% reduction by this year. Industrial/Landscape/Agricultural water consumption has decreased by 64.3% from a 2010 baseline; far exceeding the 30% reduction goal. The electric and steam generation Biomass Cogeneration Facility is more water-efficient than the old and out of date coal-fired steam plants that SRS had previously used, thus ensuring large reductions in Industrial/Landscape/Agricultural water consumption will continue for many years to come.

Continuing in 2015, SRS used WaterSense® water fixtures or other water conserving products including low-flow toilet flush valves, low-flow urinal flush valves, and low-flow faucets for all routine corrective maintenance practices.

2.2.3 Renewable Energy

The Biomass Cogeneration Facility is in its third year of full operation and has played a significant role in supporting renewable and alternative energy goals. In May 2015, a new biomass heating plant broke ground that will increase critical steam security and provide additional green power at SRS.

Solar power is a Site renewable energy source

SRS is currently exceeding the 2025 goal of 25% of thermal and electric energy accounted for by renewable and alternative energy with 48% of electric energy used in 2015 coming from the biomass plants, and 100% of the steam used on site generated using renewable biomass fuels. The Savannah River National Laboratory (SRNL) continues developing cutting-edge renewable energy technologies in the areas of hydrogen, solar, wind, and biofuels. Details related to renewable energy developments at SRS can be found on the Savannah River National Laboratory webpage.

2.2.4 Greenhouse Gas (GHG) Reduction

SRS is committed to reducing GHG Scope 1 & 2 emissions. Scope 1 consists of direct emissions such as on-site combustion of fossil fuels or fugitive GHG emissions; whereas, Scope 2 consists of indirect emissions associated with the consumption of electricity, heat, or steam. SRS has achieved a 68.4% reduction from the 2008 baseline thus far in Scope 1 & 2 greenhouse gas emissions.

Scope 1 and 2 GHG emissions are currently generated from the following source types at SRS:

- Purchased electricity
- Wood (biomass)
- Fuel Oil
- Propane
- Gasoline
- Diesel
- E85 (ethanol)
- Jet fuel
- Fugitive emissions

E85 fueling station provides fuel for Site vehicles

In 2015, the Site continued to make great progress in reducing Scope 1 and 2 greenhouse gas emissions. This was primarily due to the Biomass Cogeneration Facility and the operation of the three biomass facilities located in A Area, L Area, and K Area. Excellent tracking mechanisms combine and organize GHG data associated with the various impact sources, such as Site energy use, alternative workplace arrangements/space optimization, and vehicle/equipment use. These mechanisms allow for the development, and subsequent management, of a comprehensive inventory.

2.2.5 Transportation and Fleet Management

SRS continues to reduce the use of petroleum. Alternative fuel use accounted for over 50% of the site fuel usage in FY 2015. At the close of the fiscal year, over 90% of the site's light-duty fleet consists of alternative fueled vehicles; i.e., E85-ethanol, hybrid, and electric.

SRS continues to replace conventional unleaded fuel vehicles with alternate fueled vehicles. The site now has three E85 fuel stations located at strategic locations across the SRS.

2.2.6 Sustainable Acquisition

In 2015, over 95% of applicable solicitations for new contracts included a requirement to use cost-effective Environmentally Preferable Purchasing (EPP) products. SRS changed several acquisition processes to encourage EPP procurement practices, including:

- Review and approval of chemical purchases. This review monitors usage of hazardous chemicals and, where appropriate, recommends EPP products.
- Procurement and leasing of desktops, laptops, and monitors that meet Electronic Product Environmental Assessment Tool (EPEAT) standards and copiers that are Energy Star compliant. These standards set minimum energy efficiencies for many electrical and electronic products.
- Procurement of EPP substitutions under various new and existing contracts, including bulk janitorial supplies (e.g., cleaners, paper products) and safety items (e.g., earplugs, filters).

2.2.7 Electronic Assets Management

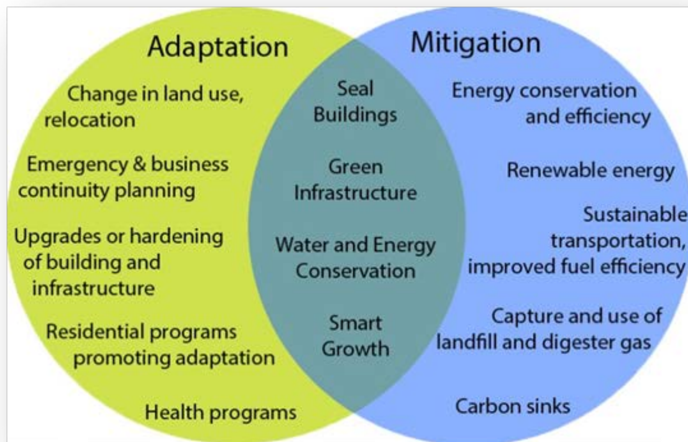
SRS implements numerous electronics stewardship strategies to reduce energy use, waste, and associated costs. In 2015, SRS continued exemplary performance and met sustainable electronics purchasing and disposal goals. SRS purchased EPEAT registered and ENERGY STAR qualified products for 100% of laptops, desktops, monitors, and printers. In total, 99.76% of SRS eligible electronic acquisitions meet EPEAT standards.

2.2.8 Sustainable Buildings

In order to meet long-range goals of SRS, and ongoing sustainability efforts, SRS works to achieve maximum facility, space and warehouse utilization. Doing so reduces the administrative and support footprint, and therefore reduces operating, routine surveillance, and maintenance costs. In 2015, SRS disconnected utilities from 41 vacated, aging trailers that were no longer in use. Of the 41 trailers, 16 were removed from the Site representing approximately 19,000 square feet of footprint reduction for SRS. In addition, eight facility roofs (106,356 sq ft.) were replaced with new green roof technology. These replacements not only significantly reduce costs, but also extend the life of the roofing system due to reduced thermal deterioration.

2.2.9 Climate Change Resilience

Climate change projections for the Site come from an online repository of global climate model (GCM) simulations and GCM simulations produced at SRNL. These simulations have undergone a process called downscaling, which uses large-scale simulations to make predictions at a local level. This process allows for a more detailed analysis of risks. The variables forecast at SRS include temperature, precipitation, humidity, and wind speed. The time period for this forecast is the years 2020-2049. A report of the downscaling process and results is under development, as is a description of observed climate change at SRS. A more extensive description of the downscaling at SRS and the results is contained in the 2015 SSP on the SRS homepage.



The analysis suggests that the major concern at SRS is the projection of more hot and humid days, which could impede outdoor work on the Site. The models generally agree that temperatures will rise, and specific humidity will naturally rise along with it. There is less agreement concerning changes in precipitation, with little overall trend towards greater rainfall at SRS, and reduced precipitation extremes. This conclusion tends to agree with the National Climate Assessment, in which extreme hot days (>95^{o} F) are expected to become more common, rising from 15 to 30 days per year (4% to 8% of all days) to 60 to 75 days per year (16% to 20% of all days).

SRS has begun the process of applying this data to estimate the vulnerabilities of site assets, making use of the U.S. Department of Transportation's Vulnerability Assessment Scoring Tool, part of the U.S. Climate Resilience Toolkit. SRS is producing formal documents that address the climate change resilience work that has been done over the past year. These documents will be reviewed externally and include:

1. An official report on observed climate change at SRS.
2. An official report on future climate change at SRS.
3. A report on the vulnerability assessments of mission critical buildings and outdoor workers at SRS.

2.2.10 Sustainable Remediation

Solar energy provides power to microblower that removes volatile contaminants from beneath the ground surface

SRS uses cost effective and sustainable remediation practices where possible. SRS currently has 515 identified waste sites, 400 of which either have completed remediation or are in various stages of characterization and remediation. SRNS frequently collaborates with SRNL and other entities to identify remedies that are both sustainable and appropriate. These sustainable remedies may include solar powered vapor extraction, barometric pressure powered soil vapor extraction, subsurface barrier walls, injection of material that allow for in situ remediation, phytoremediation, and monitored natural attenuation. See Chapter 7, "Groundwater Management Program", for additional information.

SRS currently has 37 remediation systems in place. Eleven such systems are low energy/enhanced natural systems, with an additional 18 that are passive systems requiring no energy to implement. Solar-powered vadose zone extraction wells are an example of low energy/enhanced natural systems being deployed at SRS.

Fourteen active systems have successfully transitioned from aggressive, high-energy remediation activities to more sustainable monitored natural attenuation or low energy remedies.

2.3 EMS BEST PRACTICES/LESSONS LEARNED

2.3.1 Sustainability Campaign

SRS continued to implement the "One Simple Act of Green" environmental awareness campaign. The program promotes individual action by connecting SRS employees to information, tools, and programs to make positive impacts on the environment, such as turning off lights when leaving a room or workspace.

1 Simple Act of Green
SAVANNAH RIVER SITE

2.3.2 Earth Day

SRS participated in the Earth Day celebrations in Aiken, SC on April 18, 2015. Four separate displays and booths made up the SRS contribution to the festivities that day. Over 750 visitors viewed the various interactive and informational displays at the event.

SRS displays included:

- The 2014 Chevrolet Volt hybrid electric vehicle, which is part of a General Services Administration (GSA) pilot program at SRS,
- Robots that sample and clean Waste Tanks at SRS,
- The "Reduce, Reuse and Recycle" Program,
- Highlights of the SRS Sustainability Program (including E85 fuel usage, biomass power generation as well as ideas for home recycling),
- A mock fuel assembly,
- Posters on nuclear power and its impact on the environment, and
- A demonstration on how fission works that featured mousetraps and ping-pong balls.

Children monitor natural radiation in rock during Earth Day 2015

2.3.3 Excess Equipment and Materials

SRS shipped $20.8 million in usable assets during 2015 (equipment and supplies) through Site Excess Operations for reuse and recovery. For example, fluorescent light bulbs, anti-freeze, and photographic developing solutions (that contain silver) were recovered and processed for reuse. The SSP contains such examples.

2.3.4 Challenges and Barriers to Implementation

SRS encourages its employees to adopt green behavior to improve performance, cost and delivery as we make SRS a rewarding place to work. Although limited funding to support the Sustainability Program has been a challenge, SRS continues to work toward meeting established goals by adhering to existing sustainability and conservation policies and practices across the Site. In 2015, SRS has been proactive in requesting funds through initiatives from the DOE Sustainability Program Office. SRS was the only DOE site that submitted a FY 2017 – FY 2021 Site Sustainability Program funding request. In addition, there was an opportunity presented to each site to apply for funds through the Sustainability Performance Office Funding Opportunity Announcement (SPOFOA). Although the requests were not funded, SRS completed and submitted SPOFOA applications for several sustainability related projects (i.e., LED Lighting, HVAC, and cool roof replacements).

SRS is a leader in conservation activities and management of resources and has accomplished much in this regard over many years. However, the cost effectiveness of achieving new goals is becoming significantly more difficult. SRS has many aging nuclear production and support (administrative, shops, laboratories, warehouses, etc.) facilities necessary to accomplish DOE missions yet make implementation of DOE's sustainability initiatives challenging. Economic paybacks are typically long due to low energy costs and high implementation costs. Additionally, the Site will be experiencing major energy and greenhouse gas emission increases over time as additional processing facilities such as the MOX Fuel Fabrication Facility and the Salt Waste Processing Facility begin operation. This is a major concern for 2016 and beyond.

The SRS will remain a leader in the DOE's sustainability program by continuing to make progress in energy reduction and the conservation of natural resources. The dedication of the department's staff and site contractors will ensure SRS continues to strive to meet the goals.

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3 COMPLIANCE SUMMARY

The Savannah River Site (SRS) implements programs designed to fulfill requirements of applicable federal and state environmental laws and regulations, including the U.S. Department of Energy (DOE) orders, notices, directives, policies, and guidance. SRS's exceptional compliance record demonstrates our commitment to protect human health and the environment. Our goal is to comply with regulatory requirements and minimize any potential environmental impacts.

2015 Highlights

SRS managed more than 500 operating and construction permits. SRS received one Notice of Violation (NOV) from South Carolina Department of Health and Environmental Control (SCDHEC) for failure to comply with Standards of Performance for Asbestos Projects for an incident that occurred in 2014 at the SRS Waste Solidification Building. (Page 3-12 provides information regarding the incident.)

Environmental Restoration

SRS had completed cleanup of 400 of the 515 waste units, and an additional 12 units were undergoing remediation.

The Fifth *Five-Year Remedy Review Report for SRS Operable Units with Native Soil Covers and/or Land Use Controls* was issued, which confirmed that the remedies selected for these 13 units were still protective of human health and the environment.

Waste Management

All 19 underground storage tanks containing usable petroleum fuel were in compliance, marking 13 consecutive years without a violation. These tanks are regulated under the Resource Conservation and Recovery Act (RCRA).

The 2015 annual reviews for the E-Area Low-Level Waste Facility Performance Assessment (PA) and the Saltstone Disposal Facility PA showed that SRS continued to operate these facilities in a safe and protective manner.

The Defense Waste Processing Facility (DWPF) produced 93 canisters with approximately 350,000 pounds of glass, immobilizing approximately 1.8 million curies of high-level radioactive waste. The Saltstone facilities processed over 750,000 gallons of low activity waste.

Radiation Protection of the Public and the Environment

SRS air and water discharges containing radionuclides were well below the DOE public dose limit of 100 mrem per year. (Chapter 6, "Radiological Dose Assessment", provides details on the public dose.)

2015 Highlights (continued)

Air Quality and Protection

SRS achieved a 100% compliance rate in FY 2015 with the five air permits governing operating facilities.

Water Quality and Protection

SRS monitors 28 industrial outfalls as required by the National Pollutant Discharge Elimination System (NPDES) permit and achieved a 100% compliance rate.

All 37 SRS stormwater outfalls covered under a Stormwater Pollution Prevention Plan (SWPPP) to prevent contamination and control sedimentation and erosion achieved a 100% compliance rate in 2015.

Environmental Protection and Resource Management

SRS conducted 409 National Environmental Policy Act (NEPA) reviews to identify potential environmental impacts from proposed federal activities. Three hundred and forty of these were identified as categorical exclusions.

SRS continued to comply with many other federal laws including the Emergency Planning and Right-to-Know Act (EPCRA), Superfund Amendments and Reauthorization Act (SARA) Title III, the Endangered Species Act (ESA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the National Historic Preservation Act (NHPA), and the Migratory Bird Treaty Act (MBTA).

DOE Orders/Executive Orders for Environmental Systems

There were no significant environmental events reported under the Occurrence Reporting and Processing System.

SRS made no regulatory self-disclosures.

SCDHEC, the U.S. Environmental Protection Agency (EPA), and the U.S. Army Corps of Engineers (USACE) conducted eight audits/inspections of the SRS environmental program for regulatory compliance with zero significant findings.

Release Reporting

SRS had no EPCRA or Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) reportable releases.

3.1 INTRODUCTION

Compliance with environmental regulations and DOE orders is an integral part of SRS operations. The purpose of this chapter is to provide a summary of SRS compliance with environmental regulations and programmatic requirements.

3.2 ENVIRONMENTAL RESTORATION/CLEANUP

The *Federal Facility Agreement (FFA)*, signed in 1993, integrates the CERCLA and RCRA requirements to achieve a comprehensive remediation strategy for SRS and to coordinate administrative and public participation requirements. The FFA governs the remedial action process, sets annual work priorities, and establishes milestones for cleanup actions.

SRS has 515 waste units subject to the FFA, including RCRA/CERCLA units, Site Evaluation Areas, and facilities covered by the SRS RCRA permit. At the end of Fiscal Year (FY) 2015, surface and groundwater cleanup of 400 of these units were complete and 12 units were in the remediation phase. You will find a listing of all 515 waste units at SRS in the FFA Appendices C ("RCRA/CERCLA Units List"), G ("Site Evaluation List") and H ("Solid Waste Management Units Evaluation"). You can learn more about the status of FFA activities for FY 2015 in the *Federal Facility Agreement Annual Progress Report for Fiscal Year 2015*.

CERCLA requires that reviews be conducted every five years for sites where hazardous substances remain at levels that do not allow for unrestricted use after remedy completion. The remedies are evaluated to determine if they are functioning as designed, and are still protective of human health and the environment.

EPA, SCDHEC and DOE signed the *Fifth Five-Year Remedy Review Report for SRS Operable Units (OUs) with Native Soil Covers and/or Land Use Controls* in 2015. This report spans 10 remedy decisions for 13 OUs, and all were determined to be protective of human health and the environment. DOE submitted the *Fifth Five-Year Remedy Review Report for SRS Operable Units with Groundwater Remedies* to EPA and SCDHEC in December 2015. The regulators will review and comment on the groundwater remedy review report, which is expected to be issued to the public by 2017.

3.3 WASTE MANAGEMENT

The management of waste and materials at SRS is complex and includes numerous facilities regulated under DOE Orders, as well as federal and state regulations. SRS manages, treats, and stores low-level, high-level, and transuranic (TRU) waste in compliance with DOE Order 435.1. Only low-level waste is disposed of at SRS. Low-level waste is any radioactive waste not classified as high level or TRU waste. Low-level waste is disposed of onsite at the E-Area Low-Level Waste Facility.

3.3.1 Atomic Energy Act/DOE Order 435.1, Radioactive Waste Management

As required by Manual 435.1-1, "Radioactive Waste Management," DOE is required to prepare Performance Assessments (PAs) to evaluate the potential impacts of low-level radioactive waste disposal to the workers, the public, and the environment. The PAs provide the technical basis and evaluation needed to demonstrate compliance with DOE Order 435.1. The Order also requires completion of a Composite Analysis (CA) to assess the combined impact of multiple low-level waste disposal facilities after closure.

Annually, SRS performs a comprehensive PA review for disposal facilities to ensure any developing information does not alter the original PA conclusions and there is a reasonable expectation the facility will continue to meet the performance objectives of the Order. The 2015 annual reviews for the E-Area Low-Level Waste Facility PA and the Saltstone Disposal Facility PA, showed that operations in FY 2015 were within the performance standards established by DOE Orders, and that the public and the environment were protected. In addition, SRS annually performs a CA review evaluating the adequacy of the 2010 SRS CA and verifying that SRS activities were conducted within the bounds of the 2010 analysis.

3.3.2 Radioactive Liquid Waste Processing and Disposition Facilities

Liquid radioactive waste is generated at the SRS as by-products from the processing of nuclear materials (legacy liquid waste). The waste is stored in underground waste tanks grouped into two tank farms (F-Tank Farm and H-Tank Farm). The liquid waste in tank storage exists in essentially two forms: sludge and salt, as shown in Figure 3-1.

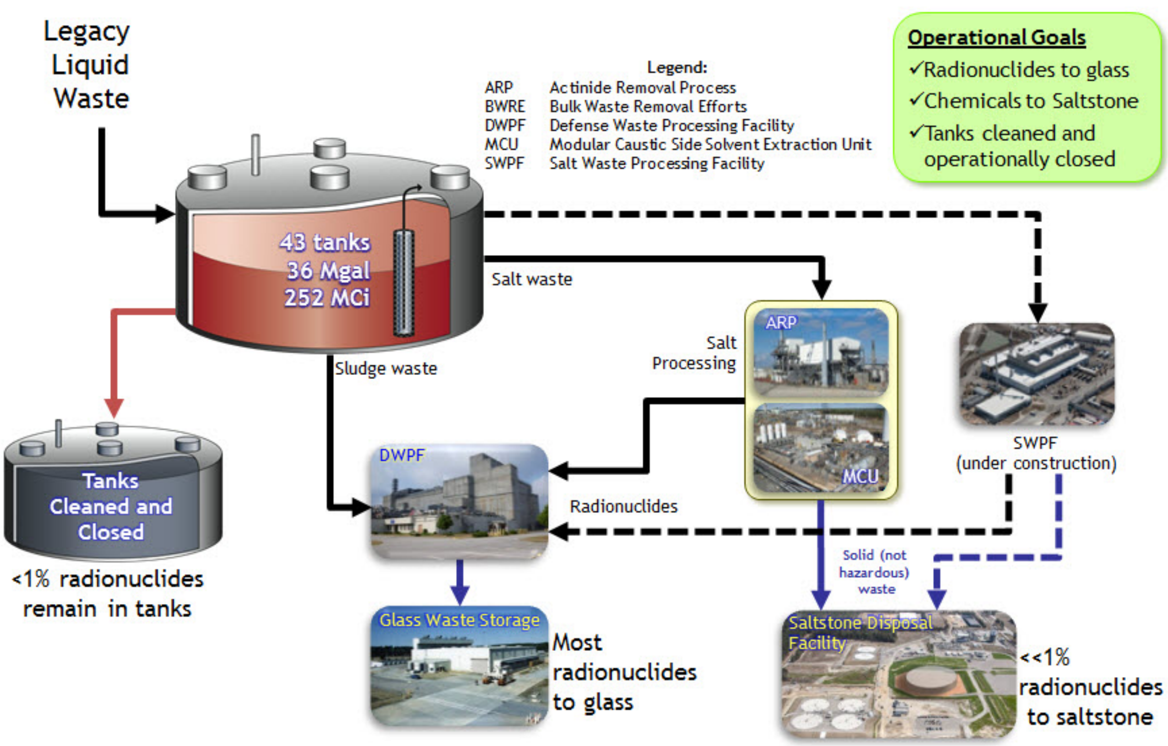


Figure 3-1 Pathway for Processing and Dispositioning of Radioactive Liquid Waste at SRS

3.3.2.1 Tank Closure Project

SCDHEC permits the F-Tank Farm and H-Area Tank Farms under the industrial wastewater regulations through the provisions of Section IX, "High-Level Radioactive Waste Tank System(s)," of the FFA. Enforceable schedules for closure activities for the liquid waste tanks are contained in the FFA. In addition, tank closure activities are subject to DOE Order 435.1, "Radioactive Waste Management," federal regulations, and the Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005 Section 3116.

The tanks undergo an extensive waste removal process that includes specialized mechanical cleaning and isolation of the tanks from all external systems. These activities culminate in regulatory confirmation that the tanks are ready for stabilization, which is done by grouting the tanks. In 2015, SRS began to manage closure of the H-Tank Farm pursuant to closure plans approved by the SCDHEC, with the closure of Tank 16H. In 2015, SRS completed operational closure of Tank 16H and continued preparation activities for the closure of Tank 12H.

NDAA Section 3116(a) is legislation that allows the Secretary of Energy, in consultation with the Nuclear Regulatory Commission (NRC), to determine that certain waste from spent fuel reprocessing is not high-level radioactive waste and does not require deep geologic disposal. The NRC performs their monitoring role of F-Tank Farm and H-Tank Farms in coordination with SCDHEC. In addition to SCDHEC representatives, EPA also participates in NRC Tank Farm monitoring activities. *The Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site* and *Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*, demonstrate that the stabilized tanks and ancillary structures in the F-Tank Farm and H-Tank Farm meet the necessary criteria and will not require permanent isolation in a deep geologic repository. During 2015, the NRC performed an on-site observation visit concerning both F- and H-Tank Farms and requested various documents for review. All requested documentation, along with other Follow-up Action Items, have been provided to the NRC as requested. The NRC did not identify any Open Issues resulting from the visit and review of the provided documentation. You can learn more by reading the NRC Onsite Observation Visit Report for the July 28-29, 2015 visit.

You will find more information on Tank Closure activities on the Tank Farms at the Savannah River Site web page.

3.3.2.2 Liquid Waste Processing

The Actinide Removal Process and Modular Caustic Side Solvent Extraction Unit (ARP/MCU) is an interim salt waste processing system. SCDHEC permitted ARP/MCU under the South Carolina industrial wastewater regulations. The salt form from the tanks comprises about 90% of the volume and contains about half of the radioactivity in the tank farms. The salt waste is treated at the MCU and the ARP. These processes remove actinides, strontium and cesium from the salt waste removed from the liquid waste tank farms. The higher activity portion of the salt waste—a very small stream—is sent to DWPF. The rest is a decontaminated salt solution sent to the Saltstone facilities. The Salt Waste Processing Facility (SWPF), which is under construction, will eventually replace the ARP/MCU process, as shown in Figure 3-1.

SRS continued processing radioactive liquid waste processing and disposition at SDUs and E-Area. You will find more information in the Liquid Waste Disposition and the Waste Solidification fact sheets on the SRS web page.

3.3.2.3 Salt Disposition

The low activity salt solution is sent to the Saltstone Production Facility after ARP/MCU for processing into grout for disposition in the Saltstone Disposal Facility (SDF). SCDHEC permits operation of the SDF under the South Carolina solid waste landfill regulations. SRS disposes of treated salt waste in the SDF based on the Secretary of Energy's determination pursuant to Section 3116 of the NDAA legislation. The Basis for this determination is found at *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*. The NRC, in coordination with SCDHEC, monitors the SDF as required by NDAA Section 3116(b).

In 2015, SRS continued to use cylindrical Saltstone Disposal Units (SDUs) for disposal operations. SRS also continued construction of a new design for the cylindrical SDUs with plans to begin operations in 2017. The new design is similar to the current cylindrical SDU and will hold approximately ten times the volume of waste. In FY 2015, over 750,000 gallons of waste was processed and disposed through the Saltstone facilities.

You will find more information on Salt Disposition 3116 activities on the Salt Waste Disposal at the Savannah River Site web page.

3.3.2.4 Defense Waste Processing Facility (DWPF) Vitrification

SCDHEC permits the operation of DWPF under the South Carolina industrial wastewater regulations. The DWPF is designed to treat the high-activity radionuclides from both forms of this waste. The sludge form, while comprising only about 10% of the volume in the tanks, contains the balance of the radioactivity. All of it goes to DWPF where the sludge-like high activity waste from the tank farms is immobilized in glass and poured into canisters. These canisters are stored at SRS in preparation for final disposal in a federal repository.

In FY 2015, DWPF produced 93 canisters with approximately 350,000 pounds of glass, immobilizing approximately 1.8 million curies of radioactivity. Since operations began in March 1996, over 15 million pounds of glass have been produced and 57.4 million curies have been immobilized.

3.3.2.5 Low Level Liquid Waste Treatment

The F and H Effluent Treatment Project (ETP) is where low-level radioactive wastewater from processes in the tank farms is treated. SCDHEC permitted the ETP under the South Carolina industrial wastewater regulations. ETP removes chemical and radioactive contaminants before releasing the water into Upper Three Runs Creek, an onsite stream that flows to the Savannah River. The point of discharge is a South Carolina NPDES permitted outfall. ETP processes up to approximately 20 million gallons of wastewater per year. ETP remained in compliance throughout 2015 with the industrial wastewater permit and the NPDES permit.

3.3.3 Transuranic (TRU) Waste Management

In 2015, Transuranic Waste Pad 16 was closed under a SCDHEC approved RCRA Interim Measures Plan. All waste was removed from the building, the Rubb™ structure was removed, the pad was covered with concrete, and the sump was filled with grout. SCDHEC approved the Interim Measures Closure Certification Report in December 2015.

Interim Closure of TRU Waste Pad 16

(clockwise from top: removal of Rubb™ enclosure atop pad; pouring concrete over the pad; and completed interim closure)

3.3.4 Resource Conservation and Recovery Act (RCRA)

RCRA establishes regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste, such as flammable or corrosive liquids. EPA authorizes SCDHEC to regulate hazardous waste and the hazardous components of mixed waste at SRS. SCDHEC issued a RCRA hazardous waste permit to SRS. In 2015, SRS submitted RCRA permit renewal applications for the TRU Pads and the Solvent Storage Tanks S33-S36.

In 2015, SRS operated active treatment, storage, and disposal facilities and maintained closed facilities in compliance with the SRS RCRA permit requirements. Nineteen underground storage tanks (USTs) at SRS contain usable petroleum products and are regulated under Subtitle I of RCRA. These tanks require an annual compliance certificate from SCDHEC. A SCDHEC inspection and audit on October 22, 2015 found all 19 tanks to be in compliance, marking 13 consecutive years without a violation.

3.3.5 Federal Facility Compliance Act (FFCA)

The FFCA's main purpose is identification of mixed waste (radioactive waste mixed with hazardous waste), and requires site owners to develop a Site Treatment Plan (STP). DOE is required to implement the STP with enforceable timetables for the development of mixed waste treatment capacities and technologies. SRS and SCDHEC held the annual STP status meeting in September 2015 to examine current milestones against projected STP goals and validated three quarters of cleanup credits.

3.3.6 Toxic Substances Control Act (TSCA)

SRS complies with TSCA regulations for the storage and disposal of lead, asbestos, and organic chemicals, including polychlorinated biphenyl compounds (PCBs). SRS disposes of routinely generated nonradioactive PCBs at an offsite EPA-approved disposal facility within the regulatory defined period of one year from the date of generation. SRS also generates radioactive waste contaminated with PCBs. Low-level radioactive PCB bulk product waste is disposed of onsite. PCB waste that is contaminated with TRU requires disposal at the Waste Isolation Pilot Plant (WIPP), located in New Mexico. SRS did not send any PCB TRU waste to WIPP in 2015. WIPP is still in recovery mode after a radioactive release occurred at their facility in 2014.

SRS completed the 2015 annual PCB document log on April 12, 2016 and submitted the 2015 annual report of onsite PCB disposal activities to EPA on June 15, 2016, meeting applicable requirements.

3.3.7 South Carolina Infectious Waste Management Regulation

SCDHEC registered SRS as a large quantity generator based on the amount of infectious (medical) waste generated per month. SRS contracts with a vendor for monthly pick-up of infectious waste. The waste is then treated and disposed of in accordance with the SCDHEC regulations. In 2015, SRS managed all infectious wastes in compliance with the requirements for treatment, storage, transportation, and disposal or destruction.

3.4 RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT

DOE Order 458.1, "Radiation Protection of the Public and the Environment," establishes the requirements to protect the public and the environment against any undue risk from radiation associated with radiological activities at DOE sites. This Order requires an Environmental Radiological Protection Program (ERPP). The SRS ERPP describes the methods used to ensure SRS implements the appropriate actions to comply with the requirements of DOE Order 458.1. This order specifies radiation dose standards for individual members of the public. The dose standard to the public is 100 millirem per year to a person from routine DOE operations.

In 2015, SRS radioactive discharges to air and water were well below regulatory standards for the public and the environment. Compliance with DOE Order 458.1 dose requirements is found in Chapter 6, "Radiological Dose Assessment." Chapter 6 provides the radioactive discharges to air and water and the potential radiation dose to the public and the DOE public dose limit.

3.5 AIR QUALITY AND PROTECTION

3.5.1 Clean Air Act (CAA)

EPA has delegated regulatory authority for all types of emissions to SCDHEC. SRS is required to comply with SCDHEC Regulation 61-62, "Air Pollution Control Regulations and Standards." SRS currently has five air permits regulating programs on Site:

- Part 70 Air Quality Permit (TV-0080-0041),
- 784-7A Biomass Boiler Construction Permit (TV-0080-0041a-CG-R1),
- 784-7A Oil Boiler Construction Permit (TV-0080-0041a-CF-R1)
- Ameresco Federal Solutions, Inc. ("Ameresco") biomass facilities permit (TV-0080-0144)
- Mixed Oxide Fuel Fabrication Facility (MFFF) (TV-0080-0139-CA-R1)

Information on these permits is available at the EPA's Enforcement and Compliance History Online (ECHO) database.

Under the CAA, SRS is considered a "major source" of non-radiological air emissions and therefore, falls under the CAA Part 70 Operating Permit Program. The Part 70 Operating Permit regulates stationary sources with the potential to emit five tons or more per year of any criteria pollutant (six of the most common air pollutants). The criteria pollutants are ozone precursors, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. These major stationary sources are subject to operating and emission limits, as well as emissions monitoring and record keeping requirements.

The National Ambient Air Quality Standards are air pollution control standards set by the EPA and regulated by SCDHEC. SRS is required by the Part 70 Operating Permit to demonstrate compliance through air dispersion modeling and the submission of an annual emissions inventory of air pollutant emissions. Table 3-1 shows the estimates for all the criteria pollutants emitted by SRS permitted sources as determined by the air emissions inventory conducted for the last five years. SCDHEC's 2015 review of the emissions found that SRS sources operated in compliance with permitted emission rates and the ambient air quality standards.

The current CAA Permit expired on March 31, 2008. SRS submitted a complete renewal application prior to the expiration allowing the Site to continue operations under the expired permit. SRS received a draft permit for review in 2011. SRS provided comments to SCDHEC on the draft permit in February 2012. SRS anticipates transmitting another draft permit for review in 2017 prior to public comment.

3.5.2 Accidental Release Prevention Program

The Clean Air Act Amendments of 1990 Section 112(r) requires any facility that maintains specific hazardous or extremely hazardous chemicals in quantities above specified threshold values to develop a risk management plan. SRS has maintained hazardous and extremely hazardous chemical inventories below the threshold value; therefore, SRS was not required to develop a risk management plan. Additionally, no reportable 112(r)-related hazardous or extremely hazardous chemical releases occurred at SRS in 2015.

Table 3-1 SRS Estimated SCDHEC Nonradiological Pollutant Air Emissions, 2011-2015 (TV-0080-0041)

Pollutant Name	Emissions (Tons/Year)				
	2011	2012 [b]	2013 [c]	2014	2015
Sulfur dioxide (SO2)	4,560	953	6.8	6.7	4.81
Total particulate matter (PM)	329	26	12.4	12.5	12.5
Particulate matter < 10 micrometers (PM10)	142	18	9.1	8.7	8.41
Particulate matter < 2.5 micrometers (PM2.5)	427	16	7.2	6.6	6.32
Carbon monoxide (CO)	125	52	21.7	58.0	54.0
Volatile organic compounds (VOCs) (Ozone Precursors) [a]	46	40	41.5	39.6	34.5
Gaseous fluorides (as hydrogen fluoride)	12.3	3	0.0025	0.0021	0.0011
Nitrogen dioxide (NO2)[d]	2,060	621	268.4	223.6	83.7
Lead (lead and lead compounds)	0.0166	0.00064	0.0047	0.0045	0.0079

[a] Corrected errors in 2009-2011 entries during 2012 annual report generation.
[b] Decreases in emissions attributed to limited use of D Area Powerhouse during 2012.
[c] D-Area Powerhouse permanently ceased all operations on April 25, 2012. Decreased emissions are attributed to no production in 2013. The increase in lead emissions is result of annual emission inventory reporting of lead and lead compounds where previously only lead was included.
[d] Less nitric acid was consumed in site operations during 2015 than in previous years. Nitric acid converts to NO2.

3.5.3 Ozone-Depleting Substances (ODS)

The CAA mandates air quality standards for the protection of stratospheric ozone. Releases of chemical gases such as chlorofluorocarbons, hydrofluorocarbons, halons, and other ODS widely used as refrigerants, insulating foams, solvents, and fire extinguishers, cause ozone depletion. The CAA requires SRS to comply with the standards for emissions reduction and the systematic reduction of ODS. It is a requirement that no ODS is knowingly or willfully released into the atmosphere. SRS reported no excursions occurred during 2015.

3.5.4 Air Emissions Inventory

SCDHEC Regulation 61-62.1, Section III ("Emissions Inventory"), requires compilation of an air emissions inventory in order to locate all sources of air pollution and to define and characterize the various types and amounts of pollutants.

SRS is required to update the Site annual air emission inventories to SCDHEC by March 31 for the previous calendar year. SRS submitted the 2015 electronic emissions inventories on March 31, 2016 (SRNS-2210-2016-00055). SRS provides its air emissions inventory to the EPA for inclusion in the National Emissions Inventory, a comprehensive and detailed estimate of air emissions of both criteria and hazardous air pollutants from all air emissions sources. You will find the most recent information on the EPA National Emission Inventories website.

3.5.5 National Emission Standard for Hazardous Air Pollutants (NESHAP)

NESHAP is a CAA-implementing program that sets air quality standards for hazardous air pollutants, such as radionuclides, benzene, Reciprocating Internal Combustion Engines (RICE) emissions, and asbestos.

3.5.5.1 NESHAP Radionuclide Program

SRS maintains compliance with the NESHAP Radionuclide Program by performing all required inspections and maintaining monitoring systems. Subpart H of the NESHAP regulations require SRS to determine and report annually by June 30 the highest effective dose from airborne emissions to any member of the public at an offsite point. During 2015, the maximally exposed individual (MEI) effective dose equivalent, calculated using the NESHAP required CAP88 computer code, was estimated to be less than 1% of the EPA standard. SRS transmitted the *SRS Radionuclide Air Emissions Annual Report for 2014* on June 24, 2015 to EPA, SCDHEC, and DOE headquarters. Chapter 6, "Radiological Dose Assessments," contains details on this dose calculation.

3.5.5.2 NESHAP Reciprocating Internal Combustion Engine (RICE) Program

In 2013, NESHAP emission standards applicable to stationary RICE, such as portable generators, emergency generators and compressors, became effective. SRS operates numerous RICE impacted by these regulations. RICE must also comply with the New Source Performance Standards. In 2015, SRS successfully submitted the semiannual compliance report.

3.5.5.3 NESHAP Asbestos Abatement Program

Asbestos operations and maintenance activities, minor and small jobs, as well as building renovations and demolitions at SRS fall under SCDHEC and federal regulations. SRS conducted 106 permitted renovations and demolitions involving asbestos in 2015.

SRS issued 91 asbestos notifications in 2015. Certified personnel removed and disposed of 388 linear feet, 48 square feet, and 22 cubic feet of friable (easily crumbled or pulverized) asbestos, and 367 linear feet, 172 square feet, and 2 cubic feet of non-friable asbestos during 2015. Non-radiological asbestos waste was disposed of at the Three Rivers Solid Waste Authority Landfill and the SRS Construction and Demolition (C&D) Landfill. Both disposal sites are SCDHEC-approved landfills for the disposal of regulated and non-regulated asbestos. Additionally, SRS disposed of 140 linear feet and 24 square feet of radiologically contaminated asbestos waste in 2015 at the SRS E-Area Low-Level Waste Facility.

On January 16, 2015, SRNS received a NOV from SCDHEC for failure to comply with SC R.61-86.1, *Standards of Performance for Asbestos Projects* at the SRS Waste Solidification Building. On December 2, 2014, an electrician removed electrical wiring from a rooftop HVAC system. The removal process generated less than 20 linear feet of asbestos containing wiring insulation. The individual who removed the wiring was not an asbestos-trained individual, nor was an abatement license obtained prior to the removal activity. No fines or penalties were assessed by SCDHEC as a result of this violation. The amount of asbestos released was below the one pound CERCLA Reportable Quantity and therefore did not require reporting to the National Response Center.

3.6 WATER QUALITY AND PROTECTION

3.6.1 Clean Water Act (CWA)

3.6.1.1 National Pollutant Discharge Elimination System (NPDES)

SCDHEC administers the NPDES program. The program protects surface waters by limiting releases of effluents into streams, reservoirs, and wetlands. With the exception of Ameresco, which has its own NPDES permit, SRS operated pursuant to eight NPDES permits in 2015:

- Land Application Permit (ND0072125)
- General Permit for Storm Water Discharges Associated with Industrial Activities (Except Construction) (SCR000000)
- Permit for Discharge to Surface Waters (SC0000175)
- Permit for Discharge to Surface Waters (SC0047431)
- General Permit for Stormwater Discharges from Construction Activities (SCR100000)
- General Permit for Utility Water Discharges (SCG250000)
- General Permit for Discharges from Application of Pesticides (SCG160000)
- General Permit for Vehicle Wash Water Discharges (SCG750000)

Information on these permits is available at the EPA's Enforcement and Compliance History Online (ECHO) database.

Throughout the year, SRS monitors 28 NPDES-permitted industrial wastewater outfalls across SRS on a frequency specified by the permits. Monitoring requirements vary from as much as once a day at some locations to once a quarter at others, although typically they are conducted once a month. For each outfall, physical, chemical, and/or biological parameters are determined and reported to SCDHEC in SRS monthly discharge monitoring reports, as required by the permit. Chapter 4, "*Non-Radiological Environmental Program*," provides additional information about sampling as required to remain compliant with the SRS's NPDES permits.

In 2015, the SRS NPDES program maintained a 100% compliance rate. SRS did not have a permit exceedance and received no NOVs for the NPDES program in 2015.

Stormwater Pollution Prevention Plans (SWPPPs) are required for construction and industrial activities on Site to prevent stormwater contamination, control sedimentation, and erosion, and to comply with CWA requirements. The SRS SWPPP contains information on all SRS outfalls and outfall facilities. SRS currently has 37 outfalls that are covered under this SWPPP.

In 2015, no construction stormwater monitoring was required at SRS and there were zero non-compliance notices issued by SCDHEC.

You will find the results from sampling of both industrial and stormwater outfalls in the 2015 Environmental Monitoring Program Data Report (SRNS 2016a).

The construction, operation, and closure of industrial wastewater treatment facilities are permitted under the NPDES program. Facilities permitted are broad in scope and include those involved with groundwater remediation, radioactive liquid waste processing, and nuclear nonproliferation. Inspections by SCDHEC in 2015 included those related to the Salt Solution Receipt Tanks at Saltstone and the Waste Solidification Building in June and the Western Sector Treatment System in December 2015.

SRNS submitted a Notice of Intent for the NPDES General Permit for Discharges from the Application of Pesticides in 2015 for woody vegetation control of approximately 35 acres at various ponds and lakes at SRS.

3.6.2 Safe Drinking Water Act (SDWA)

SCDHEC regulates drinking water facilities under the SDWA. SRS uses groundwater sources to supply onsite drinking water facilities. The A-Area drinking water system supplies most Site areas. Remote facilities such as field laboratories, barricades, and pump houses use small drinking water systems or bottled water.

SRS and SCDHEC collect and analyze samples to ensure that all Site domestic water systems meet SCDHEC and EPA bacteriological and chemical drinking water quality standards. All samples collected in 2015 met those standards. SRS samples domestic water systems for lead and copper on a three-year, rotating cycle. The A-Area water system will not be sampled again for lead and copper until 2016.

3.7 ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT

3.7.1 National Environmental Policy Act (NEPA)

The NEPA process is used to identify the potential environmental consequences of proposed federal activities and alternatives to support informed environmentally sound decision-making regarding design and implementation.

SRS initiates the evaluation process required by NEPA by completing an Environmental Evaluation Checklist (EEC) for new projects or changes to existing projects. SRS uses the EEC to review the proposed action, identify any potential environmental concerns, and determine the appropriate level of NEPA review required for the proposed activity.

SRS conducted 409 NEPA reviews in 2015 (Table 3-2). Categorical exclusion (CX) determinations accounted for 83 % of completed reviews. You will find additional information on SRS NEPA activities on the SRS NEPA web page.

Table 3-2 Summary of NEPA Reviews

Type of NEPA Review	Number
CX Determinations	340
"All No" EEC Determinations[a]	47
Actions Tiered to Previous NEPA Reviews	12
Environmental Impact Statements (EIS)[b]	3
Supplement Analysis (SA)[c]	3
Interim Action[d]	0
Revised Finding of No Significant Impact (FONSI)	1
EA	3
Total	409

[a] Proposed actions that require no further NEPA action

[b] DOE/EIS-0283-S2, Surplus Plutonium Disposition Supplemental EIS; DOE/EIS-0375, Disposal of Greater-Than-Class-C Low-Level Radioactive Waste; DOE-EIS/0423-S1, Long-Term Management and Storage of Elemental Mercury (all in process)

[c] SA on the Uranium Lease and Take Back Program for Irradiation for Production of Molybdenum-99 for Medical Use (ULTB Program)(DOE/EIS-0279-SA-05, DOE/EIS-0387-SA-02); Supplement Analysis for Interim Management of Nuclear Materials Final Environmental Impact Statement: Disposition of Mk-18A Targets at Savannah River Site (DOE/EIS-0220-SA-02)

[d] An interim action is an action within the scope of an EIS that is taken before a Record of Decision is issued. An interim action may not have adverse impacts on the environment or prejudice the selection of alternatives considered in the EIS.

SRS completed the following major NEPA reviews in 2015:

- *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement (SPD SEIS)*
- *Environmental Assessment, for Gap Material Plutonium-Transport, Receipt, and Processing* [DOE/EA-2024]
- *Supplement Analysis for the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program; Highly Enriched Uranium Target Residue Material Transportation (DOE/EIS-0218-SA-07)*

An *Environmental Assessment for a Proposal to Permit 750 Acres at the Savannah River Site for Use by the State of South Carolina Military Department* [DOE/EA-1999] and *for the Acceptance and Disposition of Used Nuclear Fuel Containing U.S. Origin Highly Enriched Uranium from the Federal Republic of Germany [DOE/EA-1977]* are in progress. Due to incorrectly identifying DOE/EA-1977 as complete in the SRS Environmental Report for 2014, an Errata, Appendix B, has been prepared to provide accurate information regarding 2014 NEPA activities.

3.7.2 Emergency Planning and Community Right-to-Know (EPCRA)/Superfund Amendment Reauthorization Act (SARA) Title III

EPCRA requires facilities to notify state and local emergency planning entities about their hazardous chemical inventories and to report releases of hazardous chemicals. The Pollution Prevention Act of 1990 expanded the EPCRA-mandated Toxic Chemical Release Inventory (TRI) report to include waste management activities. SRS complies with the applicable reporting requirements for EPCRA, and incorporates the applicable TRI chemicals into its pollution prevention efforts.

As required by Section 312 (Chemical Inventory Reporting) of EPCRA, SRS completes an annual Tier II Chemical Inventory Report for all hazardous chemicals in excess of specified quantities present at SRS during the calendar year. SRS submits hazardous chemical storage information to state and local authorities electronically via the Homeland Security E-Plan database by March 1 for the previous calendar year. SRS submitted its Tier II Chemical Inventory for 2015 on February 24, 2016.

As required by Section 313 (Toxic Chemical Release Inventory) of EPCRA, SRS must file an annual TRI report by July 1 for the previous year. SRS calculates chemical releases to the environment for each regulated chemical and reports those above the threshold value to EPA. For 2015, SRS submitted the Toxic Release Inventory Report on June 30, 2016 for each of the following regulated chemicals: ammonia, chromium compounds, ethylene glycol, formic acid, lead/lead compounds, manganese, mercury compounds, naphthalene, nickel compounds, nitrate/nitrate compounds, nitric acid, sodium nitrite, and sulfuric acid. You will find details on the EPA Toxic Release Inventory Program website.

3.7.3 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

The objective of FIFRA is to provide federal control of pesticide distribution, sale, and use. All pesticides used in the United States must be registered (licensed) by EPA. Use of each registered pesticide must be consistent with use directions contained on the label or labeling. South Carolina maintains the South Carolina Pesticide Control Act. SRS must comply with both FIFRA and the South Carolina Pesticide Control Act.

SRS has procedures in place to ensure compliance with FIFRA that establishes the requirements for application of pesticides, record keeping for pesticide applications, storage of pesticides, and the disposal of empty containers and excess pesticides. General Use Pesticides (ready- to-use products that are available for public use) are applied at SRS per the label instructions. Restricted Use Pesticides are applied at SRS per their Pesticide Program Plan. Application records for General Use and Restricted Use Pesticides are generated and maintained for each application.

3.7.4 Endangered Species Act (ESA)

The ESA provides for the designation and protection of wildlife, fish, and plants in danger of becoming extinct. This federal law also protects and conserves the critical habitats on which such species depend. Several federally listed plant and animal species exist at SRS, including the wood stork, the Red-Cockaded Woodpecker, the Shortnose Sturgeon, the Atlantic Sturgeon, the Pondberry, and the Smooth Coneflower. In addition, SRS is home to the Gopher Tortoise, which recently was listed as a candidate for protection under the ESA. The SRS is one of the first sites to conduct experimental translocations of gopher tortoises. Protocols developed during the translocation project are now widely used by conservation organizations to establish viable populations elsewhere in the species' range. South Carolina has enacted legislation that lists additional plants and animals not on the federal list to encourage management of populations of those species of conservation concern. Those found on SRS include the Carolina Gopher Frog and the Swallow Tailed Kite. While the Bald Eagle is no longer on the federally listed endangered or threatened species list, nesting Bald Eagles and wintering Golden Eagles remain protected by the Bald and Golden Eagle Protection Act. Bald Eagles nest on SRS and are considered year-round residents. Golden Eagles use SRS as wintering habitat. The U.S. Forest Service-Savannah River (USFS-SR) manages programs onsite to enhance the habitat and survival of these species.

The USFS-SR actively manages over 65,000 acres in the Red-Cockaded Woodpecker habitat management area using mechanical, chemical, and prescribed fire operations to effectively create and improve habitat by restoring the natural fire regime, improving native plant diversity in the understory, and enhancing native pine stands. Additionally, the USFS-SR inserts artificial cavities into living pine trees to supplement the available cavities for roosting and nesting. From 1985 through FY 2015, the number of active Red-Cockaded Woodpecker clusters has increased from three to 87 due to successful habitat restoration.

Gopher Tortoise and Smooth Purple Coneflower, Two Protected Species, Found at SRS

During FY 2015, while implementing the *United States Department of Energy Natural Resources Management Plan for SRS*, USFS-SR amended two SRS watershed management plans resulting in two reviews of biological evaluations for timber, research, and wildlife-related management activities. Three other biological evaluations were written during this time. Two were for standard USFS-SR project plans and one was at DOE's request for the SC National Guard's Training Operations on the Savannah River Site. These biological evaluations determined that forest implementation plans are not likely to affect federally listed endangered or threatened species adversely due to beneficial, insignificant, or discountable effects.

3.7.5 National Historic Preservation Act (NHPA)

The NHPA requires that all federal agencies consider the impacts to historic properties in all their undertakings. SRS ensures compliance with the NHPA through several processes. SRS uses the Site Use Program, the *Cold War Programmatic Agreement,* and *SRS's Cold War Built Environment Cultural Resource Management Plan* to ensure compliance with NHPA. The Savannah River Archaeological Research Program (SRARP) provides cultural resource management guidance to DOE to ensure fulfillment of compliance commitments. SRARP also serves as a primary facility for investigation of archaeological research problems associated with cultural development within the Savannah River valley, using the results to help DOE manage more than 1,900 known archaeological sites at SRS.

Through this program, SRARP evaluates and documents all locations being considered for activities, such as construction, to ensure that archaeological or historic sites are not impacted. In FY 2015, 936 acres of land on the SRS were investigated for cultural resource management; including 26 field surveys and testing. Twenty-nine newly discovered sites were recorded, and seven previously recorded sites were revisited.

You will find more information on activities conducted by the SRARP on the SRARP website. In addition, SRARP's 2015 report is located on the *Savannah River Site Environmental Report for 2015* web page.

3.7.6 Migratory Bird Treaty Act (MBTA)

The MBTA prohibits the taking, possession, import, export, transport, selling, purchase, barter of, offering for sale, or purchase of any migratory bird or its eggs, parts, and nests, except as authorized under a valid permit.

Three abandoned Northern Mockingbird nests (*Mimus polyglottos)* were discovered in government vehicles in 2015. In May 2015, an SRS worker drove a government vehicle to another site location for maintenance service. A nest containing three Northern Mockingbird eggs was discovered under the hood in the engine compartment of the vehicle. Two other abandoned Northern Mockingbird nests were discovered in government vehicles during September and October 2015.

Barn Swallows in Nest

A subcontractor initiated repair work on HVAC units located on the roof of Building 730-2B. Birds mobbed workers, causing them to stop work. SRS conducted the first walk down on June 25, 2015. Two Barn Swallow (*Hirundo rustica*) nests were located on the external ductwork of HVAC Units 1 and 3; each nest contained four nestlings. A stop work order was initiated requiring all work to stop until the nestlings fledged. Weekly inspections documented the continued use of the nests until fledging. The Unit 1 nestlings fledged between July 1 and July 8. The Unit 3 nestlings fledged between July 8 and July 15. HVAC repair work resumed after fledging.

In 2014, an osprey (*Pandion haliaetus*) nest was discovered on a power pole at the L-Lake Dam. USFS-SR consulted with U.S. Fish and Wildlife Service (USFWS) on moving the nest. A pole with a nest platform was erected and the nesting material was moved from the power pole to the platform. Exclusion devices were placed on the power pole to discourage the ospreys from rebuilding their nest on the power pole. In 2015, USFS-SR staff monitored the nest platform for nesting activity. The osprey did nest and produced three fledglings. The exclusion device on the power pole was an effective deterrent.

3.8 RELEASE REPORTING

Federally permitted releases comply with legally enforceable licenses, permits, regulations, or orders. If an unpermitted release to the environment of an amount greater than, or equal to, a reportable quantity (RQ) of a hazardous substance (including radionuclides) occurs, EPCRA, CERCLA, CWA and the CAA require notification to the National Response Center and state agencies. SRS had no reportable releases in 2015.

SRS had two releases reported to SCDHEC as a “courtesy” due to exceeding 50% of the RQ. On March 11, a leak on a fuel truck released 25 gallons of diesel fuel at the MOX project. On September 24, H-Tank Farm reported that a leak on the chromate cooling water system had released 8.7 pounds of sodium chromate. One other incident of interest was a CSX Train Derailment on January 27 that was partially on SRS property near Martin, South Carolina. This resulted in a release of 19,000 gallons of hydrochloric acid and 4,000 gallons of diesel fuel. CSX Railroad handled all reporting and cleanup. DOE and SRNS served in a support role.

3.9 MAJOR DOE ORDERS FOR ENVIRONMENTAL COMPLIANCE

SRS complies with the following major DOE Orders in addition to state and federal regulations for environmental compliance:

- DOE O 451.1B, Administrative Change 3, National Environmental Policy Act Compliance Program. See NEPA section of this chapter.
- DOE O 436.1, Departmental Sustainability. See Chapter 2, Environmental Management Systems.
- DOE O 458.1, Administrative Change 3, Radiation Protection of the Public and the Environment. See Chapters 5 and 6 of this report.
- DOE O 435.1, Change 1, Radioactive Waste Management. See Waste Management Section in this chapter.
- DOE O 231.1B, Environment, Safety and Health Reporting, requires the preparation of this Annual Environmental Report.
- DOE O 232.2, Administrative Change 1, Occurrence Reporting and Processing of Operations Information. This order requires DOE to use the designated system called *Occurrence Reporting and Processing System (ORPS). The ORPS* ensures that the DOE complex and the National Nuclear Security Administration are informed of events that could adversely affect the health and safety of the public and workers, the environment, DOE missions, or the

credibility of the Department. In 2015, there were no significant environmental ORPS reportable events.

- DOE O 226.1B, Implementation of Department of Energy Oversight Policy. This Order requires DOE to provide oversight related to protection of the public, workers, environment, and national security assets effectively through continuous improvement.

3.9.1 Regulatory Self-Disclosures

SRS did not make any regulatory self-disclosures in 2015.

3.9.2 Environmental Audits

SCDHEC, EPA, and the United States Army Corps of Engineers (USACE) conducted inspections and audits of the SRS environmental program for regulatory compliance. Table 3-3 provides a summary of the results of the 2015 audits and inspections.

Table 3-3 Summary of External Agency Audits/Inspections of the SRS Environmental Program and Results

Audit/Inspection	Purpose	Results
632-G C&D Landfill, 288-F Landfill, 488-4D Ash Landfill Inspections	SCDHEC conducted four quarterly inspections of the landfills.	No issues were identified.
SCDHEC Sanitary Survey of Domestic Water Systems	SCDHEC inspected the A-Area water system and three smaller systems on February 23, 2015. SCDHEC pulled water samples for bacteriological analysis.	SCDHEC indicated the systems are "satisfactory," and are operating in compliance with the State Primary Drinking Water Regulations.
Comprehensive Groundwater Monitoring Evaluation	SCDHEC inspected groundwater facilities associated with the F- and H-Area Seepage Basins, M-Area Settling Basin, Metallurgical Laboratory Basin, Mixed Waste Management Facility, and Sanitary Landfill March 2-3, 2015.	A records review of groundwater related files was also completed. Inspectors identified one damaged groundwater monitoring well sign. SRS replaced the sign, and no other issues were noted.
Industrial Wastewater Construction Permit Inspections	SCDHEC conducted inspections to approve the operation or closure of a variety of industrial wastewater treatment projects including the Waste Solidification Building, the Western Sector Treatment System, the Salt Solution Receipt Tanks, and Tanks 18F and 19F in the F-Area Tank Farm.	No issues were identified.
Interim Sanitary Landfill Post-Closure Inspection	SCDHEC conducted an annual review of the landfill.	No issues were identified.

Table 3-3 Summary of External Agency Audits/Inspections of the SRS Environmental Program and Results (continued)

Audit/Inspection	Purpose	Results
RCRA Compliance Evaluation Inspection (CEI)	SCDHEC inspected eight facilities and reviewed hazardous waste program requirements (i.e., notifications and reports to SCDHEC, plans, training records, internal inspections, and waste documentation) during their March 24 – 26, 2015 CEI.	SCDHEC noted failure to note the “time” on E-Area inspections. This deficiency was corrected prior to the conclusion of the inspection.
Underground Storage Tank CEI	SCDHEC inspected 19 USTs.	No issues were identified.
Z-Area Saltstone Solid Waste Landfill Inspections	SCDHEC performed inspections monthly of the SDF.	SCDHEC reviewed facility procedures and performed a walk-down of the SDF. No issues were noted.

3.10 PERMITS

SRS had 509 construction and operating permits in 2015 that specified operating levels to each permitted source. Table 3-4 identifies these permits. These numbers reflect permits for all organizations at SRS, with the exception of Ameresco.

Table 3-4 SRS Permits

Type of Permit	Number of Permits
Air	5
USACE - Section 10, Rivers & Harbors Act of 1899	0
USACE Nationwide Permit	5
USACE - 404 Permit (Dredge and Fill)	0
Asbestos Demolition/Abatement/Temporary Storage of Asbestos Waste	107
Domestic Water	175
GA Department of Natural Resources Scientific Collecting Permit	1
Industrial Wastewater	77
NPDES Permits	8
Construction Stormwater Grading Permit	10
RCRA Hazardous Waste	1
RCRA Solid Waste	4
RCRA Underground Storage Tank	7
Sanitary Wastewater	98
SC Department of Natural Resources Scientific Collecting Permit	2
SCDHEC 401	0
SCDHEC Navigable Waters	1
Underground Injection Control	8
Total	509

3.11 KEY FEDERAL LAWS COMPLIANCE SUMMARY

Federal laws are implemented by regulations contained in the Code of Federal Regulations and/or state regulations if the program has been delegated to the state by the federal agency. You can find additional information online at epa.gov. Table 3-5 summarizes SRS's 2015 compliance status with applicable key federal environmental laws.

Table 3-5 Status of Key Federal Environmental Laws Applicable to SRS

Regulatory Program Description	2015 Status
Atomic Energy Act/DOE Order 435.1 grants authority to DOE to develop applicable standards (documented in DOE Orders) for protecting the public and environment from radioactive materials.	The 2015 PA review showed that radioactive low-level waste operations were within the required performance envelope and the facilities continued to protect the public and environment.
Clean Air Act (CAA) establishes air quality standards for criteria pollutants, such as sulfur dioxide and particulate matter, and for hazardous air emissions, such as radionuclides and benzene.	SRS continues to operate under a CAA Permit that expired on March 31, 2008. SRS anticipates receiving a renewal draft permit in 2017. SRS continues to operate in accordance with all permit requirements of the CAA.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes criteria for liability and compensation, cleanup, and emergency response requirements for hazardous substances released to the environment.	By the end of FY2015, 400 RCRA/CERCLA waste unit cleanups were completed and 12 waste units were in the remediation phase.
Clean Water Act (CWA) regulates liquid discharges at outfalls (e.g., drains or pipes) that carry effluent to streams (NPDES, Section 402); regulates dredge and fill operations in waters of the United States (Section 404) and water quality for those activities (Water Quality Criteria, Section 401).	The SRS NPDES program maintained a 100% compliance rate.
Emergency Planning and Community Right-to-Know Act (EPCRA) also referred to as SARA, Title III, requires reporting of hazardous substances and their releases to EPA, state emergency response commissions, and local planning units.	SRS complied with all reporting and emergency planning requirements.
Endangered Species Act (ESA) prevents the extinction of federally listed endangered or threatened species and conserves critical habitats.	SRS continued to protect these species and their habitats as outlined in the Natural Resource Management Plan for SRS.

Table 3-5 Key Federal Environmental Laws Applicable to SRS (Continued)

Regulatory Program Description	2015 Status
The Federal Facility Agreement for the Savannah River Site (FFA) between the EPA, DOE, and SCDHEC integrates CERCLA and RCRA requirements to achieve a comprehensive remediation of high-level radioactive waste tanks at SRS.	SRS completed operational closure of Tanks 16H and continued preparation for the closure of 12H.
Federal Facility Compliance Act (FFCA) requires compliance on the part of Federal agencies with all requirements of federal, state, and local solid/hazardous waste laws.	SRS and SCDHEC held the annual Site Treatment Plan (STP) status meeting in October. No concerns were identified that required submittal of a 2015 STP update.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates restricted-use pesticides through a state-administered certification program.	SRS continues to operate in compliance with FIFRA requirements.
Migratory Bird Treaty Act (MBTA) provides for the protection of migratory birds, including their eggs and nests.	SRS continues to comply with the MBTA. A new osprey (Pandion haliaetus) nest platform at the L-Lake Dam was built at the suggestion of the USFWS. USFS-SR staff monitored the nest platform for nesting activity. The osprey did nest and produced three fledglings.
National Defense Authorization Act, Section 3116(a) (NDAA) allows the Secretary of Energy, in consultation with the NRC, to determine that certain waste from reprocessing is not high-level radioactive waste requiring deep geologic disposal if it meets the criteria set forth in Section 3116. Section 3116(b) addresses monitoring by NRC and SCDHEC.	NRC continues to monitor SRS facilities in accordance with NDAA 3116(a), making two site visits in 2015.
National Environmental Policy Act (NEPA) requires federal agencies to identify potential environmental consequences of proposed federal actions and alternatives to ensure informed, environmentally sound decision-making regarding design and implementation of programs and projects.	SRS is in full compliance with NEPA requirements and completed 409 NEPA reviews.

Table 3-5 Key Federal Environmental Laws Applicable to SRS (Continued)

Regulatory Program Description	2015 Status
National Historic Preservation Act (NHPA) protects historical and archaeological sites.	The SRARP provides cultural resource management guidance to DOE.
Resource Conservation and Recovery Act (RCRA) governs the management of hazardous and non-hazardous solid waste and underground storage tanks (USTs) containing petroleum products, hazardous materials, and wastes. RCRA also regulates universal waste and recyclable used oil.	SRS continues to manage hazardous, non-hazardous solid waste and USTs in compliance with RCRA.
Rivers and Harbors Act (RHA) regulates construction over, or obstruction of, navigable waters of the United States.	SRS continued to operate within the requirements of the RHA.
Safe Drinking Water Act (SDWA) provides for the protection of drinking water and public drinking water resources.	SRS maintained one large and several smaller domestic water systems. These systems met all primary drinking water standards, as well as operational and maintenance requirements.
Toxic Substances Control Act (TSCA) regulates polychlorinated biphenyls (PCBs), radon, asbestos and lead and requires evaluation and notification to EPA for new chemicals and significant new uses of existing chemicals.	SRS managed all TSCA-regulated materials in compliance with all requirements. SRS submitted the 2015 annual report of onsite disposal activities to EPA on June 15, 2016.

3.12 ENVIRONMENTAL COMPLIANCE SUMMARY

SRS was not involved in any environmental lawsuits during 2015.

SRS received one NOV in 2015.

Table 3-6 summarizes the NOVs/NOAVs received from 2011 through 2015.

Table 3-6 NOV/NOAV Summary, 2011 – 2015

Program Area	NOV/NOAV				
	2011	2012	2013	2014	2015
CAA	0	0	0	0	1
CWA	0	1	2	0	0
RCRA	0	0	0	0	0
CERCLA	0	0	0	0	0
Others	0	0	0	0	0
Total	**0**	**1**	**2**	**0**	**1**

4 NONRADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The Savannah River Site (SRS) nonradiological environmental monitoring program confirms compliance with state and federal regulations and/or permits, as well as, monitors any effects SRS operations have on the environment both onsite and offsite. The program includes monitoring of permitted point source discharges from on Site facility operations and the collection and analysis of environmental media such as air, water, sediment, and fish. Monitoring of nonradiological parameters is required by state and federal regulations and/or permits, but is also performed to reduce public concerns about SRS operations.

2015 Highlights

Effluent Releases

Nonradiological effluent releases for all categories were below permit limits and applicable standards.

All SRS industrial wastewater outfalls, under the National Pollutant Discharge Elimination System (NPDES) permit, achieved a 100% compliance rate.

All SRS industrial stormwater outfalls, under the NPDES permit, were compliant.

Onsite Drinking Water

All SRS drinking water systems complied with South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (EPA) water quality standards.

Surveillance Program

SRS discharges are not significantly affecting the water quality of onsite streams and the Savannah River.

Stream sediment results from SRS streams were consistent with the background control location and were comparable with historical levels.

Fish flesh sample results indicated the majority of measured metals were not detectable. Zinc, found in all samples, was at levels consistent with the background control location. Mercury, detected in 84 (60%) of the samples, was consistent with five-year historical trends for catfish, bream, mullet and red drum. Mercury in bass results from 2015 were similar to 2014 results but still elevated compared to the previous three years.

4.1 INTRODUCTION

Environmental monitoring programs at SRS examine both radiological and nonradiological constituents that could be released to the environment as a result of SRS activities. The radiological components of this monitoring program are discussed in Chapter 5, "Radiological Environmental Monitoring Program."

The nonradiological monitoring program involves the collection and analysis of air, water, sediment, and fish samples from numerous locations throughout SRS and the surrounding area. The nonradiological monitoring program encompasses environmental sampling both onsite and offsite. The program is divided into two focus areas: 1) effluent monitoring and 2) environmental surveillance. The effluent monitoring sample results are used to demonstrate permit compliance, as discussed in the respective sections of this chapter. The environmental surveillance sample results are used to assess the environmental impacts of Site operations on the surrounding area. Sampling frequency and analyses are determined by permit-mandated monitoring requirements and federal regulations.

SRS conducts nonradiological environmental monitoring activities for the following categories:

- Atmospheric (airborne emissions and precipitation with a special focus on mercury deposition),
- Water (wastewater, stormwater, sludge, onsite drinking water, river and stream water quality),
- Stream and river sediment, and
- Fish.

Figure 4-1 shows the types and typical locations (e.g., upstream and downstream of SRS influence) of nonradiological sampling performed at SRS.

This chapter presents a summary of the nonradiological environmental monitoring programs and data results. All data associated with the SRS sampling efforts described in this chapter are documented in the *2015 Environmental Monitoring Data Report* (SRNS 2016a). Appendix Table C-2 of this document provides a summary of the nonradiological surveillance sampling media and frequencies.

Chapter 4 – Key Terms

Effluent *is a release of treated or untreated water or air from a pipe or a stack to the environment. Liquid effluent flows into a body of water such as a stream or lake. Airborne effluent (also called emission) discharges into the atmosphere.*

Effluent monitoring *is the collection of water or air data from the point at which a facility discharges liquid or gaseous releases to the environment.*

Environmental Surveillance *is the collection of water, sediment or fish data from the environment around a facility.*

Outfall *is a place where treated or untreated water flows out of a pipe or ditch.*

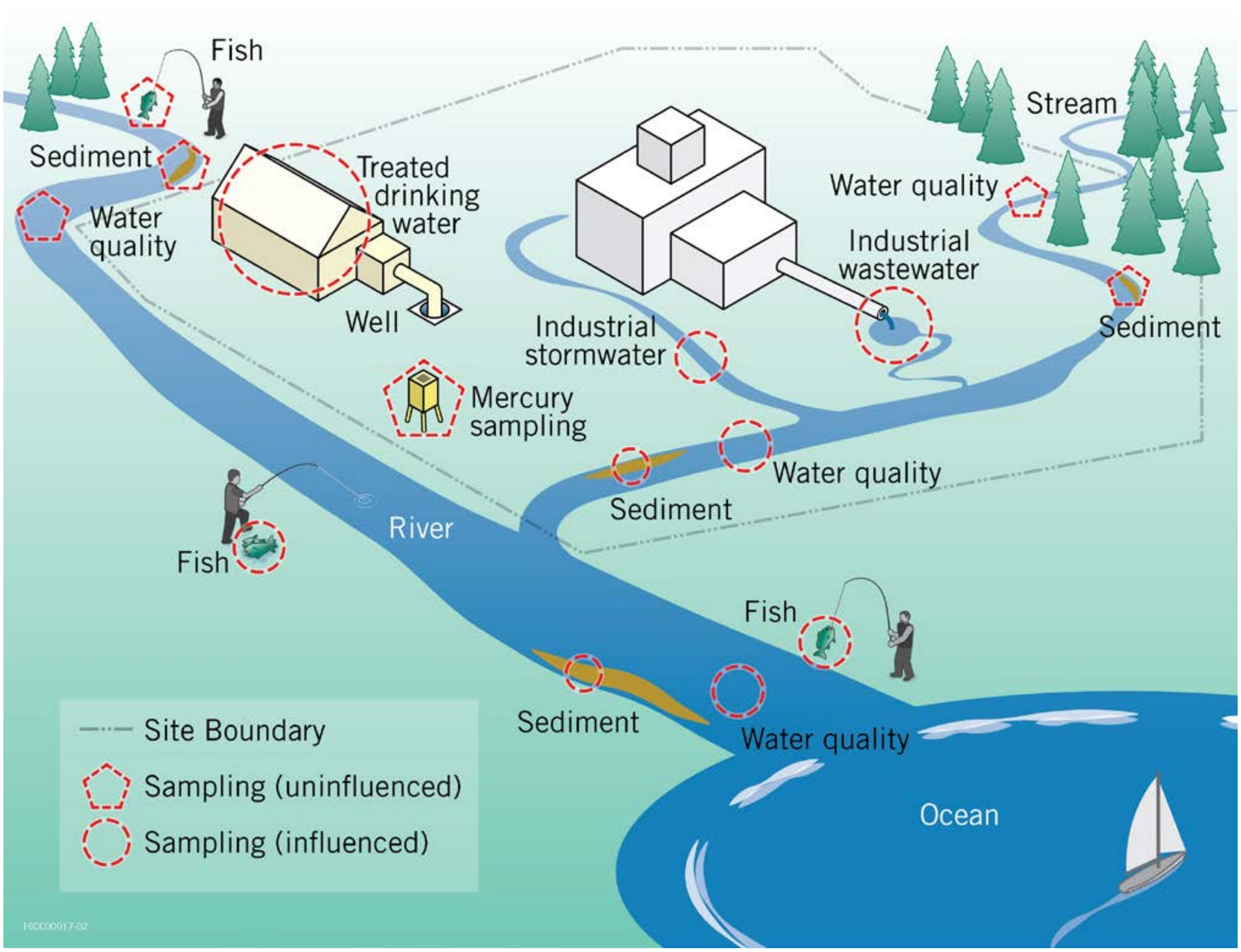


Figure 4-1 Types and Typical Locations of Nonradiological Sampling

4.2 CALCULATED AIR EMISSIONS

Airborne contaminants can present a risk to public health and the environment. Thus, identification and quantification of these contaminants is an essential component of a nonradiological monitoring program. SCDHEC regulates nonradioactive air pollutant emissions from SRS sources. The regulations provide a listing of pollutants, the compliance limits, and the methods to be used to demonstrate compliance.

SRS operations utilize a number of nonradioactive volatile chemicals, fuels, and combustion products that have the potential to adversely impact the environment, if released into the air in sufficient quantities. However, most of these materials are used in very small quantities and the potential environmental impact from their potential release is negligible. Because of the nature and quantity of potential air emissions, SRS is not required to monitor the ambient air for chemical pollutants. Using process data, SRS calculates emissions as required by SCDHEC. Table 3-1, in Chapter 3 “Compliance Summary”, shows the chemicals and the quantity emitted based on the air emissions calculations.

Many of the applicable regulatory standards are source-dependent (i.e., applicable to certain types of industries, processes, or equipment). The SCDHEC issued a Title V operating permit providing the source specific limits for facility operation, source sampling, testing, monitoring and reporting frequency as required by the regulations. SRS is required to demonstrate compliance through air dispersion modeling and the submission of an annual emissions inventory of air pollutant emissions. Emissions from SRS sources are determined from standard calculations using source operating parameters, such as hours of operation, process throughput, and EPA-approved emission factors. However, many of the SRS processes are unique sources requiring nonstandard, complex calculations. SRS compares the hourly and total actual annual emissions for each source against their respective permit limitations. Information associated with these emissions is presented in Chapter 3, "Compliance Summary", Section 3.5.4, "Air Emissions Inventory."

4.3 WATER MONITORING

SRS nonradiological water monitoring includes collection of samples from various water sources, sediments, and fish living in the water sources. This monitoring supports evaluation of whether there is long-term buildup of pollutants downstream of discharge points and meeting permit requirements.

4.3.1 Wastewater & Stormwater Monitoring

Nonradiological surface water monitoring primarily consists of sampling water discharges (industrial wastewater and industrial stormwater) associated with SRS NPDES permitted outfalls. Groundwater monitoring is conducted at SRS and is discussed in Chapter 7. SRS monitors nonradiological liquid discharges to surface waters through the NPDES program, as mandated by the Clean Water Act. The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

SCDHEC administers the NPDES permit program and is responsible for the permitting, compliance tracking, monitoring, and enforcement activities of the program. The permits issued by SCDHEC to SRS provide specific requirements for sampling locations, parameters to be tested, monitoring frequency, and analytical and reporting methods.

A Field Technician Verifies Flow Rate at an Industrial Wastewater Outfall

NPDES samples are collected in the field according to 40 CFR 136 (*Guidelines Establishing Test Procedures for the Analysis of Pollutants*). This document lists specific sample collection, preservation, and analytical methods acceptable for the type of pollutant.

In 2015, 28 industrial wastewater outfalls were monitored for various physical and chemical properties including flow, dissolved oxygen, pH, ammonia, biochemical oxygen demand, fecal coliform, metals, oil & grease, volatile organic compounds, and total suspended solids. These locations are shown in Figure 4-2. SRS monitored the outfalls on a frequency specified by the permits. Some locations required monitoring once a day while others are monitored once a quarter. Typically, locations are sampled once a month. As specified by permits, SRS collected either composite or grab samples. SRS reported results to SCDHEC in required monthly discharge monitoring reports.

In 2015, 37 industrial stormwater outfalls were monitored for copper, zinc, fecal coliform, pH and visual assessment (e.g., color, odor, solids, foam, oil sheen, etc.). These locations are shown in Figure 4-3. SRS monitored the outfalls on a frequency specified by the permit, varying from quarterly to annually. Grab sample techniques were used to collect the stormwater samples.

Stormwater sampling can be conducted only during a qualifying rain event. In order to collect a sample: 1) at least 72 hours must have elapsed since the previous flow event and 2) the sample must be collected during the first 30 minutes of the initial flow. SRS continued the use of wireless notification technology that includes immediate text notifications of rain events and wireless startup of automated samplers at specific locations. This allows SRS to comply with the SCDHEC permit requirements of sampling within 30 minutes of rain flow.

Sludge from the sanitary wastewater treatment facilities is managed under the requirements contained in the land application permit issued by SCDHEC. SRS transfers sludge generated at the sanitary wastewater treatment facilities from the sludge thickener to the drying beds. The air-dried sludge removed from the drying beds is then stored in a shed until it is spread on land. Approximately 151 cubic yards of the dried sludge was applied from October 19 through October 23, 2015. All sample results were within permit limits for metals and nutrients.

SCDHEC assesses the SRS NPDES program during compliance evaluation inspections. The evaluation includes records and procedures reviews; personnel interviews; and outfall, treatment facility, and land application site inspections. SCDHEC did not perform a compliance evaluation inspection in 2015. The last compliance evaluation inspection was conducted in August 2014. At that time SCDHEC issued a satisfactory rating, the highest grade possible.

4.3.2 Wastewater & Stormwater Results Summary

SRS reports NPDES industrial wastewater analytical results to SCDHEC through monthly discharge monitoring reports. All of the approximately 3,260 sample analyses performed during 2015 were within the NPDES permit limits, a 100% compliance rate.

SRS monitored all industrial stormwater outfalls per the requirements of the permit. Sample results demonstrated compliance with permit requirements.

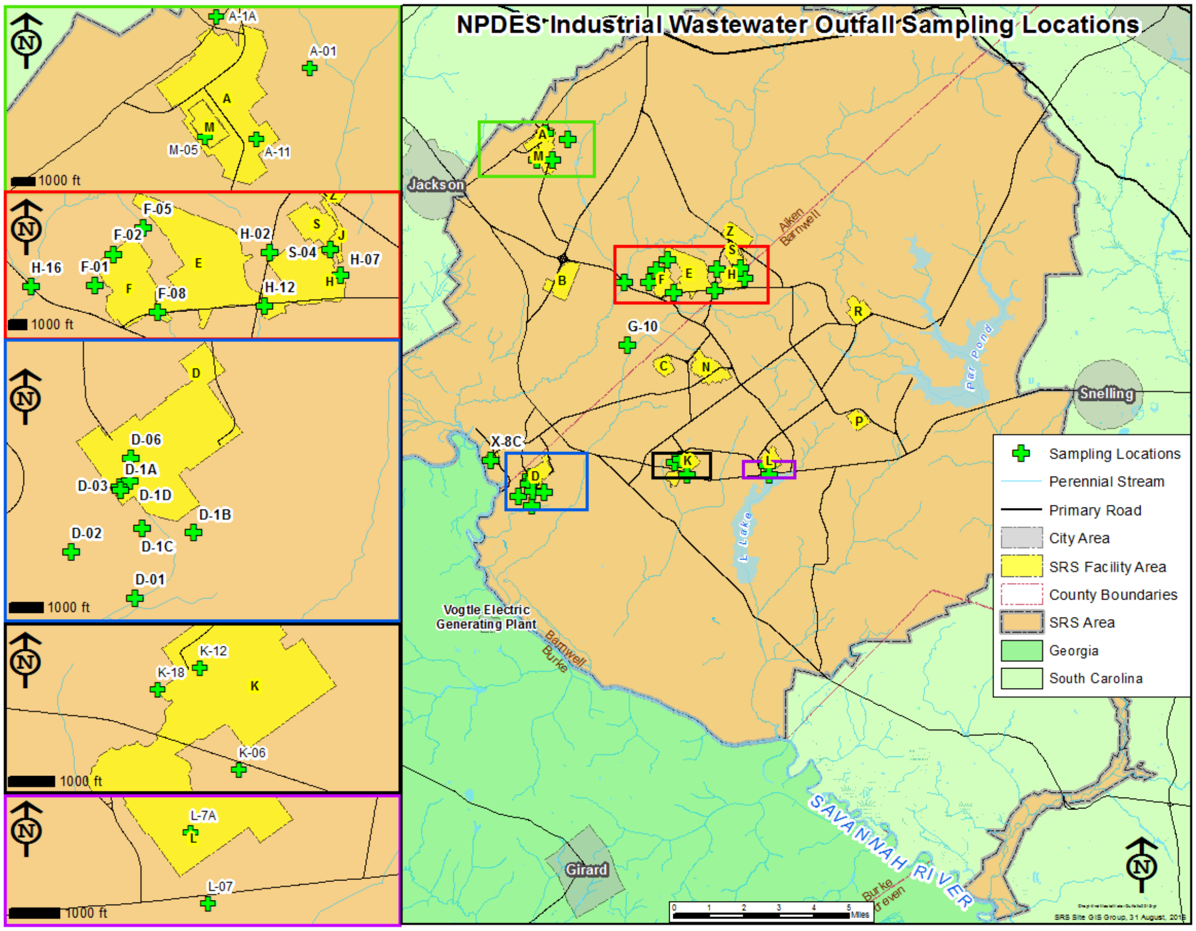


Figure 4-2 NPDES Industrial Wastewater Outfall Sampling Locations

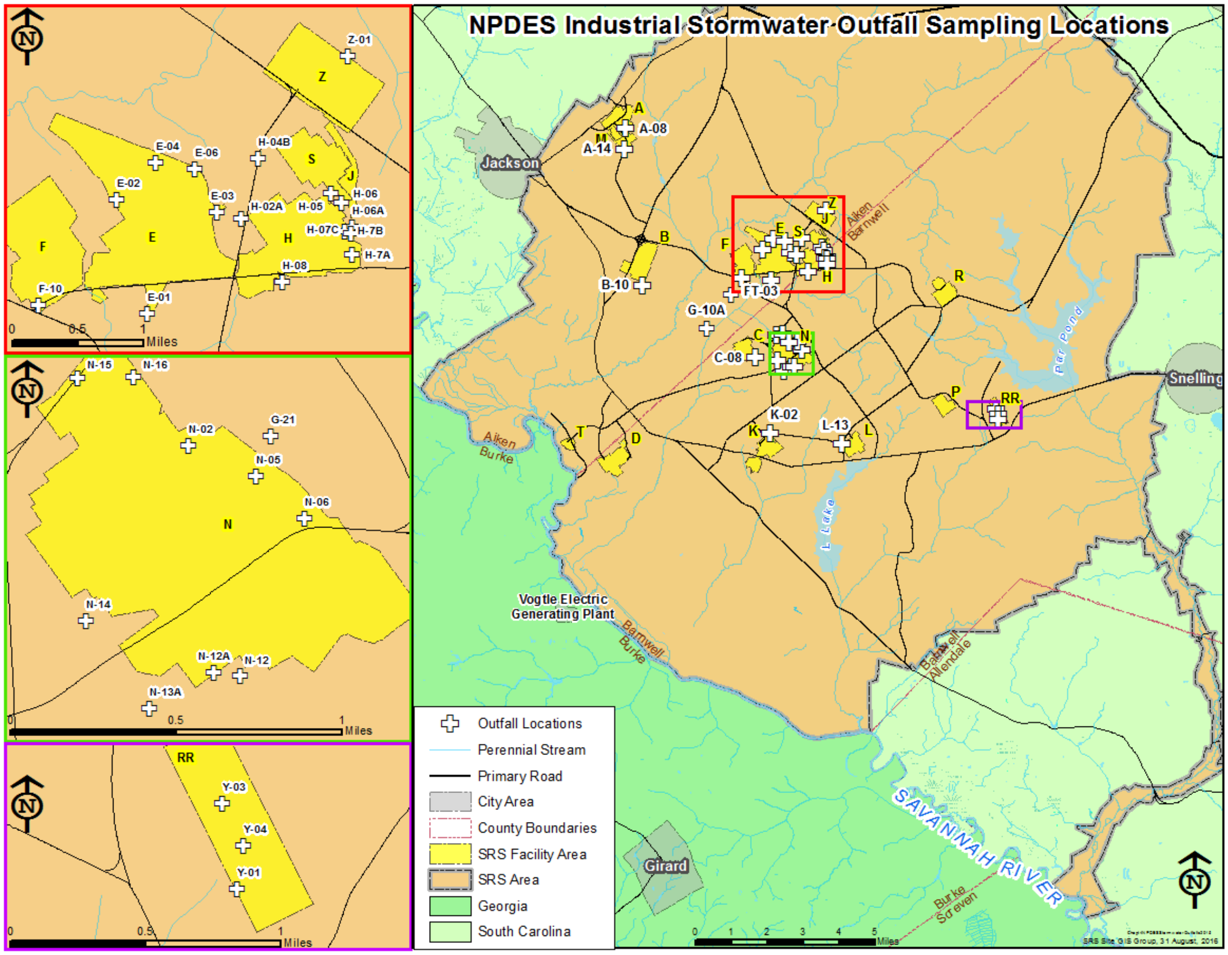


Figure 4-3 NPDES Industrial Stormwater Outfall Sampling Locations

4.3.3 Onsite Drinking Water Monitoring

SRS uses groundwater sources to supply onsite drinking water facilities. The treatment plant in A Area supplies most of the drinking water at SRS. The Site also has four smaller drinking water facilities, each of which serves populations of fewer than 25 people.

SRS collects and analyzes samples from the A Area treatment plant to ensure that domestic water from that system meets SCDHEC and EPA bacteriological drinking water quality standards. Samples are collected, analyzed and reported to SCDHEC monthly. All samples collected in 2015 met those standards. The Safe Drinking Water Act section of Chapter 3, "Compliance Summary" provides additional information regarding sampling and analyses performed by SCDHEC on SRS domestic water systems.

4.3.4 River and Stream Water Quality Surveillance

SRS streams and the Savannah River are classified as "freshwaters" by South Carolina Regulation 61-69, "Classified Waters." Freshwaters as defined in Regulation 61-68, "Water Classifications and Standards" (SCDHEC 2014) support:

- Primary and secondary contact recreation and as a drinking water source after conventional treatment in accordance with SCDHEC requirements;
- Fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora; and
- Industrial and agricultural uses.

A Field Technician Collects a Water Quality Sample

SRS conducts river and stream water quality surveillance to identify any degradation that could be attributed to the water discharges regulated by Site NPDES permits and materials that may be released inadvertently from sources other than routine release points.

Under the SRS water quality surveillance program, ten SRS stream and five Savannah River locations are sampled for various physical and chemical properties including dissolved oxygen, pH, temperature, hardness, metals, pesticides/herbicides, and total organic carbon. Figure 4-4 illustrates the sampling locations. River and stream sampling sites are located to provide data to compare the SRS contribution of pollutants with background levels of chemicals from natural sources and from contaminants produced by municipal sewage plants, medical facilities, and other upstream industrial facilities. The water quality locations are sampled at monthly and quarterly frequencies by the conventional grab-collection technique. SCDHEC also collects samples at several onsite stream locations; most of them are co-located with SRS sample locations as a quality control check of the SRS program.

4.3.4.1 River and Stream Water Quality Results Summary

SRS performed 5,400 individual analyses on samples collected from the 15 stream and river water quality locations during 2015. Metals were detected in at least one sample at each location. No sample results showed detectable levels of pesticides, herbicides, or polychlorinated biphenyls (PCBs). Appendix Table D-1 presents a summary of the analytical results. These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the Savannah River.

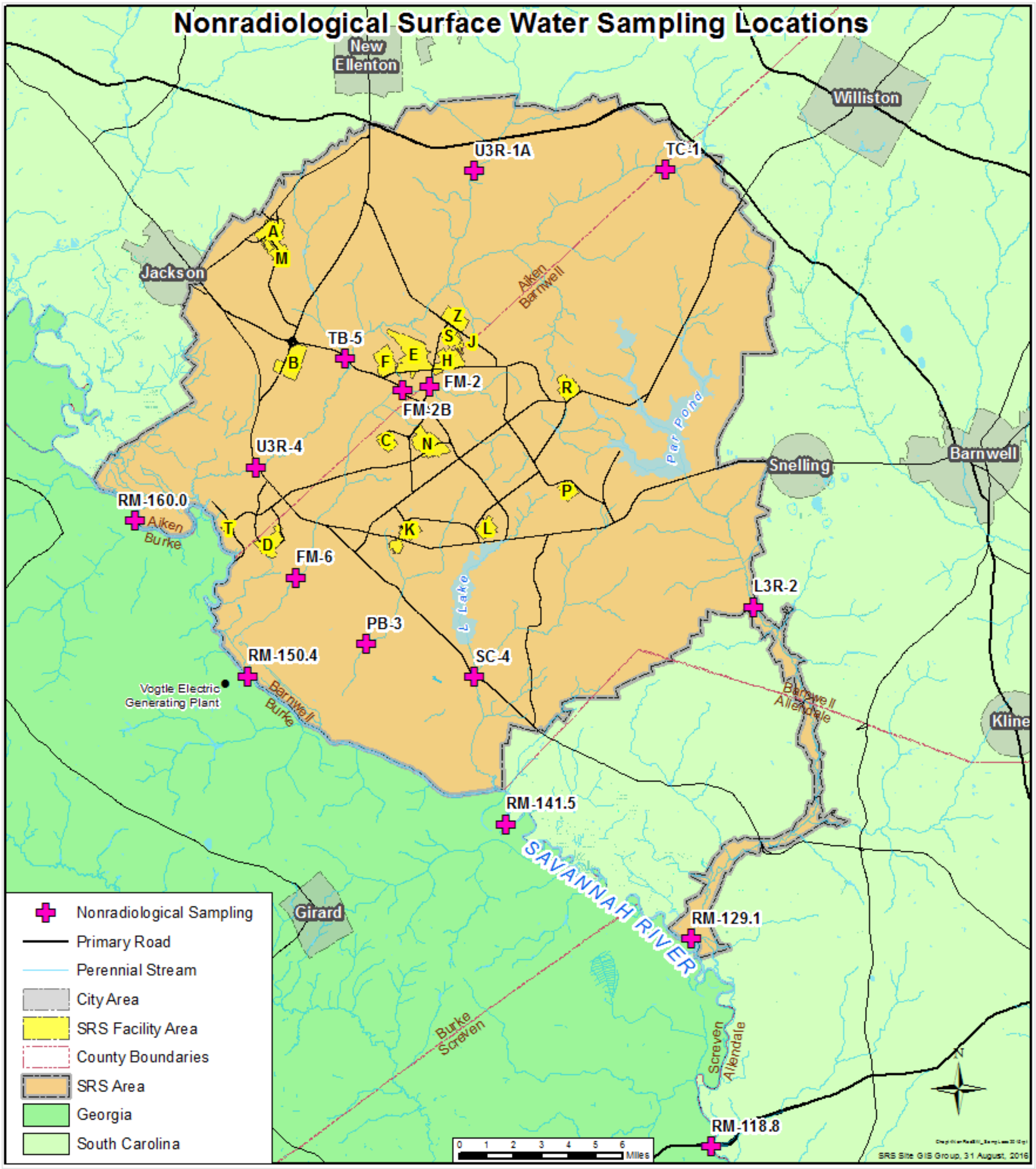


Figure 4-4 Nonradiological Surface Water Sampling Locations

4.3.5 Streams and River Sediment Monitoring

SRS's nonradiological sediment surveillance program provides a method to determine the deposition and accumulation of nonradiological contaminants in stream systems and the Savannah River. One of the important contaminants measured is mercury. Mercury is a contaminant that could pose a health exposure risk to humans through various pathways including drinking water and fish. Mercury enters waterbodies naturally through volcanic activity and mineral weathering of rocks over time, as well as through industrial and urban sources such as coal-burning power plants. Mercury that is released into the air may eventually settle into or be washed into water, where it deposits onto streambeds and wetlands.

The nonradiological sediment program collects sediment samples at various stream, basin, and Savannah River locations (Figure 4-5). The locations vary from year-to-year depending on the rotation schedule agreed upon with SCDHEC. SCDHEC performs duplicate sampling at various locations onsite as a quality control check of the SRS program. In 2015, SRS sampled 13 onsite stream locations, four basin locations, and nine Savannah River locations.

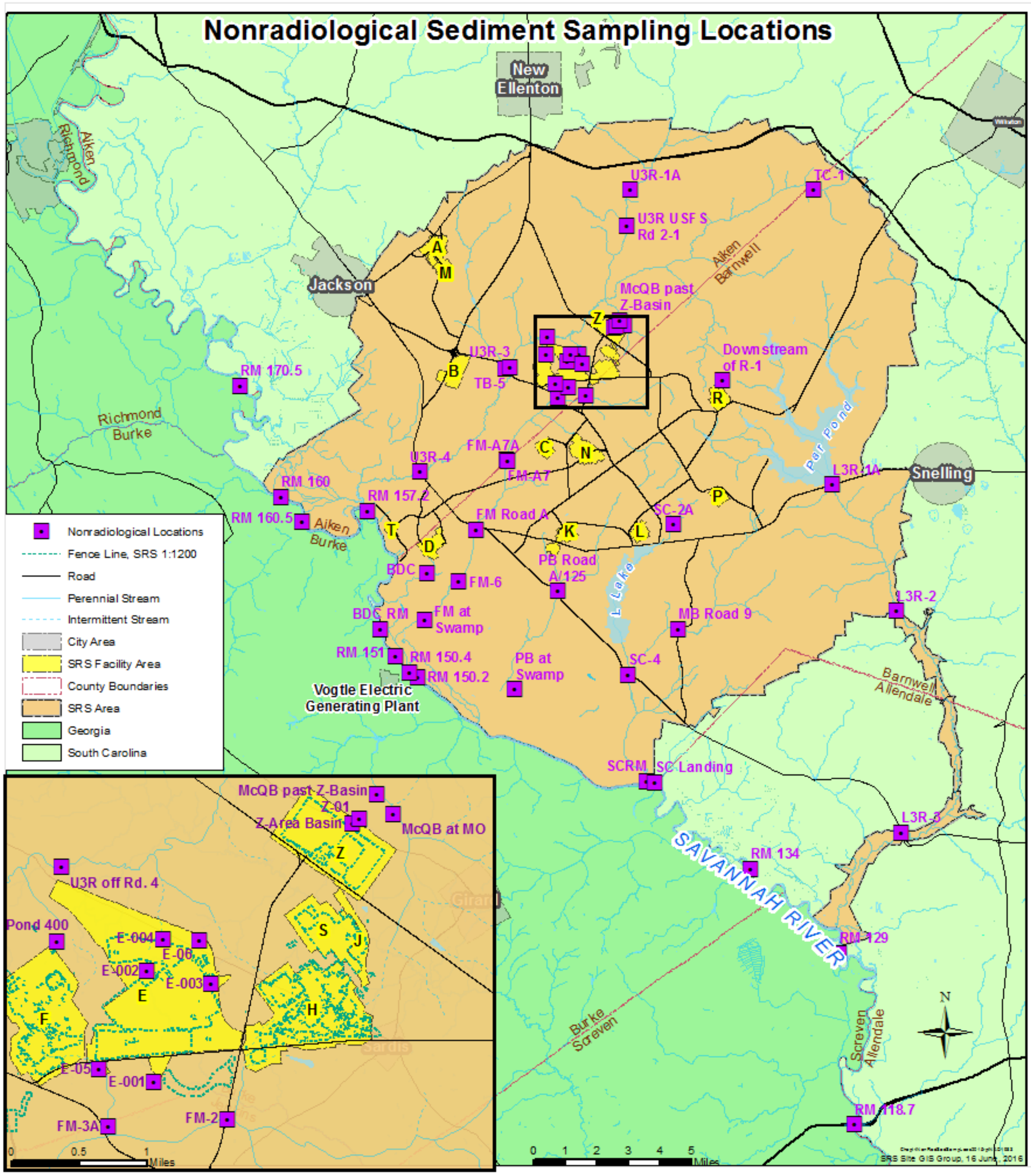


Figure 4-5 Nonradiological Sediment Sampling Locations

4.3.5.1 Stream and River Sediment Results Summary

Samples are analyzed for various inorganic contaminants, metals and cyanide to determine if there is a human health risk from exposure to sediments. The EPA has Regional Screening Levels for Residential Soil that were used for comparison.

In 2015, all mercury results for river sediment samples were below the lowest levels the laboratory can detect (practical quantitation limit). Five samples from onsite stream locations contained mercury that ranged from 0.017 mg/kg in Steel Creek to 0.33 mg/kg in Beaver Dam Creek. All mercury results were well below the EPA Regional Screening Level for resident soil (Figure 4-6).

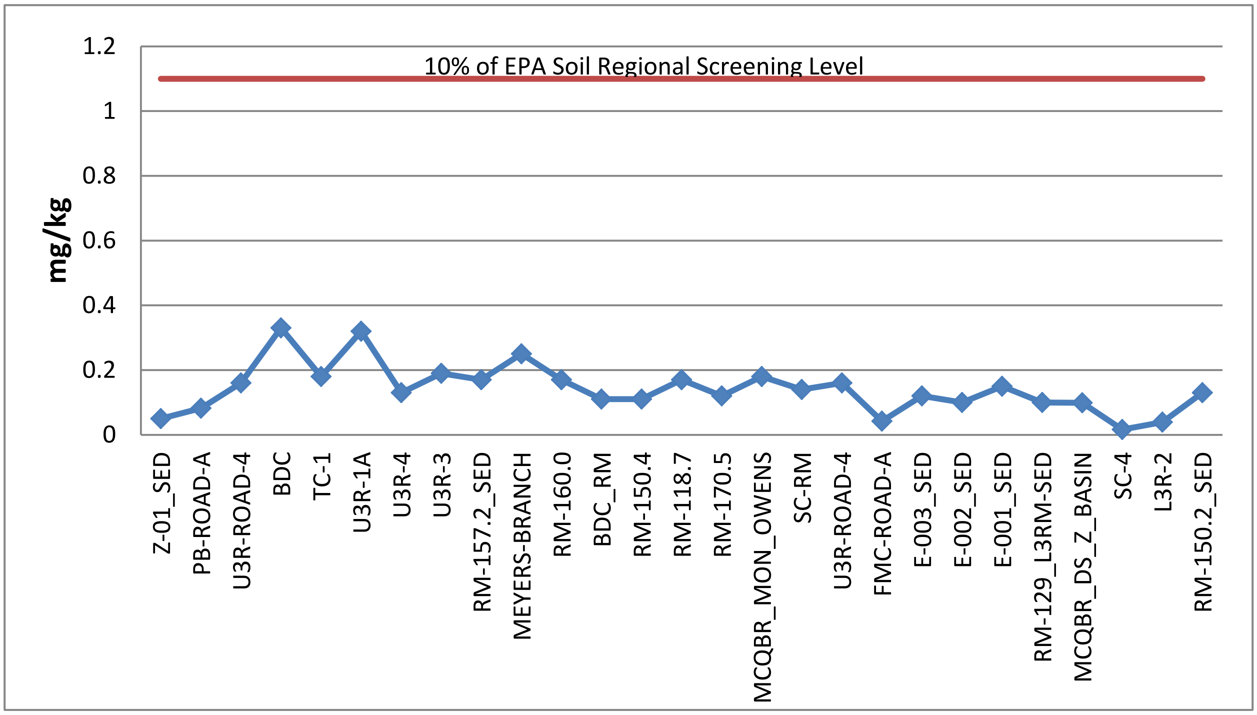


Figure 4-6 Mercury in Sediment Locations

Metals results for river and stream sediments showed some metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, uranium, and zinc) with levels greater than the practical quantitation limit for 2015, but were consistent with those seen in the background control location in Upper Three Runs and comparable to those of the previous five years.

4.3.6 Fish Monitoring

SRS collects samples of aquatic species to identify and evaluate any impact of Site operations on contaminant levels in fish. Freshwater fish (i.e., bass, catfish, and panfish) are collected at six locations on the Savannah River from above SRS at Augusta, Georgia to the coast of Savannah, Georgia. Freshwater fish are collected at the mouth of the streams that flow through the Site. Saltwater fish (i.e., red drum and mullet) are collected at the Savannah River mouth near Savannah, Georgia. SRS analyzes samples of the edible flesh for metals uptake. Nonradiological analyses are performed for mercury, arsenic, cadmium, chromium, copper, lead, manganese, nickel, zinc, and antimony.

4.3.6.1 Fish Results Summary

In 2015, 140 fish flesh samples were collected and analyzed for a total of 1,400 individual analyses. The majority (56%) of the results were non-detected (less than the method detection limit). Appendix Tables D-2 and D-3 present summaries of the analytical results. Two hundred twenty-nine (229) results of the 1,400 individual analyses were detected and quantified (16%), with the majority of these results being for mercury (84) and zinc (140).

A Field Technician Nets a Fish for Analysis

Review of the 2015 zinc data indicate the results for the SRS creek mouths is comparable with the results for the control location at the New Savannah Bluff Lock and Dam. Review of mercury data for the period 2011 through 2015 (Figure 4-7) indicates the results from 2014 and 2015 are similar with values for bass showing higher levels during this two-year period than from 2011 through 2013. Mercury data for catfish and panfish in 2015 are consistent with the results for the five-year period (2011-2015).

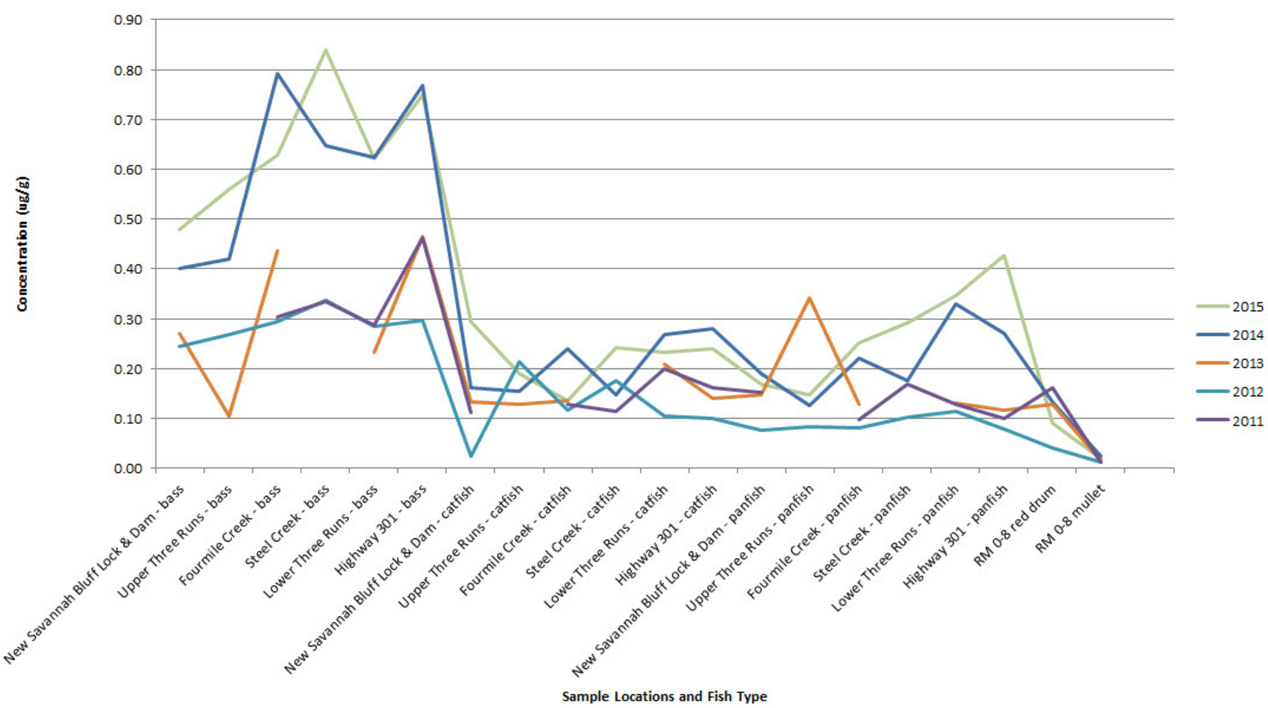


Figure 4-7 Mercury in Fish by Location and Species

4.4 SAVANNAH RIVER NATIONAL LABORATORY (SRNL) ASSESSMENT OF MERCURY IN THE SRS ENVIRONMENT

In 2012 the Agency for Toxic Substances and Disease Registry published a report on the assessment of biota exposure to mercury originating from SRS (ATSDR 2012). In an effort to address the conclusion that the mercury contribution to the Savannah River from SRS activities is not known, SRNL conducted a review of existing literature, monitoring data, and a comprehensive accounting of the mass balance of mercury usage and deposition from offsite sources to the SRS. The results are compiled in a report entitled, “2015 Assessment of Mercury in the Savannah River Site Environment and Responses to the Agency for Toxic Substances and Disease Registry 2012 Report on the Assessment of Biota Exposure to Mercury Originating from the Savannah River Site” (Kuhne et al. 2015).

SRS continues to conduct routine monitoring of biota, water, sediment and rainwater for analyses of mercury. SRS has enhanced environmental activities to address recommendations made by the Agency for Toxic Substances and Disease Registry including the identification of biota consumed by humans residing near SRS and the monitoring of those biota including alligators, rabbits, squirrels, ducks, turtles and other small animals through the Savannah River Ecology Laboratory. SRNL personnel are continuing to address contributions of mercury to the site from atmospheric deposition pathways and identifying remediation strategies for contaminated locations. Continued monitoring of sediment shows no accumulation of mercury in tributary sediments. Concentrations in freshwater fish show a downward trend in species starting from 2009 and continuing into 2013 (latest data available during preparation of the SRNL report) with levels decreasing in catfish to panfish. Measurements in a small number of alligators indicate that mercury levels are consistent with those found in freshwater fish.

4.4.1 Precipitation Chemistry and Deposition

The SRS nonradiological atmospheric monitoring program includes collection of samples and monitoring data to calculate air emissions from Site sources and for the National Atmospheric Deposition Program (NADP). The NADP monitors the geographic distribution of specific airborne contaminants.

SRS sponsors a collection station in support of the NADP. This station, located near the center of the SRS at the SRNL Central Climatology facility, collects weekly precipitation (rain, sleet, and snow) samples and submits them to NADP laboratories for chemical analysis. Since 2001, this station has been part of the Mercury Deposition Network (MDN) of the NADP. The MDN provides data on the geographic distributions and trends of mercury in precipitation. Mercury is emitted into the atmosphere and surface waters from natural sources, including volcanoes and wildfires. It also occurs naturally in some soils. Yet most of the attention on mercury in the environment has focused on anthropogenic sources: coal combustion, medical waste incineration, and chlorine production, among others. The MDN is the only network providing a long-term record of mercury concentrations in North American precipitation. All monitoring sites follow standard procedures and have uniform precipitation collectors and gauges. Beginning in 2012, the station at SRS was added to the National Trends Network (NTN). This network tracks changes in acid deposition precipitation (commonly referred to as acid rain).

Sample analysis associated with the NTN network includes free acidity (pH), conductivity, calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, and ammonium. In addition to supporting national-scale observations relating to trends in precipitation chemistry, results from this surveillance provides specific information related to the chemistry of precipitation at SRS.

4.4.1.1 Precipitation Chemistry and Deposition Results Summary

During calendar year 2014 (the last year for which data are available) the average (volume weighted) concentration of total mercury in precipitation was 9.2 ng/L and the wet deposition rate was 10.8 µg/m^2. These observations are consistent with historical observations associated with this surveillance and are consistent with other observations from the southeastern United States. Data from 2015 will not be available until the fall of 2016. Additional information on the MDN as well as the location and data from surrounding stations is accessible via the following link: http://nadp.sws.uiuc.edu/mdn/.

The results from the precipitation results for calendar year 2014 are presented in Appendix Table D-4. Additional information on the NTN is accessible via the following link: http://nadp.sws.uiuc.edu/NTN/.

5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The Savannah River Site (SRS) Radiological Environmental Monitoring Program (REMP) monitors any effects SRS operations have on the environment and demonstrates compliance with applicable U.S. Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and U.S. Department of Energy (DOE) standards. REMP at SRS is designed to detect and identify the effects, if any, of SRS operations on human health and the environment. Thousands of samples are collected throughout the year and analyzed for radionuclides that could be present from SRS operations. Samples are collected both onsite and in the communities surrounding SRS. State and federal regulations drive some of the monitoring conducted at SRS, such as limitations on discharges to air and water. DOE Orders 231.1B, Environment, Safety and Health Reporting, and 458.1, Radiation Protection of the Public and Environment, also address environmental monitoring requirements.

2015 HIGHLIGHTS

Air and Water Pathways

The atmospheric and water contaminants released from SRS were all below permit limits and applicable standards. Radiological results for surveillance media associated with the airborne and liquid pathways were within expected historical levels when compared to background.

Wildlife Surveillance

All animals harvested during the annual hunts on the SRS are monitored to ensure the total dose to any hunter is below the SRS 22 mrem/year limit. Monitoring of the deer, feral hogs, turkeys, and coyotes harvested during annual hunts resulted in the release of 449 animals.

5.1 INTRODUCTION

Environmental monitoring programs at SRS examine both radiological and nonradiological constituents that could be released to the environment as a result of SRS activities. Nonradiological monitoring was discussed previously in Chapter 4, “Nonradiological Environmental Monitoring Program.”

The REMP involves monitoring of radiological contaminants from both atmospheric and liquid point-sources, as well as the collection and analysis of environmental samples from numerous locations throughout SRS and the surrounding area offsite. Monitoring of radiological analytes is required to assess the environmental impact of Site operations on SRS and the surrounding area from routine and non-routine releases from SRS facilities.

Chapter 5 – Key Terms

<u>Derived concentration standard</u> *is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in a dose of 0.1 rem (1 mSv).*

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

<u>Environmental monitoring</u> *is the collection of samples of, or data on, air, water, soil, foodstuffs, biota, and other media from the environment. The samples are used to measure the amount of radioactivity and other contaminants in the environment.*

<u>Exposure pathway</u> *is the way that a person could be impacted from releases of radionuclides into the water and air.*

<u>Fallout</u> *is the settling to the ground of airborne particles ejected into the atmosphere from the earth by explosions, eruptions, forest fires, etc. or from human production activities such as found at nuclear facilities.*

<u>Emission</u> *is the release of a gas.*

<u>Thermoluminescent Dosimeter (TLD)</u> *is a passive device that measures the exposure from ionizing radiation.*

The REMP is divided into two focus areas: 1) effluent monitoring, and 2) environmental surveillance. Sampling frequency and analyses conducted are determined by permit-mandated monitoring requirements and/or federal regulations.

SRS gauges the effluent monitoring program against DOE derived concentration standards (DCSs) by comparing the annual average concentrations to the DOE DCSs as documented in DOE Derived Concentration Technical Standard (DOE 2011) and in accordance with DOE Order 458.1, "Radiation Protection of the Public and the Environment." These DCSs are applicable at the point of discharge and the SRS uses them as a screening method to determine if existing effluent treatment systems are appropriate and effective. SRS uses the same DCSs as reference concentrations for conducting environmental protection programs. These DCSs are used by all DOE sites.

SRS designed the radiological surveillance program to sample the types of media that may be impacted by Site Operations. Figure 5-1 shows the liquid and airborne pathways, as well as the types of media sampled through those pathways.

SRS conducts radiological environmental monitoring activities for the following:

- Atmospheric (airborne emissions, airborne filters, airborne moisture, rainwater),
- Vegetation,
- Soil,
- Food Products (milk, meat, fruit, nuts, green vegetables),
- Water (stream, river, drinking water, stormwater basins),
- Stream and River Sediment,
- Aquatic Food Products
- Wildlife

The sampling results provide the data needed to assess the exposure pathways for the people living near the SRS, as documented in Chapter 6, "Radiological Dose Assessment." Appendix Table C-1 of this document provides a summary of the radiologial surveillance sampling media and frequencies.
All raw data associated with the SRS sampling efforts described in this chapter are documented in *the 2015 Environmental Monitoring Program Data Report* (SRNS 2016a).

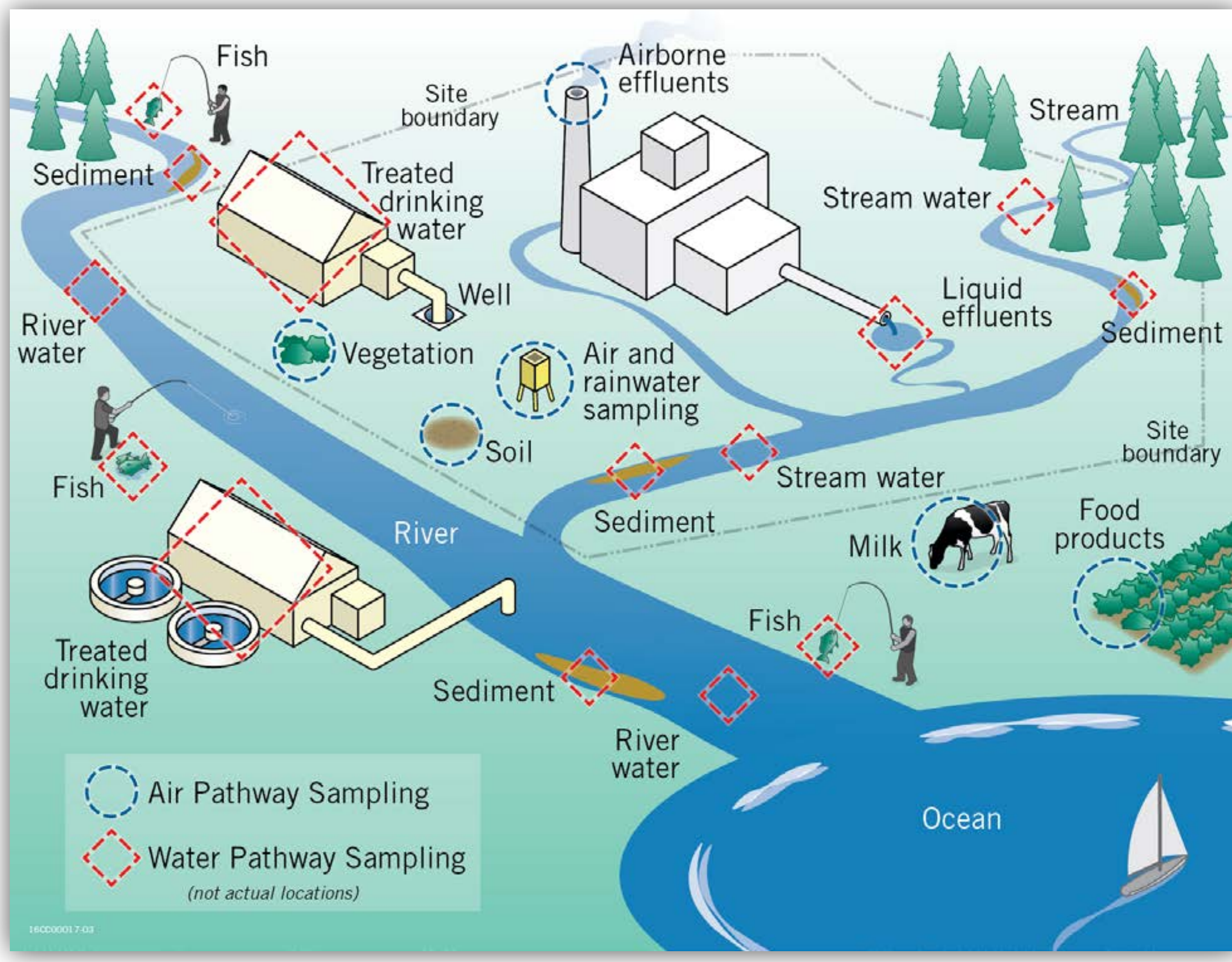


Figure 5-1 Radiological Air and Liquid Pathway Samples

5.2 SRS OFFSITE MONITORING

Offsite monitoring involves collecting and analyzing samples of air, river water, soil, sediment, vegetation, milk, food products, fish, and other media from many locations. SRS analyzes these samples for radioactive contaminants to monitor any effects SRS operations have on the environment and assess long-term trends of the contaminants in the environment. SRS collects samples beyond the SRS perimeter in Georgia (GA) and South Carolina (SC) at 25 and 100 miles from the Site. Additionally, the SRS collects samples at the population centers of Aiken, Allendale, Barnwell, New Ellenton, North Augusta, and Williston in South Carolina and Augusta, Savannah, and Waynesboro in Georgia.

SRS monitors the Savannah River at River Mile 118.8 (Georgia Welcome Center at Highway 301), locations downriver of each SRS stream entry point, and above the Site at River Mile 160 as a control location. Figure 5-2 displays the SRS offsite environmental sampling locations. Chapter 7, "Groundwater Management Program" provides information on the SRS groundwater monitoring activities. Table 5-1 summarizes the SRS offsite radiological sampling performed in Georgia and South Carolina, excluding samples collected in the Savannah River.

Table 5-1 SRS Offsite Radiological Sample Distribution by State

Environmental Media	Approximate Number of Samples (Number of Locations)	
	South Carolina	Georgia
Air Filters	28 (1)	56 (2)
Silica Gel	26 (1)	54 (2)
External Ambient Gamma Radiation Monitoring (thermoluminescent dosimeters[TLDs])	160 (7)	80 (4)
Rain Ion Columns	0 (0)	13 (1)
Rainwater	13 (1)	26 (2)
Food Products	19 (20)	4 (5)
Milk	16 (4)	16 (4)
Soil	1 (1)	3 (3)
Vegetation (nonedible)	1 (1)	2 (1)
Drinking Water	24 (2)	0 (0)
Total	**288 (38)**	**254 (24)**

Note: This table excludes groundwater monitoring locations/samples which are discussed in Chapter 7, "Groundwater Management Program."

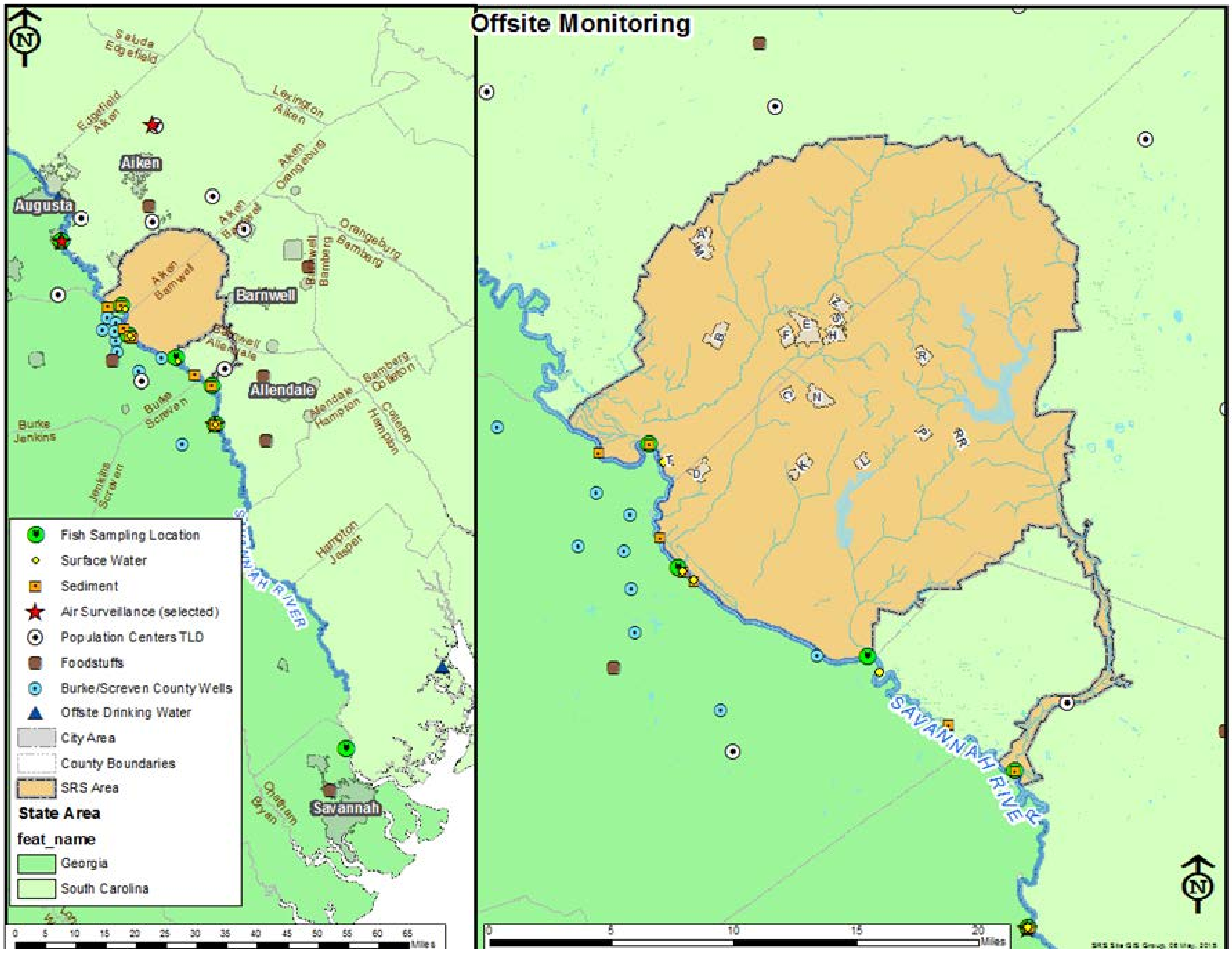


Figure 5-2 SRS Offsite Sampling Media Locations for Georgia and South Carolina

5.3 AIR PATHWAY

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

5.3.1 Atmospheric Monitoring

SRS conducts atmospheric monitoring to determine whether airborne radionuclides from SRS emissions have reached the environment in measurable quantities and to ensure that radiation exposure to employees and the public remain below regulatory limits. In order to demonstrate compliance with radiation dose standards established by the EPA and DOE for public protection, SRS performs radiological atmospheric effluent monitoring at the point of discharge of airborne radionuclides from operating SRS facilities. The SRS conducts additional atmospheric sampling at air monitoring stations along the SRS perimeter and within communities surrounding SRS.

Radionuclides present in and around the SRS environment are from a number of sources, including natural background, fallout from historical atmospheric testing of nuclear weapons, offsite nuclear power plant operations, and SRS operations. Tritium in elemental and oxide forms make up the majority of the radionuclide emissions from SRS to the air. The amount of tritium released from SRS varies yearly, based on mission activities and on the annual production schedules of the tritium processing facilities.

5.3.2 Airborne Emissions

EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) program establishes the limits for radionuclide emissions detailing the methods for estimating and reporting radioactive emissions from DOE-owned or operated sources.

SCDHEC regulates radioactive airborne pollutant emissions from SRS sources. SCDHEC issues Clean Air Act Part 70 Air Quality Permits for each major source of airborne emissions on the SRS. Each permit has specific limitations and monitoring requirements.

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

- Data obtained from monitored airborne effluent release points,
- Calculated releases of unmonitored isotopes from the dissolution of spent fuel, and
- Estimates for unmonitored sources based on approved EPA calculation methods.

SRS monitors the emissions from process area stacks at facilities that release or have the potential to release airborne radioactive materials. SRS typically uses laboratory analyses of samples to determine concentrations of radionuclides in airborne emissions. Airborne effluent samples are collected on filter papers for particulates, on charcoal sampling media for gaseous iodine, and in a bubbler solution for airborne tritium. For some stacks, SRS uses inline monitoring systems to determine airborne tritium emissions instead of laboratory analyses.

5.3.2.1 Airborne Emissions Summary

SRS uses a variety of methods to estimate atmospheric emissions, including periodic sampling systems or approved calculation methods. Depending on the processes involved, SRS may also use real-time instrumentation to monitor discharge stacks to determine instantaneous and cumulative releases (e.g., of tritium) to the atmosphere.

Each year, SRS calculates radionuclide release estimates (in curies [Ci]) from unmonitored diffuse and point sources. Point sources include stacks or other exhaust points, such as vents. In contrast, emissions from diffuse sources are not actively ventilated or exhausted. Diffuse emissions may not originate from a single location, but are released over a larger discrete area. SRS diffuse sources include research laboratories, disposal sites and storage tanks, and deactivation and decommissioning activities. Appendix Table E-1 presents these estimates in the SRS radioactive release totals.

SRS calculates emissions from unmonitored releases using the methods contained in Appendix D of EPA's NESHAP regulations (EPA 2002). Because these methods employ conservative assumptions, they generally lead to overestimation of actual emissions. Although SRS does not monitor these releases at their source, SRS uses onsite and offsite environmental surveillance monitoring to assess the impact, if any, of unmonitored releases.

Figure 5-3 depicts the amount of SRS tritium releases. The annual average tritium released during the past 10 years is 29,290 Ci with a range between about 17,000-41,000 Ci per year. The 2015 tritium emissions of 19,100 Ci is significantly below this ten-year average. Compared to the 27,300 Ci of tritium released in 2014, SRS tritium releases decreased by 30% in 2015. Reduced emissions from the five tritium processing facilities account for the decreased tritium releases. One building in the tritium processing facilities was shut down in 2015, causing a significant reduction in tritium releases. Activities which were required to prepare for shutdown caused increases in tritium releases in 2013 and 2014.

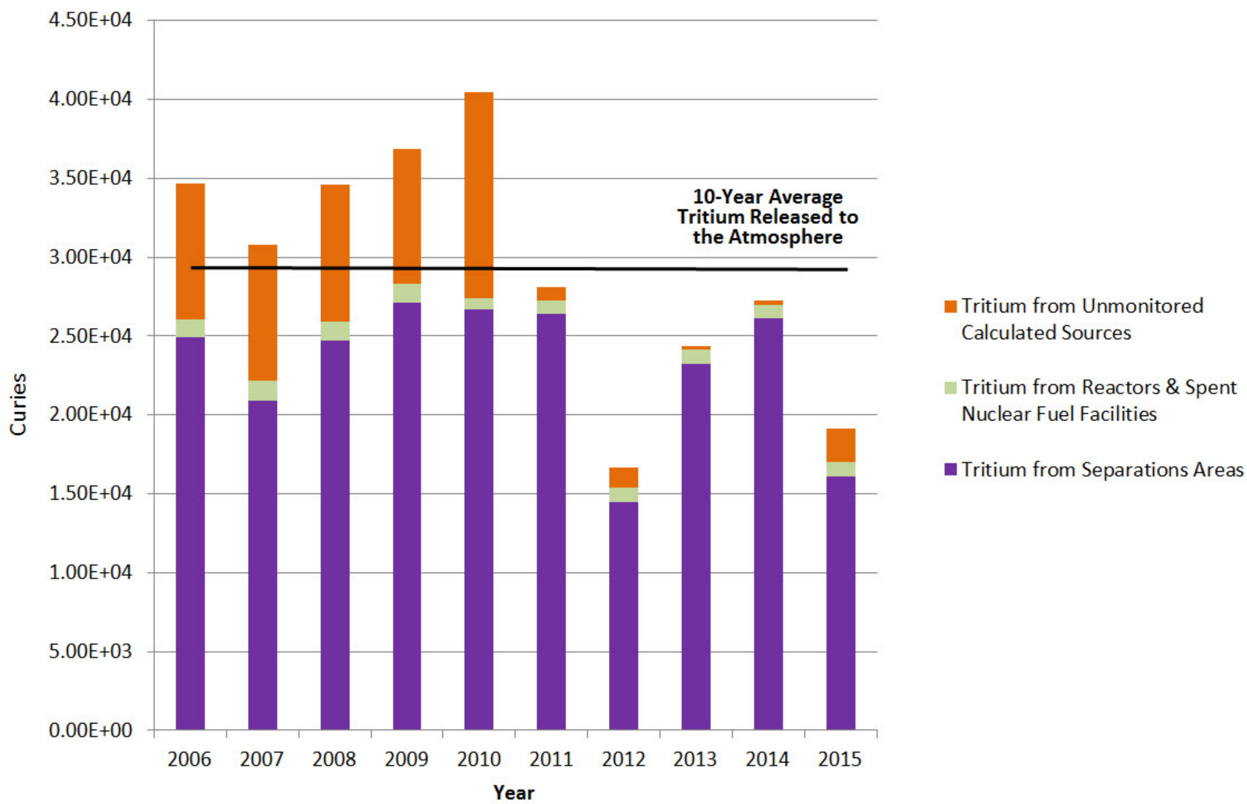


Figure 5-3 Ten-Year History of SRS Annual Tritium Releases to the Atmosphere

In 2015, tritium accounted for more than 87% of the total radioactivity released to the atmosphere from SRS operations. Tritium processing facilities are responsible for 84% of the SRS tritium releases, while the dissolution of spent nuclear fuel in H Canyon resulted in the release of less than 1% of the SRS tritium releases. The combination of releases from the tritium processing facilities and the dissolution in H Canyon comprise the releases from Separations Areas. The Separations Areas, Reactors and Spent Nuclear Fuel Facilities, and Unmonitored Sources are shown in Appendix Table E-1 and Figure 5-3 and Figure 5-4. The estimated tritium releases from unmonitored sources increased in 2015. Based on the review of the unmonitored emission sources for the 2015 reporting period, SRS identified and implemented a more conservative method to calculate tritium emissions from several sources located at the Solid Waste Management Facility.

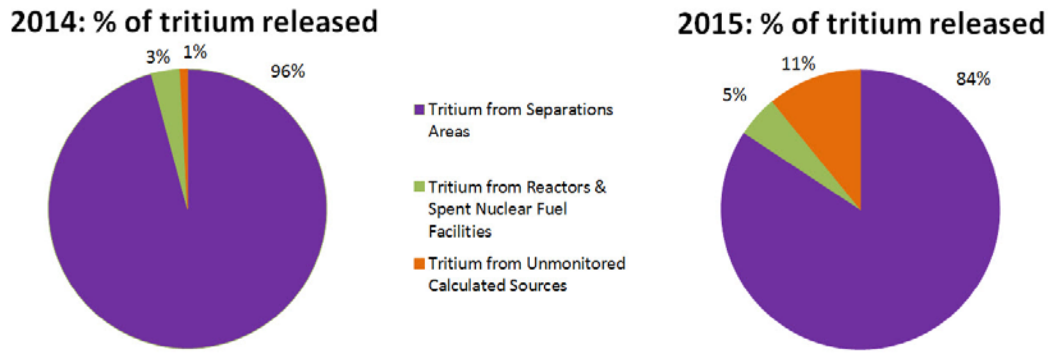


Figure 5-4 Percent of Tritium Released to the Atmosphere for 2014 and 2015

Appendix Table E-2 provides a summary of the 2015 air effluent DCS sum of fractions. The specific radionuclide average concentrations and associated DOE DCS for each monitored discharge point within the facilities are included in the raw data (SRNS 2016a). These concentrations correspond only to isotopic emissions that occur during sampling events. The average concentration is determined only if there is at least one statistically significant result for the isotope. However, concentrations for other periods are represented in the radionuclide dose assessment, including any time between stack samples, gross alpha and gross beta results, and emissions estimated using calculations (i.e., unmonitored diffuse and point) (Jannik and Dixon, 2016). The raw data (SRNS 2016a) contains calculated concentrations for tritium from the reactor areas and from the tritium processing facilities and for krypton-85, carbon-14, and tritium from the H Canyon facility during dissolving operations. These calculated concentrations are based on the annual releases in Curies and the annual stack volume.

Most of the SRS stacks and facilities release small quantities of radionuclides at concentrations below the DOE DCSs. Because of the nature of the operations and the comparison of DCSs to measured concentrations at the release point, C Area, K Area, L Area, and the tritium facilities exceed the tritium DCS. However, the offsite dose from all airborne releases remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv). Chapter 6, "Radiological Dose Assessments" discusses this further.

5.3.3 Atmospheric Surveillance

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

The sampling stations are located at the center of SRS, around the Site perimeter, in population centers 25 miles from SRS, and at a control location, the Georgia Welcome Center in Screven County nearly 25 miles from SRS (assumed to be un-impacted by SRS operations). SRS placed air-sampling stations near the Site boundary and beyond to be representative of the atmospheric distribution of airborne releases into the environment. Each atmospheric sampling station consists of all or some of the following components listed in Table 5-2. Rain ion exchange columns are placed at six of the 14 locations. Rainfall washes the dry deposition material (particles) through the column.

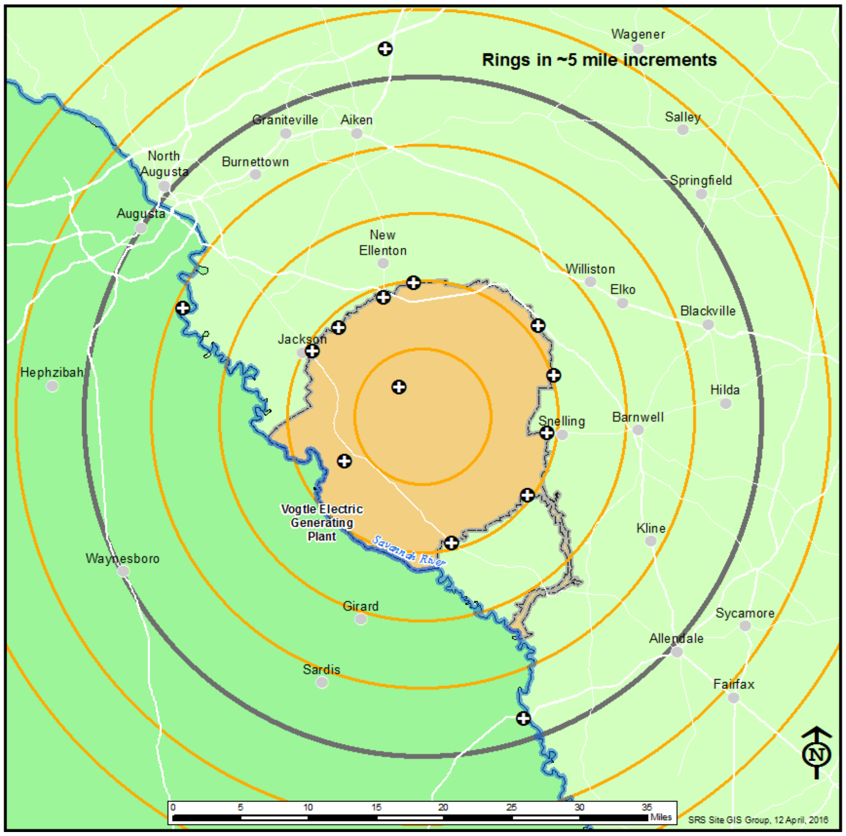


Figure 5-5 Air Sampling Locations Surrounding SRS up to 25 Miles

Table 5-2 Atmospheric Sampling Media

Media	Purpose	Radionuclides
Glass-Fiber Filter	Airborne Particulate Matter	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides
Charcoal Canister	Gaseous States of Radioiodine	Iodine-129, Iodine-131, gamma-emitting radionuclides
Silica Gel	Tritiated Water Vapor	Tritium
Rain Ion Column	Wet and Dry Deposition	Gamma-emitting radionuclides, gross alpha/beta-emitting radionuclides, total strontium, actinides (plutonium, americium, uranium, curium, and neptunium)
Rainwater	Tritium in Rainwater	Tritium

SRS selected the radionuclides presented in Table 5-2 based on known SRS airborne emission sources. Background levels in the atmosphere consist of naturally occurring radionuclides (e.g., uranium, thorium, and radon) and radionuclides (e.g., strontium-90, cesium-137) from global fallout due to historical nuclear weapons testing.

Above: Technician Prepares Rain Ion Exchange Columns

Left: Close-up of Silica Inside Rain Ion Exchange Column

5.3.3.1 Results Summary

Appendix Tables E-3, E-4, and E-5 provide summaries of the atmospheric monitoring results for 2015 and comparison to the background control location at Highway 301. SRS detected elevated levels of gross alpha in all environmental filters during December of 2015. SRS analyzed the samples for gross alpha-specific radionuclides to determine the source of the elevations. Alpha specific results indicated positive thorium and uranium that exist naturally in the environment. With the exception of the elevated gross alpha levels in December of 2015, all other radionuclides for surveillance air sampling media (Table 5-2) were within the historical trend levels for the previous ten years. All offsite location results were near the levels observed at the background control location at Highway 301.

Tritium-in-air results for 2015 were comparable or slightly lower than those observed in 2014 and the previous five years. Results showed detectable levels in 75 of 347 (22%) samples for 2015. As shown in previous years, tritium levels decrease to levels at or below background once offsite.

Tritium-in-rainwater results showed detectable levels in 18 of the 182 rainwater samples (10%) for 2015 with levels similar to the previous five to ten years. Concentrations from all locations are below the EPA drinking water standard of 20,000 pCi/L. As in previous years, values were highest near the center of the SRS and decreased with distance from the Site (SRNS 2016a). Appendix Table E-5 provides a summary of the tritium-in-rainwater results.

5.3.4 Ambient Gamma Surveillance

SRS has been monitoring ambient (surrounding) environmental gamma exposure rates with thermoluminescent dosimeters (TLDs) since 1965 to determine the impact of Site operations on the gamma exposure to the public and the environment and to evaluate trends in exposure levels. Other uses include support of routine and emergency response dose calculations.

An extensive network of TLDs in and around SRS monitors external ambient gamma exposure rates (Environmental Maps "SRS Thermoluminescent Dosimeter (TLD) Sampling Locations"). The SRS ambient gamma radiation-monitoring program has four subprograms: Site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor exposures from Georgia Power's Vogtle Electric Generating Station). Most gamma exposure monitoring is conducted onsite and at the SRS perimeter.

SRS conducts offsite monitoring in population centers within nine miles of the Site boundary, but only limited monitoring beyond this distance and at the 25-mile air surveillance stations.

5.3.4.1 Ambient Gamma Surveillance Results Summary

Ambient gamma exposure rates at all TLD monitoring locations show some variation based on normal site-to-site and year-to-year differences in the components of natural ambient gamma radiation exposure levels. In 2015, ambient gamma exposure rates varied between 73 mR/yr at location NRC2 (onsite southwest) and 137 mR/yr at location Burial Ground North (center of the site) (SRNS 2016a). Population centers ranged from 98 mR/yr at the Windsor location to 129 mR/yr at the Williston location.

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

5.3.5 Soil Surveillance

SRS conducts soil surveillance to provide:

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

SRS collected soil samples in 2015 from five onsite locations, ten Site perimeter locations, and three offsite locations (Environmental Maps "Radiological Soil Sampling Locations"). Concentrations of radionuclides in soil vary greatly among locations because of differences in rainfall patterns and retention and transport in different types of soils. Therefore, a direct comparison of data from year-to-year could be misleading. However, SRS evaluated the data for long-term trend analysis.

Soil sampling involves the use of hand augers, shovels, or other similar devices for collection to a depth of 3 inches. SRS analyzes these samples for gamma-emitting radionuclides, strontium-89,90, and the actinides.

5.3.5.1 Soil Results Summary

In 2015, SRS detected radionuclides in soil samples from all 18 sampling locations (five onsite, ten at the perimeter, and three offsite). Increasing uranium-234, uranium-235, and uranium-238 trends were observed at many of the locations with the maximum level of 3.73 (uranium-234) pCi/g observed near the center of the site and the control location (Highway 301) at 1.79 pCi/g (uranium-234). Uranium is naturally occurring in soil and expected to be present in the environment. Naturally occurring uranium in soil typically ranges from about 1 to 5 pCi/g with the average U.S. soils about 2 pCi/g. There are many factors that affect the uranium concentration in soil that over time could have caused the increasing trend. These include the pH of the soil, the type of soil, and deposits from the air caused from rainfall. Organic matter and clay minerals provide exchange sites in soil which can increase the uranium sorption. This increasing trend will continue to be evaluated in the surveillance program but at this point no action levels have been exceeded; all levels were below the EPA's Soil Screening Levels for ingestion of home produce (5.9 pCi/g for uranium-234, 5.77 pCi/g uranium-235, and 4.65 pCi/g uranium-238).

The concentrations of other radionuclides at these locations are consistent with historical results, with the maximum cesium-137 concentration found at onsite perimeter air station Darkhorse (northeast perimeter) at 0.37 pCi/g and the control location (Highway 301) at 0.15 pCi/g. Appendix Table E-6 provides a summary of the results.

5.3.6 Grassy Vegetation Surveillance

SRS conducts the radiological program for grassy vegetation from onsite and offsite locations (Environmental Maps "Radiological Vegetation Sampling Locations") to complement soil and sediment samples for evaluation of the environmental accumulation of radionuclides and to help validate SRS dose models. Vegetation can be contaminated externally by airborne radioactive contaminants and by uptake from soil or water by the roots. Bermuda grass is preferred for surveillance because of its importance as a pasture grass for dairy herds. Vegetation sample locations include:

- Locations where soil radionuclide concentrations are expected to be higher than normal background levels,
- Locations receiving water that has the potential to be contaminated, and
- All air sampling locations.

Vegetation sample analyses consist of tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and the actinides.

5.3.6.1 Grassy Vegetation Results Summary

SRS detected various radionuclides in the grassy vegetation samples collected during 2015 at all locations (one onsite, ten at the perimeter, and three offsite). Appendix Table E-7 provides a summary of the results. Results for all radionuclides are within the trends of the previous ten years.

5.3.7 Terrestrial Food Surveillance

SRS personnel collect terrestrial food products grown and consumed in the communities surrounding the Site, as well as aquatic food products harvested from the Savannah River. Samples are analyzed for radionuclides. The results provide information on whether radionuclides are present in the environment and, if present, where the radionuclides are located. Tritium releases from SRS and non-SRS sources are the primary contributors to tritium in food products.

Agricultural products, livestock, and game animals for human consumption may contain radionuclides. Livestock and game animals may be exposed to radionuclides if the radionuclides are in the air. These radionuclides in the air can deposit on grass, which can then be eaten by the animals. If humans consume the meat of these exposed animals, humans become exposed to radiation. In the case of dairy cows, they produce milk that we consume, leading to a potential radiation exposure. SRS samples milk, meat, fruit, nuts, and green vegetables based on the potential to transport radionuclides to people via the food chain.

Local gardens, farms, and dairies are the source of the terrestrial food products. Annually, beef, watermelon, and greens are collected. A variety of vegetables, grains, and nuts are collected on a rotational schedule resulting in two specific crops being collected each year from the four quadrants. Once a quarter, milk samples are collected. Food product samples are collected in each of four quadrants surrounding the SRS and extending 10 miles from the Site boundary. Additionally, the SRS collects a control sample in the southeast quadrant at a distance between 10 miles and 25 miles from the Site boundary.

5.3.7.1 Terrestrial Results Summary

In 2015, the terrestrial foodstuffs sampled were greens, watermelons, beef, pecans and corn. Beef samples from livestock butchered in 2015 were obtained in two of the four quadrants and the control location. No beef samples were identified in the southeast-10 miles and southwest-10 miles quadrants. Laboratory analysis of the food samples includes gamma-emitting radionuclides, tritium, strontium-89,90, uranium-234, uranium-235, uranium-238, neptunium-237, plutonium-238, plutonium-239, americium-241, curium-244, technetium-99, gross alpha, and gross beta. The analytical results of the terrestrial foodstuffs and dairy are consistent with historical trends. A majority of results for the radionuclides associated with foodstuffs is non-detectable (92% for terrestrial foodstuffs and 97% for dairy).

Appendix Tables E-8 and E-9 provide a summary of the foodstuffs and dairy results. The detectable results are near the laboratory instrumentation method detection limits.

5.4 WATER PATHWAY

The media presented in this section support the water pathway dose assessment discussed in Chapter 6, "Radiological Dose Assessment."

5.4.1 Liquid Effluents Monitoring Program

SRS routinely samples, analyzes for radioactivity, and monitors flow at each liquid effluent discharge point that releases, or has potential to release, radioactive materials.

Figure 5-6 shows the effluent sampling points near SRS facilities.

Appendix Table E-10 provides SRS liquid radioactive releases for 2015. The total amount of tritium released directly from process areas to SRS streams during 2015 was 85.6 Ci. This is an increase from the 42.3 Ci released in 2014. As seen in Figure 5-7, Separations Areas experienced a 25.6 Ci increase; this is due to higher tritium concentrations in the waste handled by the Effluent Treatment Plant. Reactor areas saw a 17.7 Ci increase due to normal fluctuations in the amount of water released annually by PAR pond and L-Lake. Although the tritium released in 2015 was higher than 2014, Figure 5-7 shows that the total direct release of tritium has a general decreasing trend over the last ten years.

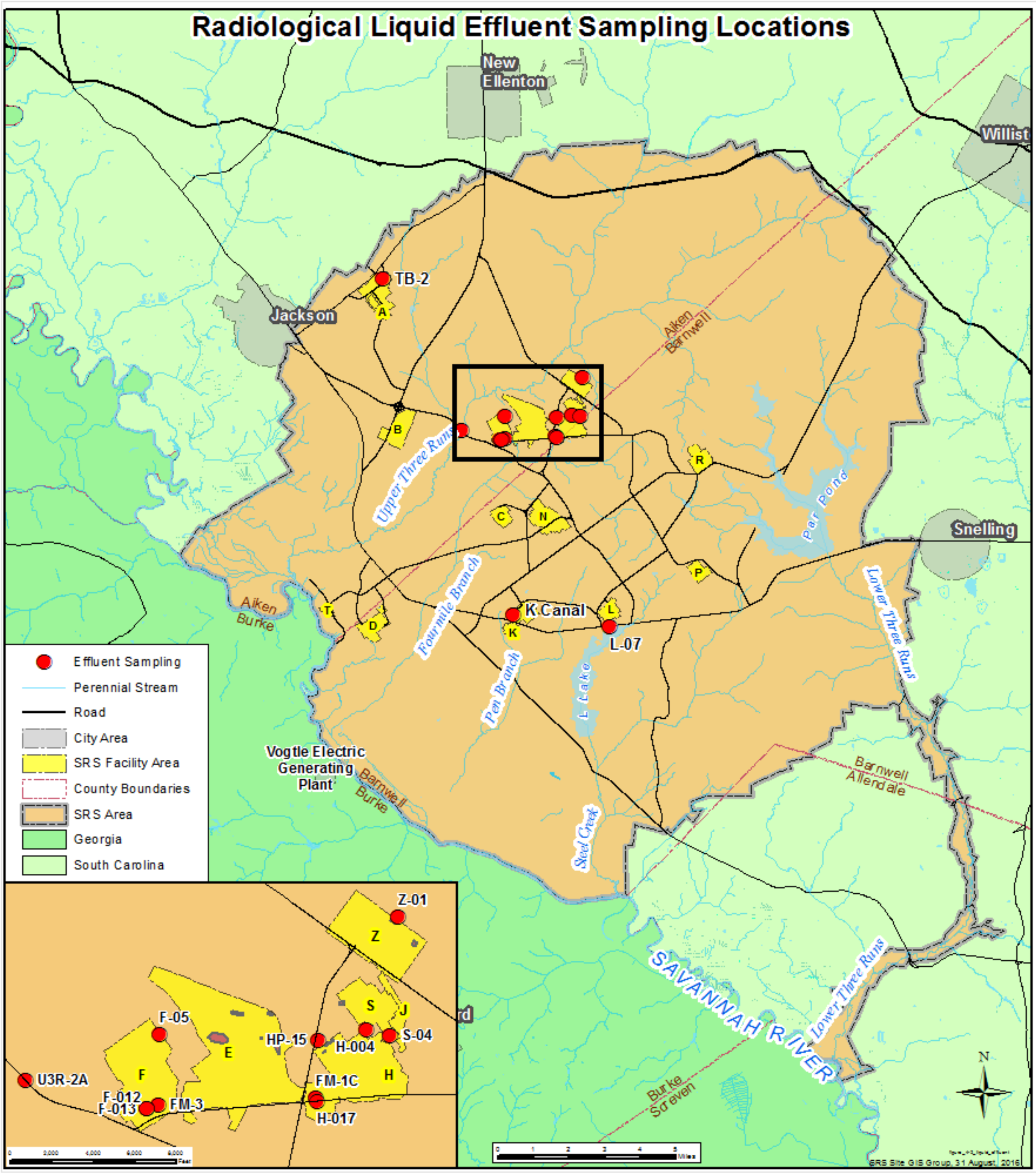


Figure 5-6 Radiological Liquid Effluent Sampling Locations

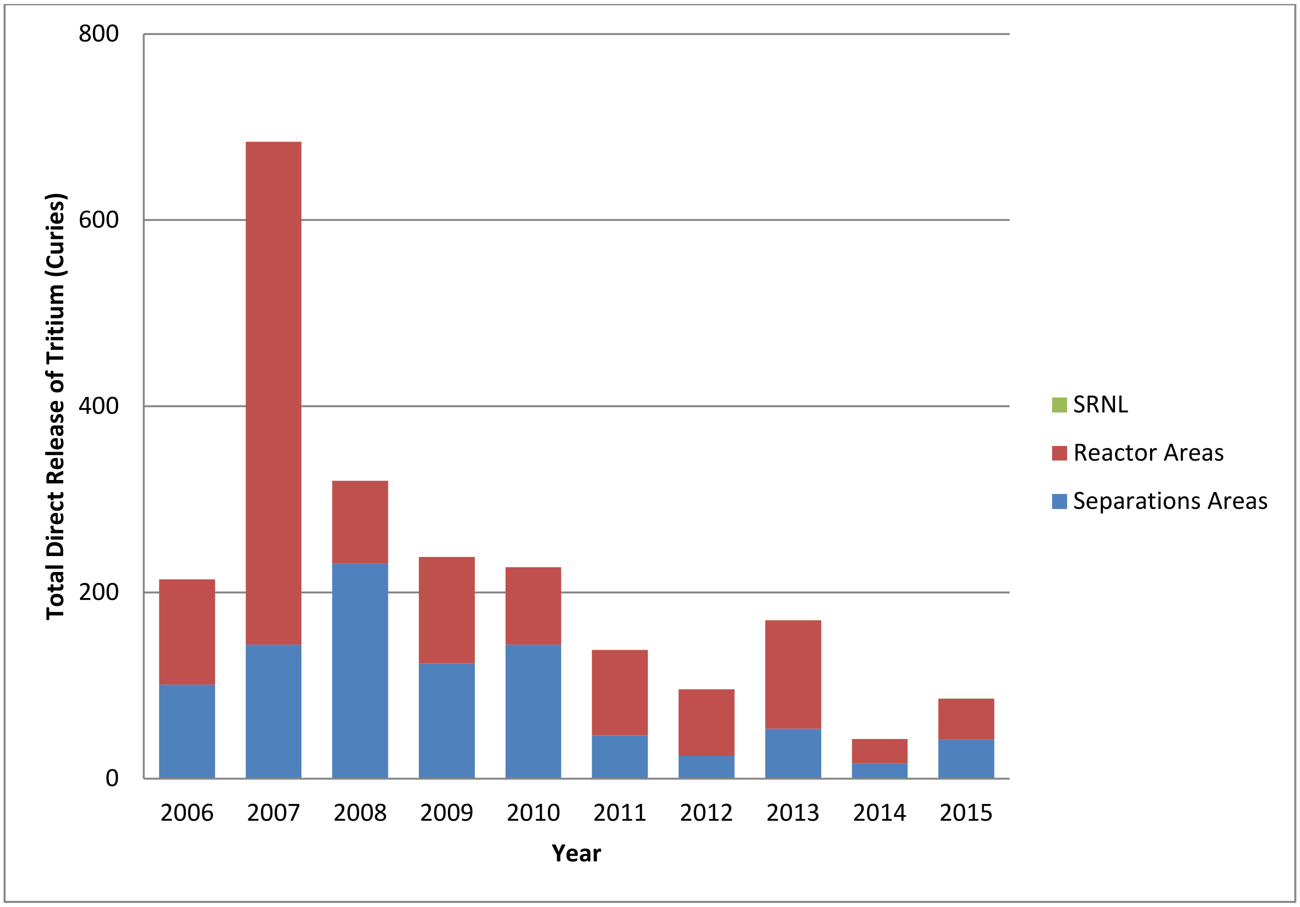


Figure 5-7 Ten-Year History of Direct Releases of Tritium to SRS Streams

NOTE: SRNL contribution to Direct Releases is minimal; thus, not visible on this figure.

5.4.1.1 Liquid Effluent Results Summary

All discharges in 2015 were well below the standards and the DCS sum of the fractions for all locations was less than 1.00. Appendix Table E-11 provides a summary of the 2015 liquid effluent sum of fractions and radionuclides monitored for each outfall or facility. The specific radionuclide average concentrations and associated DOE DCS for each monitored facility and outfall are included in the raw data (SRNS 2016a).

DCSs are based on a 100-mrem exposure and the highly conservative assumption that a member of the public has continuous direct access to the actual liquid at the point of discharge. Because of security controls and the considerable distances between most SRS operating facilities and the SRS boundary, this scenario is highly improbable, if not impossible.

5.4.2 Stormwater Basin Surveillance

SRS performs sampling of stormwater accumulating in the Site's stormwater basins (Figure 5-8) for gross alpha, gross beta, tritium, strontium, gamma-emitting radionuclides, and actinides. With no active processes discharging to stormwater basins onsite, the accumulations in the stormwater basins are primarily stormwater runoff. Monitoring for specific radionuclides occurs where previous operational history indicates the possible presence of certain radionuclides. The E-Area basins receive stormwater from the Solid Waste Disposal Facility (SWDF), E-Area Vault, and stormwater from the controlled clean-soil pit on the east side of E Area. F-Area Pond 400 receives stormwater from F Area and the Mixed Oxide Fuel Fabrication Facility. Z-Area Stormwater Basin receives stormwater from Z Area (Saltstone processing and disposal facilities).

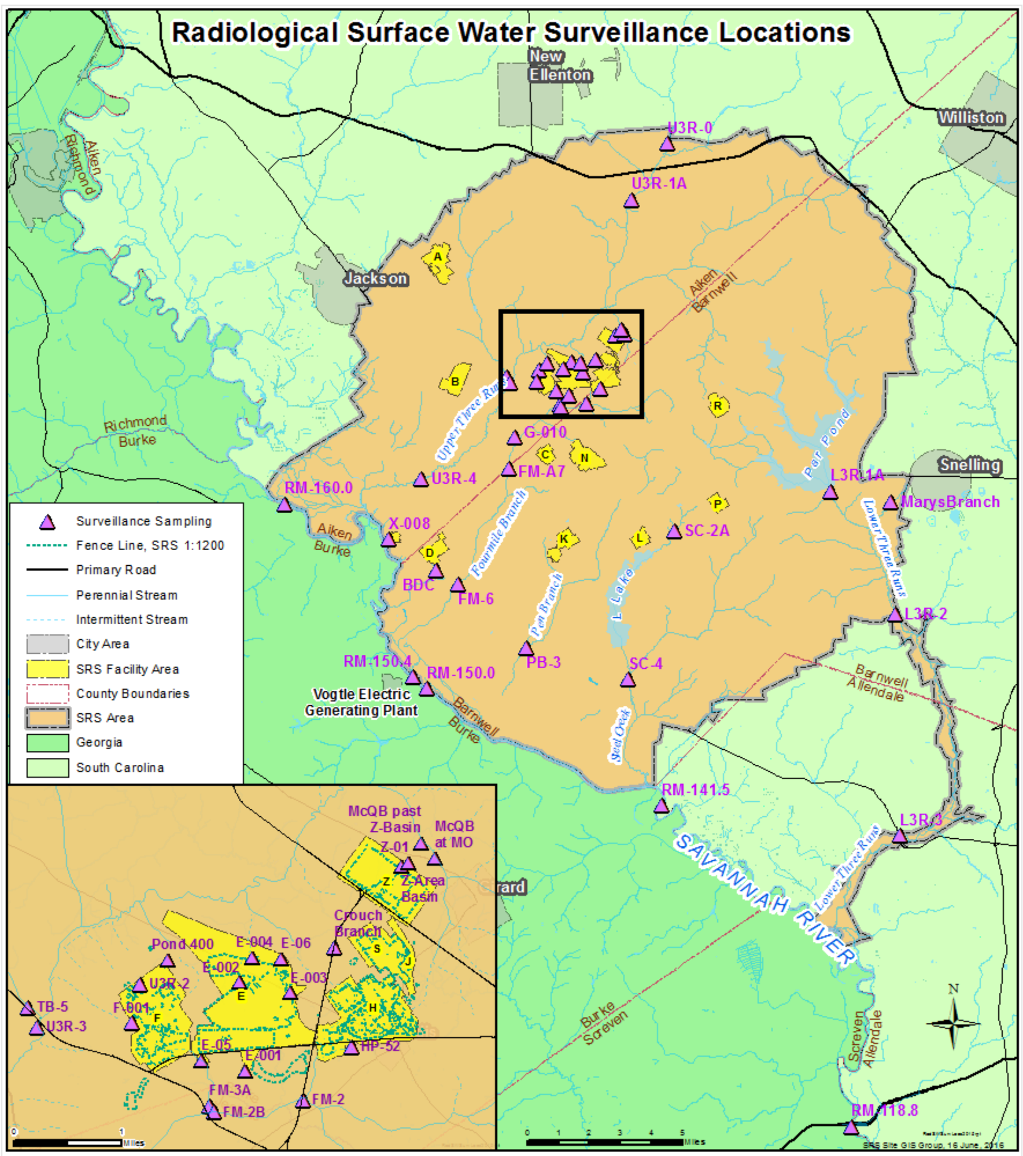


Figure 5-8 Radiological Surface Water Sampling Locations

5.4.2.1 Stormwater Basin Results Summary

In 2015, SRS conducted sampling at five E-Area basins, as well as at the Z-Area Stormwater Basin and F-Area Pond 400. One E-Area basin was not sampled due to dry conditions. Table 5-3 provides a summary of gross alpha, beta, and tritium results for the SRS stormwater basins. The highest tritium concentration was observed at the E-005 Basin, at 32,200 pCi/L, consistent with the previous five years of historical results. The stormwater basins do not actively discharge to the environment.

Table 5-3 Radionuclide Concentrations Summary for Stormwater Basins (pCi/L)

Basin Location	Average Gross Alpha	Average Gross Beta	Average Tritium	Maximum Tritium
E-001	0.457	3.33	5,530	8,650
E-002	0.319	4.62	13,300	24,200
E-003	1.06	2.42	6,560	16,700
E-004	0.297	2.30	7,420	10,200
E-005	0.823	3.05	15,800	32,200
Pond 400	0.433	4.98	577	1,310
Z-Basin	0.411	202	1,170	2,230

5.4.3 Settleable Solids Surveillance

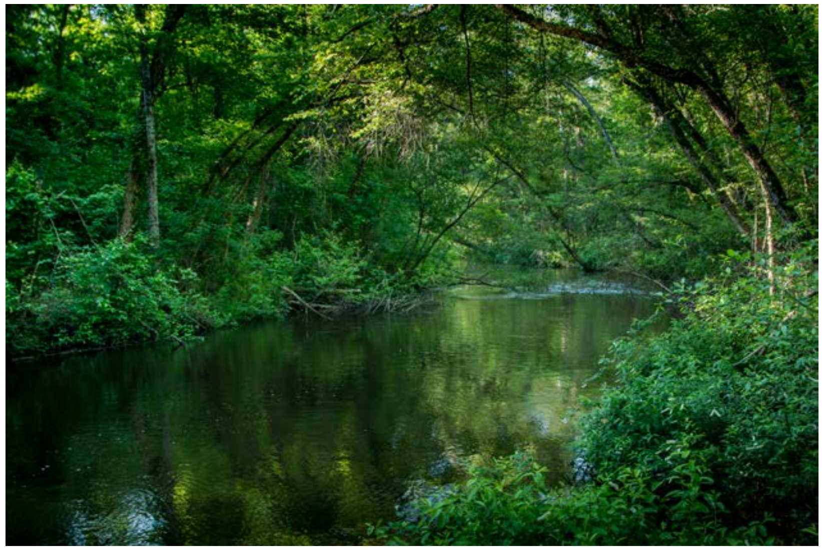
Settleable solids are solids in water that are heavy enough to sink to the bottom of the collection container. SRS evaluates settleable solids in water to determine, in conjunction with routine sediment monitoring, whether a long-term buildup of radioactive materials occurs in stream systems. DOE has set limits for the radioactivity levels in settleable solids to 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides. Accurate measurement of radioactivity levels in settleable solids is impractical in small amounts with low Total Suspended Solids (TSS). The TSS limit set by DOE is 40 parts per million. If TSS results are below this limit, no samples are analyzed for alpha-emitting and beta/gamma-emitting radionuclides. SRS monitors for TSS as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program from outfalls co-located at or near radiological effluent points. If TSS results are greater than or equal to 40 parts per million, samples are analyzed for radionuclides.

5.4.3.1 Settleable Solids Results Summary

In 2015, all NPDES TSS sample results were well below 40 parts per million. The 2015 NPDES TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

5.4.4 SRS Stream Sampling and Monitoring

SRS conducts continuous sampling of SRS streams downstream of several process areas to detect and quantify levels of radioactivity transported to the Savannah River by effluents and shallow groundwater migration. The five primary streams that deposit into the Savannah River are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. SRS monitors and quantifies the migration of radioactivity from SRS seepage basins and the Solid Waste Disposal Facility (SWDF) as part of its stream surveillance program. Seepage basins include the General Separations Area (F and H Area) Seepage Basins and K-Area Seepage Basin, which have been closed. SRS closed the F-Area and H-Area Seepage Basins in 1991 and the K-Area Seepage Basin during 2002. Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF continues to migrate through the groundwater and enter Fourmile Branch and Upper Three Runs. Groundwater migration from the F-Area Seepage Basins enters Fourmile Branch at three monitoring locations, FM-3A, FM-2B, and FM-A7, located along the stream. Groundwater contamination from K-Area Seepage Basin migrates into Pen Branch.



Onsite Stream - McQueens Branch

Figure 5-8 displays the radiological surface water sampling locations. The sampling frequency and types of analyses are dependent on the upstream discharges and groundwater migration history of radionuclides.

5.4.4.1 SRS Stream Results Summary

Table 5-4 presents the average 2015 concentrations of gross alpha, gross beta, and tritium in SRS streams. SRS found detectable concentrations of tritium at least once at all stream locations in 2015. The ten-year trend for the average tritium levels in the streams shows a decreasing trend, which is due to a combination of decreases in Site releases and the natural decay of tritium. Figure 5-9 indicates that average tritium levels in Fourmile Branch are trending closer to the EPA standard of 20,000 pCi/L, though onsite streams are not a direct source of drinking water. In the surveillance program, the EPA standard is used as a benchmark for comparing stream surface water results. Tritium levels are higher in Fourmile Branch compared to the other streams due to surface groundwater migration from the historical seepage basins and SWDF. SRS has taken active measures to reduce this migration.

In order to reduce the tritium flux to Fourmile Branch, SRS has taken active measures to reduce this migration by conducting phytoremediation. Phytoremediation is the direct use of plants to clean up contamination, such as tritium, from soil and water. Using natural processes, plants can break down, trap and hold, or transpire (release to the atmosphere in a modified form) contaminants.

Table 5-4 Radionuclide Concentrations in SRS Streams by Location

Location	Average Alpha (pCi/L)	Average Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
Onsite Stream Locations				
Tims Branch (TB-5)	2.32	1.82	223	497
Lower Three Runs (L3R-3)	5.41	5.18	769	1,490
Steel Creek (SC-4)	0.787	1.53	1,950	2,970
Pen Branch (PB-3)	0.913	1.18	13,600	22,000
Fourmile Branch (FM-6)	1.25	4.77	26,700	31,400
Upper Three Runs (U3R-4)	5.86	3.32	678	1,100
Onsite Control Locations (for comparison purposes)				
Upper Three Runs (U3R-1A)	4.67	2.76	47.5	207

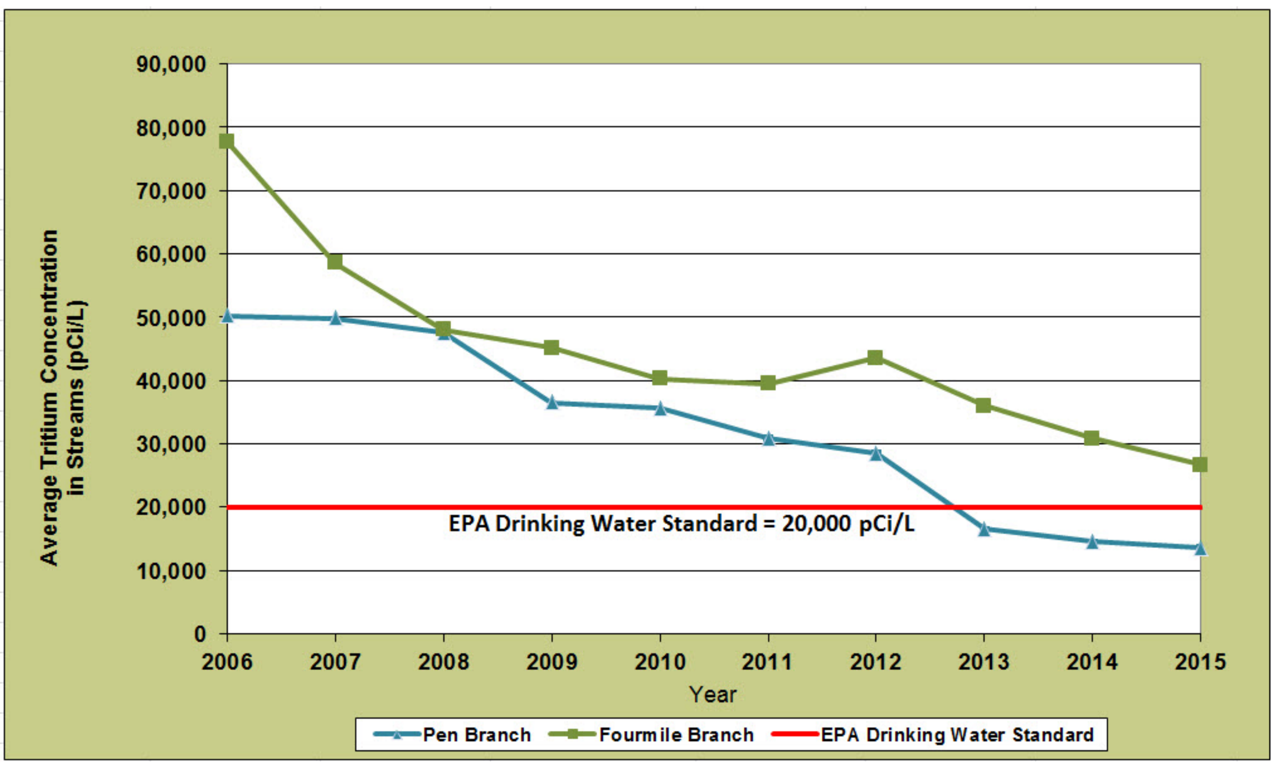


Figure 5-9 Ten-Year Trend of Tritium in Pen Branch and Fourmile Branch (pCi/L)

Figure 5-10 presents a graphical representation of releases of tritium via migration to Site streams from 2006 through 2015. As seen in the figure, migration releases of tritium generally have declined the past ten years, with year-to-year variability caused mainly by the amount of annual rainfall. During 2015, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 652 Ci compared to 657 Ci in 2014, which represents a <1% decrease. The ten-year trend displays a decrease in tritium migration.

Of the 652 Ci of tritium migrating into SRS streams, 457 Ci (70%) were measured in Fourmile Branch. Migration releases of other radionuclides vary from year-to-year but have remained below 0.1 Ci the past ten years. Sampling in Pen Branch measures the tritium migration from the seepage basin and the percolation field below the K-Area Retention Basin. It is estimated that 195 Ci migrated in 2015, which is comparable to the 186 Ci recorded in 2014.

Stream transport accounts for tritium migration releases from C-Area, L-Area, and P-Area Disassembly Basins (see "Tritium Transport in Streams and Savannah River Surveillance" section of this chapter).

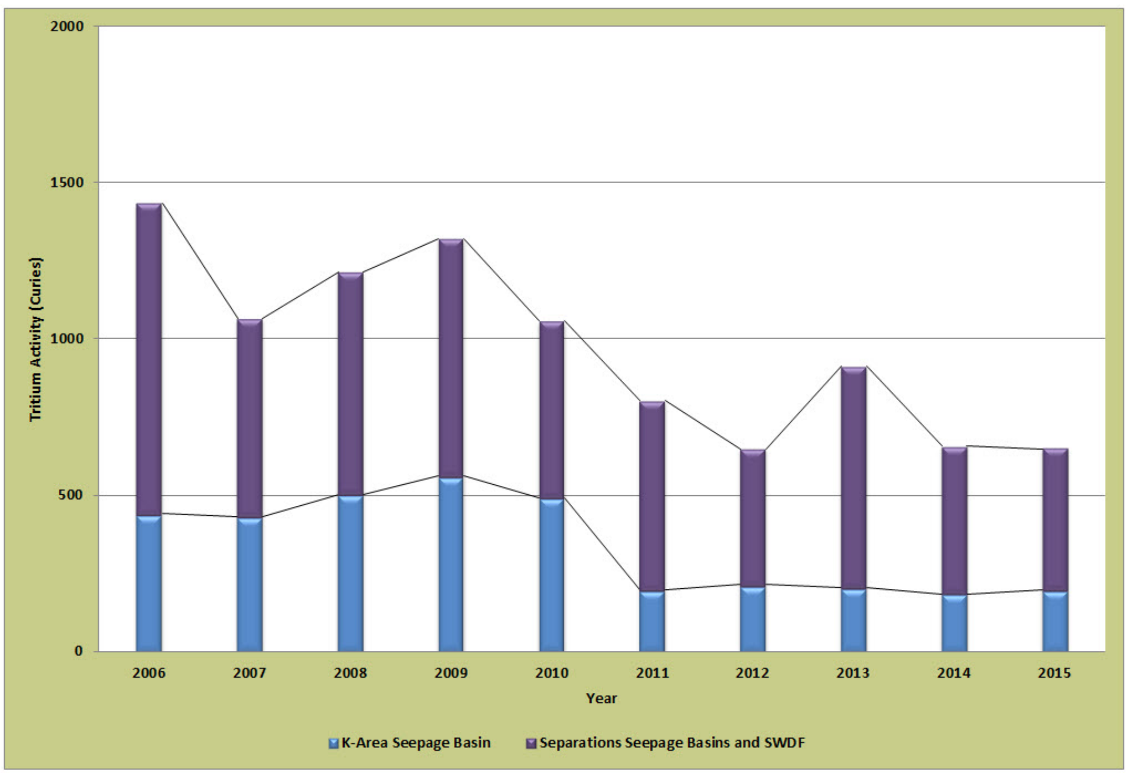


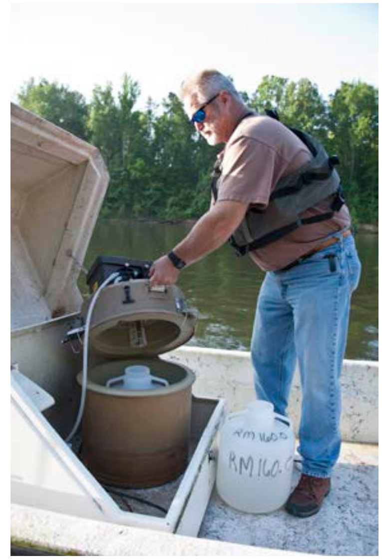
Figure 5-10 Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

SRS measures streams for alpha specific isotopes, such as the actinides (uranium, plutonium, americium, and curium), when gross alpha results for the five major streams are greater than the EPA screening level of 15 pCi/L gross alpha. Overall, the alpha specific (Pu-238, Pu-239, Am-241, Cm-244, U-234, U-235, and U-238) isotope values for 2015 showed no elevated levels and were consistent with historical measurements.

5.4.5 Savannah River Sampling and Monitoring

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

Five locations (Figure 5-8) along the river continued to serve as environmental surveillance points in 2015. Samples are collected at these river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides.



Field Technician Collects Composite River Surface Water at River Mile 160

5.4.5.1 Savannah River Results Summary

The average 2015 concentrations of gross alpha, gross beta, and tritium at river locations are listed in Table 5-5. The tritium concentration levels are well below the EPA drinking water standard of 20,000 pCi/L.

Table 5-5 Average Radionuclide Concentrations in the Savannah River

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)
RM-160 (CONTROL)	0.188	2.01	84.8
RM-150.4 (VEGP)	0.233	2.06	1,230
RM-150	0.231	1.96	271
RM-141.5	0.283	1.99	443
RM-118.8	0.257	1.93	481

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS and VEGP tritium estimates based on concentration results and average flow rates at Savannah River Mile (RM) 118.8 were 2,394 Ci in 2015 compared to 2,513 Ci in 2014. In addition to the weekly samples collected for tritium, gross alpha, gross beta, and gamma analyses, SRS collects annual samples to provide a more comprehensive suite of radionuclides for analysis (strontium-89,90, technetium-99, and actinides). SRS analyzed all annual samples from RM 118.8 and several other locations for uranium-234, uranium-238, and americium-241 in 2015. The analytical results for the 2015 samples are provided in the *2015 Environmental Monitoring Program Data Report* (2016a). Tritium averages for 2015 are consistent with the averages for the previous five years. Overall, river results are within the trends of the previous five to ten years.

5.4.6 Tritium Transport in Streams and Savannah River Surveillance

Because of the mobility of tritium in water and the quantities released during the years of SRS operations, SRS performs a comparison of tritium concentrations at various SRS stream locations and Savannah River monitoring locations. The comparison uses the following methods of calculation:

- Total direct tritium releases, including releases from facility effluent discharges and measured shallow groundwater migration of tritium from SRS seepage basins and SWDF (direct releases measured at the source);
- Tritium transport in SRS streams, measured at the last sampling point before entry into the Savannah River (stream transport which measures the amount of tritium leaving the Site); and
- Tritium transport in the Savannah River, measured downriver of SRS (near RM 118.8) after subtraction of any measured contribution above the SRS (river transport).

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

5.4.6.1 Tritium Transport in Streams and Savannah River Results Summary

In 2015, tritium levels in streams showed a general increase, while river transport showed a slight decrease specifically:

- The direct releases of tritium increased by approximately 5.29% (from 701 Ci in 2014 to 736 Ci in 2015).
- The stream transport of tritium increased by approximately 23% (from 677 Ci in 2014 to 786 Ci in 2015).
- The river transport of tritium decreased by approximately 4.68% (from 2,513 Ci in 2014 to 2,398 Ci in 2015) [VEGP, Barnwell Low-Level Disposal Facility (BLLDF), and SRS contributed to these values]

The increases, observed from 2014 to 2015, for direct releases and stream transport are attributable to shallow groundwater migration and increases in direct releases to Upper Three Runs from the Effluent Treatment Facility. The decrease for river transport from 2014 to 2015 is attributable to decreases from both VEGP and BLLDF, in addition to a decrease in the river flows.

SRS tritium transport data from 1960-2015 (Figure 5-11), shows the history of direct releases, stream transport, and river transport and a zoomed in graph of the previous ten years. The general trend over time is attributable to 1) variations in tritium production and processing at SRS; 2) the implementation of effluent controls beginning in the early 1960s; and 3) the continuing depletion and decay of the SRS's tritium inventory.

Within the past five years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the BLLDF operated by Energy Solutions, LLC. The tritium continues to enter the SRS stream system at Mary's Branch, which deposits into Lower Three Runs. The facility is privately owned and adjacent to SRS. The tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. In 2014, SRS implemented monitoring at Mary's Branch to account for the amount of tritium contributed from BLLDF. For 2015, the amount of tritium from BLLDF was estimated to be 70 Ci, which was not included in the SRS direct release or stream transport totals.

For compliance dose calculations, the highest value between the SRS direct releases and stream transport measurements (which was 786 Ci in 2015) is used (see Chapter 6, "Radiological Dose Assessments").

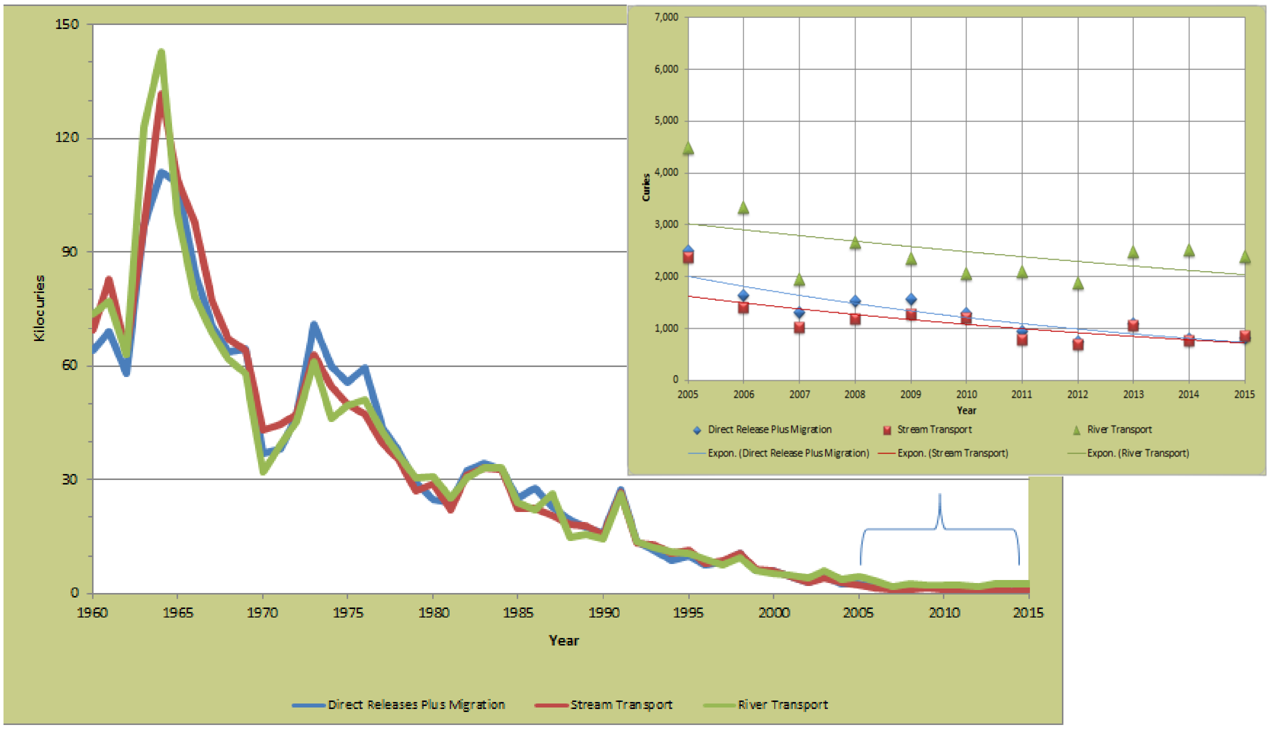


Figure 5-11 SRS Tritium Transport Summary

5.4.7 Sediment Sampling

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed.

Significant year-to-year differences may be evident because sediment is continuously moved and deposited at different locations in the stream and riverbeds (or because of slight variations in sampling locations), but the data obtained can be used to observe long-term environmental trends. Sediment samples were collected at eight Savannah River locations and 31 onsite streams, basins, ponds, or swamp discharge locations during 2015 (Environmental Maps "Radiological Sediment Sampling Locations").

5.4.7.1 Sediment Results Summary

The maximum of each radionuclide is included in Appendix Table E-12 compared to the SRS control location. The maximum cesium-137 concentration of 812 pCi/g was observed in the Z-Area Stormwater Basin, a posted Soil Contamination Area. Soil Contamination Areas at SRS are areas where the contamination levels exceed 150 pCi/g for beta and gamma radionuclides. For the river and stream sediments, cesium-137 ranged from below the minimum detectible concentration (MDC) to 19 pCi/g at Steel Creek-2A Location. The highest level from the river, 0.578 pCi/g, was from RM 129 (Lower Three Runs River Mouth); the lowest levels were below detection.

Field Technician Collecting Sediment Sample from Savannah River Site Stream

The levels in SRS streams show a decreasing trend, which is due to a combination of decreases in Site releases and the natural decay of radionuclides. Sediment sample results indicate no buildup of radioactive materials from effluent release points.

5.4.8 Drinking Water Monitoring

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

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

SRS monitors potable water at offsite treatment facilities to ensure that SRS operations do not adversely affect the water supply and to provide assurance that drinking water does not exceed EPA drinking water standards for radionuclides. SRS collects samples offsite from two locations (Figure 5-12):

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

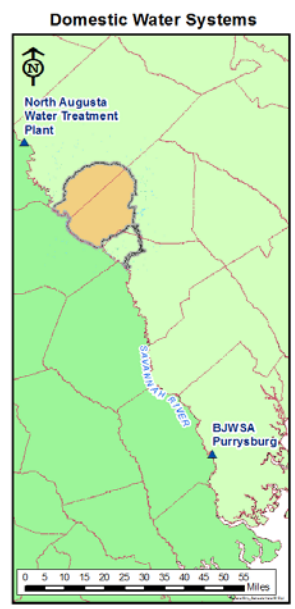


Figure 5-12 Offsite Drinking Water Sampling Locations

SRS collects treated water from these two WTPs as consumed by the public. The North Augusta WTP is the SRS location used to determine concentrations in drinking water upstream of SRS. The intake for the BJWSA Purrysburg WTP intake is the furthest downriver sampling location. These locations are compared to evaluate potential impacts from upstream sources that include SRS.

5.4.8.1 Drinking Water Results Summary

In 2015, SRS performed gross alpha and gross beta screening on all onsite and offsite drinking water samples. No results exceeded EPA's 15 pCi/L alpha concentration limit or 50 pCi/L beta concentration limit. In addition, no onsite or offsite drinking water samples exceeded the 20,000 pCi/L EPA standard for tritium or the 8 pCi/L strontium-89,90 MCL.

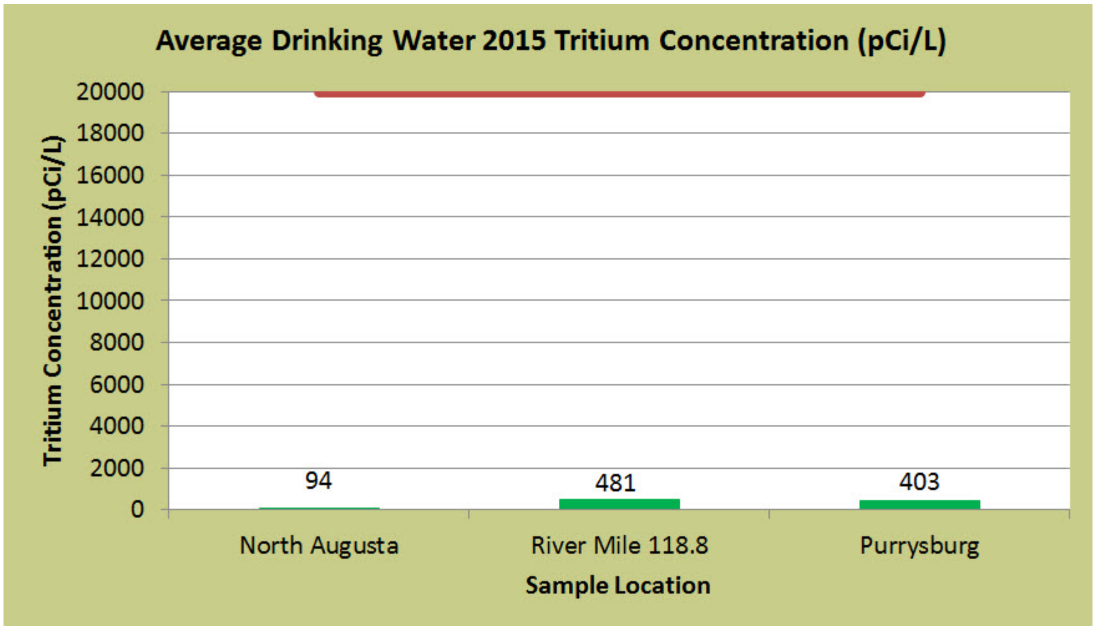


Figure 5-13 Tritium in Offsite Drinking Water and River Mile 118.8 (pCi/L)

Figure 5-13 presents the average drinking water tritium concentrations for the local water treatment plants upstream and downstream from SRS in comparison to the average of weekly river water samples collected at RM 118.8. The average tritium concentration at RM 118.8 is less than 3% of the EPA standard for tritium and decreases further at the downstream sampling location.

Cobalt-60, cesium-137, strontium-89,90, plutonium 238, plutonium 239, and curium-244 were not detected in any drinking water samples. Sample results indicated detectable levels of americium-241 in five onsite samples and uranium-234, uranium-235, and uranium-238 in four, one, and six onsite samples, respectively. A summary of the results are provided in Appendix Table E-13. Concentrations are near the levels of detection for these four analytes. All analytical results are well below the EPA standard.

5.5 AQUATIC FOOD PRODUCTS

5.5.1 Fish Collection in the Savannah River

The SRS collects aquatic food products from the Savannah River. Freshwater fish are collected at six locations on the Savannah River from above SRS at Augusta, Georgia to the coast of Savannah, Georgia (Environmental Maps "Fish Sampling Locations"). Freshwater fish are collected at the mouth of the streams that traverse the Site. Saltwater fish are collected at the Savannah River mouth near Savannah, Georgia. Additionally, shellfish are purchased from vendors in the Savannah area that harvest from local saltwater that is potentially influenced by waters of the Savannah River. Table 5-6 identifies the aquatic products collected in 2015.

Fish Collection – Netting Fish

Table 5-6 Species of Aquatic Food Types Collected by SRS in 2015 for the Radiological Environmental Monitoring Program

Freshwater Fish	Saltwater Fish	Shellfish
Bass	Mullet	Crabs
Catfish	Red Drum	
Bream		

SRS analyzes both edible (meat and skin only) and non-edible (bone) types of freshwater and saltwater fish samples. Analyses conducted on edible samples include tritium, gross alpha, gross beta, gamma-emitting radionuclides (that is cesium-137 and cobalt-60), strontium-89,90, technetium-99, and iodine-129. Strontium-89,90 is the only analyses conducted on the non-edible samples. Only the edible portion of shellfish is analyzed. Shellfish analyses include gross alpha, gross beta, gamma-emitting radionuclides, strontium-89/90, technetium-99 and iodine-129.

5.5.1.1 Fish in Savannah River Results Summary

In 2015, SRS analyzed 48 freshwater fish composites, six saltwater fish composites, and one shellfish composite. The freshwater and saltwater composites consist of three to eight fish each. The shellfish composite consists of one bushel of crabs. The analytical results of the freshwater and saltwater fish, and shellfish collected in 2015 are consistent with 2010 through 2014 results. A majority of results for the specific radionuclides associated with SRS operations are non-detectable (70% for freshwater fish, 87% for saltwater fish, and 100% for shellfish). Table 5-7 lists the maximum concentration for those radionuclides detected in the flesh of all fish types sampled. The fish type and the collection location associated with the maximum concentration are identified for each radionuclide. Cobalt-60 was not detected in any fish flesh samples. Summary tables of the results for all fish and shellfish are provided in Appendix Tables E-14, E-15, and E-16 for freshwater fish, saltwater fish and shellfish, respectively.

The gross alpha result for shellfish was detected at 0.203 pCi/g. This value is less than the gross alpha trigger level of 0.951 pCi/g, which SRS uses as the basis for additional analyses of alpha-emitting

Table 5-7 Location and Fish Type for the Maximum Detected Concentration of Specific Radionuclides Measured in Flesh Samples

Radionuclide	Maximum Concentration	Location	Fish Type
Tritium	0.778 pCi/g	Four Mile Creek River Mouth	Panfish
Cesium-137	0.311 pCi/g	Lower Three Runs Creek River Mouth	Bass
Strontium-89,90 (edible)	0.00724 pCi/g	Lower Three Runs Creek River Mouth	Panfish
Iodine-129*	0.0438 pCi/g	Steel Creek River Mouth	Catfish
Technetium-99	0.101 pCi/g	Upper Three Runs Creek River Mouth	Bass

*NOTE: Only two detected results out of 55 total results.

radionuclides. Gross alpha results were below the MDC for all edible fish composites of saltwater and freshwater fish. Gross beta activity was detectable in all freshwater and saltwater fish, as well as shellfish. The concentrations are consistent with 2010 through 2014 results and are most likely attributed to the naturally occurring radionuclide potassium-40.

The data from the fish monitoring is included in the determination of the potential dose and risk to the public, as reported in Chapter 6 "Radiological Dose Assessment."

5.6 WILDLIFE SURVEILLANCE

Monitoring for Cesium-137 during SRS wildlife hunt

The wildlife surveillance program provides the monitoring of wildlife harvested from SRS and subsequently released to the public. The purpose of the monitoring is to assess any impact of Site operations on the wildlife populations and ensure that the SRS Annual Administrative Game Animal Release Limit of 22 mrem/year is not exceeded for any individual. Annual game animal hunts for deer, coyote and feral hogs are open to members of the public. One turkey hunt for Wounded Warriors and those with mobility impairments was held in the spring and 10 fall annual game animal hunts in 2015. SRS also conducted a roadside deer removal program in 2015. The annual hunts and deer removal activities are conducted to reduce animal-vehicle collisions and control site deer, coyote and feral hog populations.

All animals harvested during the annual hunts on the SRS are monitored to ensure the total dose to any hunter is below the SRS 22 mrem/year limit. SRS uses portable sodium iodide detectors to perform field analyses for cesium-137. The cesium-137 concentration detected in the animal is used to calculate dose. A dose is assigned to each-hunter for every animal harvested if the cesium-137 concentration is above the background concentration of 3.25 picocurie per gram (pCi/g). In addition to the field monitoring, SRS collects samples of muscle for laboratory analysis of cesium-137 concentrations in both deer and hogs based on (1) a set frequency, (2) the field measured cesium-137 levels, or (3) exposure limit considerations. This laboratory-analyzed data provides a quality control check on the field monitoring results. Cesium-137 is chemically similar to and behaves like potassium in the environment. Cesium-137 has a half-life of about 30 years and tends to persist in soil. If it is in soluble form, it can readily enter the food chain through plants. It is widely distributed throughout the world from historic nuclear weapons detonations from 1945 to 1980 and is present at low levels in all environmental media.

5.6.1.1 Wildlife Results Summary

During one of the ten game animal hunts conducted in 2015, as well as the turkey hunt, monitoring results indicated all animals were at or below background cesium-137 concentration of 3.25 pCi/g. No dose was assigned to any hunters for the animals harvested during those hunts.

A total of 473 deer, 80 feral hogs, 23 coyotes, and 27 turkeys were monitored during 2015.

All 27 turkeys harvested during the spring hunt were released. All 319 deer and 80 hogs harvested during the 10 game animal hunts were released. Twenty-three coyotes were harvested and approved for release, but hunters chose to keep only two. One hundred fifty-four (154) deer were harvested during the roadside deer removal project activities. Six deer were not released because monitoring results indicated cesium-137 concentrations were above the cesium-137 background concentration of 3.25 pCi/g.

Muscle and bone samples were collected from a subset of the deer and hogs. A summary of the results is provided in Appendix Table E-17. As observed in previous years, cesium-137, a man-made gamma-emitting radionuclide, was detected in muscle tissue during laboratory analysis. Strontium-89,90, a beta-emitting radionuclide, was detected in both bone and muscle tissue.

Generally, cesium-137 concentrations measured by field detectors and laboratory methods were similar. Field measurements for cesium-137 from all released animals ranged from the lowest default value of 1.00 pCi/g (assigned to field results less than 1.00 pCi/g) to 15.29 pCi/g while laboratory measurements ranged from non-detect to 11.3 pCi/g. Results of field and laboratory measurements are summarized in Table 5-8. The muscle and bone samples from a subset of the animals undergo laboratory analysis for cesium-137 and strontium-89,90. Because of its chemistry, strontium exists at higher concentration in bone than in muscle tissue.

Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past 50 years, as well as the last ten years. The historical trend analysis is in Figure 5-14.

In 2015, all 45 deer bone and 12 hog bone samples had detectable levels of strontium-89,90 greater than the MDC. Strontium-89,90 was detected in deer bone with an average of 3.49 pCi/g and a maximum of 6.32 pCi/g. Strontium-89,90 was detected in hog bone with an average of 4.17 pCi/g and a maximum of 15.0 pCi/g.

For the deer muscle tissue samples, seven out of the 52 muscle tissue samples had detectable levels greater than the MDC for strontium-89,90 with a maximum detectable concentration of 0.029 pCi/g. These average results are similar to those of previous years.

Calculation of dose from the consumption of wildlife harvested on the SRS is included in Chapter 6 "Radiological Dose Assessment."

Table 5-8 Cesium-137 Results for Laboratory and Field Measurements in Wildlife

2015	Number of Animals	Field Gross Average Cs-137 Concentration (pCi/g)	Field Maximum Cs-137 Concentration (pCi/g)	Lab Average Cs-137 Concentration (pCi/g)	Lab Maximum Cs-137 Concentration (pCi/g)
Deer- Game Hunts	319	1.68	15.29	2.46	7.70
Deer – Roadside Deer Removal	154	1.11	11.52	2.12	11.3
Hog	80	0.84	5.43	1.60	9.19
Coyote	23	0.69	1.50	-----	-----
Turkey	27	0.24	0.94	-----	-----

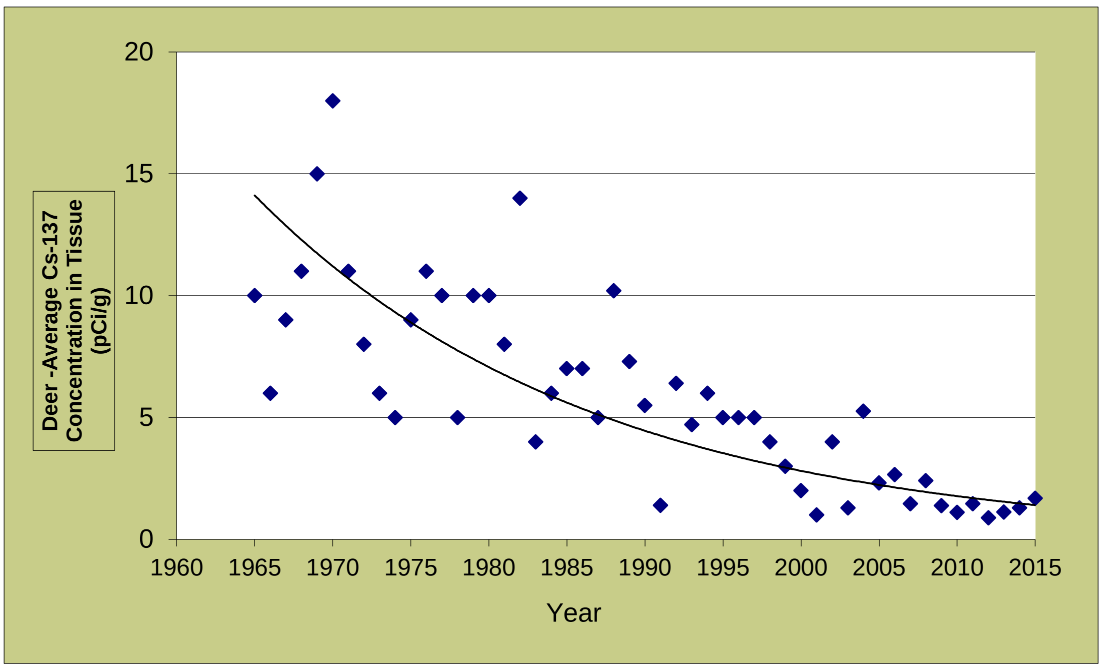


Figure 5-14 Historical Trend of Cesium-137 Concentration in Deer (pCi/g)

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6 RADIOLOGICAL DOSE ASSESSMENT

Department of Energy (DOE) Order 458.1, "Radiation Protection of the Public and the Environment," establishes an annual public dose standard for the public and biota dose limits for plants and animals that are at levels that would provide protection of the public and environment from the effects of radiation resulting from DOE activities. The Savannah River Site (SRS) calculates the potential doses to members of the public from atmospheric and liquid radioactive releases to verify that these releases and exposures do not exceed the DOE public dose standard of 100 mrem/yr from routine DOE operations through all reasonable exposure pathways. Also, SRS considers and quantifies rare exposure pathways that are not included in the standard calculations of the doses to the representative person. This is because they apply to unlikely scenarios such as eating fish caught only from the mouths of SRS streams or to special scenarios such as onsite volunteer hunters. In addition, DOE Order 458.1 provides for the establishment of authorized surface contamination limits, which in turn allow unconditional release of personal and real property. SRS governs the unconditional release of equipment and material by procedures and performs radiological surveys on all equipment and material considered for release.

2015 HIGHLIGHTS

Dose to the Offsite Representative Person

The 2015 dose to the offsite representative person from SRS liquid releases was 0.15 mrem and from SRS air releases was 0.032 mrem. To show compliance with the DOE all-pathway dose standard of 100 mrem/yr, SRS conservatively adds these two doses for a total representative person dose of 0.18 mrem, which is 0.18% of the 100 mrem/yr DOE dose standard.

Sportsman Doses

Onsite Hunter: SRS conducts annual hunts to control onsite deer and feral hog populations. The estimated dose from the consumption of harvested deer or hog meat is determined for every onsite hunter. During 2015, the maximum dose that could have been received by an onsite hunter was estimated at 12.9 mrem, or 12.9% of the 100 mrem/yr DOE dose standard.

Creek Mouth Fisherman: SRS estimated the maximum potential dose from fish consumption at 0.28 mrem from bass collected at the mouth of Lower Three Runs. This dose is 0.28% of the 100 mrem/yr DOE dose standard. SRS bases this hypothetical dose on the low probability scenario that, during 2015, a fisherman consumed 53 lbs of bass caught exclusively from the mouth of Lower Three Runs.

Release of Material Containing Residual Radioactivity

SRS did not release any real property (land or buildings) in 2015. SRS unconditionally released a total of 10,124 items of personal property (such as tools) from radiological areas in 2015. Most of these items did not leave the Site. However, all of these items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria.

2015 HIGHLIGHTS (continued)

Radiation Dose to Aquatic and Terrestrial Biota

SRS conducts evaluations of plant and animal doses for water and land systems. For 2015, all SRS water, sediment and soil locations passed this screening and no further assessments were required.

6.1 INTRODUCTION

Routine SRS operations result in releases of radioactive materials to the environment by atmospheric and liquid pathways. These releases could result in a radiation exposure to people offsite. To confirm that this exposure is below public dose limits, SRS calculates annual dose estimates using environmental monitoring and surveillance data combined with relevant site-specific data (such as weather conditions, population characteristics, and river flow). SRS also confirms that the potential doses to plants and animals (biota) living onsite remain below the DOE biota dose limits. This chapter explains radiation doses, describes how doses are calculated, and presents the estimated doses from SRS activities for 2015.

All SRS dose calculation methods and results are in a report titled *Radiological Environmental Dose Assessment Methods and Compliance Dose Results for 2015 Operations at the Savannah River Site* (Jannik and Dixon 2016) found on the *SRS Environmental Report for 2015* webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

SRS used the data generated by the programs described in Chapter 5, "Radiological Environmental Monitoring Program" to calculate the potential doses to the public.

Chapter 6 Key Terms

Reference person *is a hypothetical person with average physical and physiological characteristics, including factors like age and gender, and is used internationally for the purpose of standardizing radiation dose calculations.*

Representative person *is a hypothetical individual receiving a dose that is representative of highly exposed individuals in the population. At SRS, the representative person equates to the 95th percentile of applicable national human usage radiation exposure data.*

6.2 WHAT IS RADIATION DOSE?

Radiation dose to a person is the amount of energy absorbed by the human body from a radioactive source, located either inside or outside of the body. SRS typically reports dose in millirem (mrem), which is one-thousandth of a rem. A rem is a standard unit used to measure the amount of radiation that is deposited in human tissue.

Humans, plants, and animals potentially receive radiation doses from natural and man-made sources. The average annual "background" dose for all people living in the United States is 625 mrem; this includes an average background dose of 311 mrem from naturally occurring radionuclides found in our bodies and in the earth, and from cosmic radiation, such as from the sun. Man-made sources include medical procedures

(300 mrem), consumer products (13 mrem), and less than 1 mrem from industrial and occupational exposures.

DOE has established dose limits to the public so that DOE operations will not contribute significantly to this average annual exposure. DOE Order 458.1 (DOE 2013) establishes 100 mrem/yr (1 mSv/yr) as the annual dose limit to a member of the public. Exposure to radiation primarily occurs through the following pathways, as shown in Figure 6-1:

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

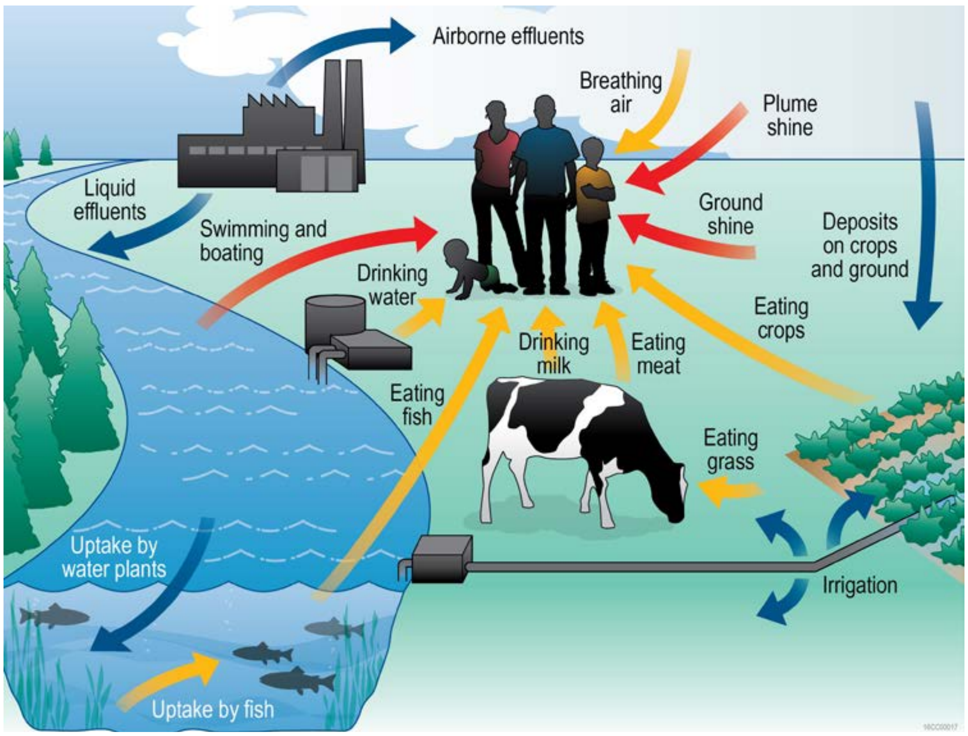

Figure 6-1 Exposure Pathways to Humans from Atmospheric and Liquid Effluents

6.3 CALCULATING DOSE

In compliance with DOE Order 458.1, dose can be calculated to the maximally exposed individual (MEI) or to a representative person. Since 2012, SRS has used the representative person concept for dose compliance.

The representative person dose is calculated using reference person criteria developed specifically for SRS. The SRS representative person falls at the 95th percentile of national and regional data. The applicable national and regional data used are from the Environmental Protection Agency's *EPA Exposure Factor Handbook*, 2011 Edition (EPA 2011).

The reference person is weighted based on gender and age and this weighting is based on the six age groups documented in International Commission on Radiation Protection Publication 89, (ICRP 2002): Infant (0 years), 1 year, 5 years, 10 years, 15 years, and Adult. The reference person accounts for the fact that younger people are, in general, more sensitive to radioactivity than older people. SRS also developed usage parameters at the 50th percentile to use in calculating dose to a “typical” person for determining population doses.

The SRS report *Site Specific Reference Person Parameters and Derived Concentration Standards for SRS* (Stone and Jannik, 2013) documents the SRS-specific reference and typical person usage parameters. All other applicable land and water use parameters used in the dose calculations are documented in the *Land and Water Use Characteristics and Human Health Input Parameters for Use in Environmental Dosimetry and Risk Assessments at the Savannah River Site* (Jannik et al. 2016). These parameters include local characteristics of food production, river recreational activities, and other human usage parameters required in the SRS models used to calculate radioactive dose exposure.

For determining compliance with DOE public dose requirements, SRS calculates the potential offsite doses from SRS effluent releases of radioactive materials (atmospheric and liquid) for the following scenarios:

- Representative person living at the SRS boundary, and
- Population living within a 50-mile (80-kilometer [km]) radius of SRS.

For all routine environmental dose calculations, SRS uses environmental transport and dose models based on codes developed by the Nuclear Regulatory Commission (NRC) (NRC 1977). The NRC-based transport models use DOE accepted methods, consider all significant exposure pathways, and permit detailed analysis of the effects of routine operations. The SRS report “Environmental Dose Assessment Manual” (Jannik 2012) describes the specific models used at SRS.

At SRS, the dose to a representative person is based on:

1) The SRS-specific reference person usage parameters at the 95th percentile of appropriate national or regional data, which are documented in Stone and Jannik (2013),
2) The reference person (gender- and age-averaged) ingestion and inhalation dose coefficients provided in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011), and
3) The external dose coefficients provided in the DC_PAK3 toolbox, which can be accessed at http://www.epa.gov/rpdweb00/federal/techdocs.html. Currently, there are no age-specific external dose factors available.

6.3.1 Weather Database

Complete and accurate weather (meteorological) data are an important part of determining the offsite contamination levels. SRS calculated potential offsite doses from releases of radioactivity to the atmosphere with quality-assured weather data from the years 2007-2011 (Viner 2013).

Figure 6-2 is the H-Area wind rose for 2007-2011, with the directions shown being toward which the wind blows. As shown, the wind blows towards the East Northeast the highest percentage time (about 9%), but there is no strongly prevalent wind direction.

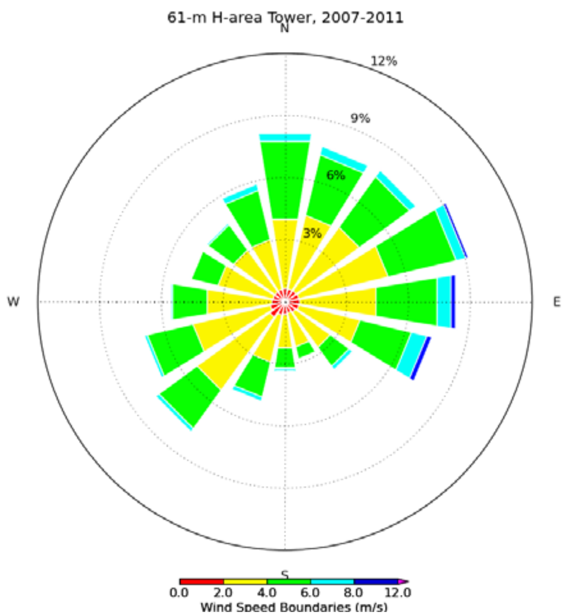

Figure 6-2 2007-2011 Wind Rose for H Area
(Direction is toward which the wind blows)

6.3.2 Population Database and Distribution

SRS calculates the collective (population) doses from atmospheric releases for the population within a 50-mile radius of the Site. Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of the center of SRS is 781,060. This translates to about 104 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area.

Some of the collective doses from SRS liquid releases are calculated for the populations served by the water supply plants shown in Table 6-1.

Table 6-1 Regional Water Supply Service

Water Supply Plant	Nearest City	Population Served
City of Savannah Industrial and Domestic Water Supply Plant (City of Savannah I&D)	Port Wentworth, Georgia	35,000 people
Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea Water Treatment Plant	Beaufort, South Carolina	82,900 people
Beaufort-Jasper Water and Sewer Authority's (BJWSA) Purrysburg Water Treatment Plant	Beaufort, South Carolina	64,200 people

The total population dose resulting from routine SRS liquid releases is the sum of five contributing categories:

1) BJWSA water consumers,
2) City of Savannah I&D water consumers,
3) Consumption of fish and invertebrates of Savannah River origin,
4) Recreational activities on the Savannah River, and
5) Irrigation of foodstuffs using river water near River Mile (RM) 118.8 (U.S. Highway 301 bridge).

6.3.3 River Flow Rate Data

The annual rate of flow in the Savannah River, which varies greatly from year to year, is an important criterion for determining down river concentrations of contaminants released from SRS. SRS uses the Savannah River flow rate measured by the U.S. Geological Survey (USGS) at their River Mile 118.8 gauging station, located near the US Hwy 301 Bridge. Figure 6-3 provides the river flow rates measured at this location from 1954 through 2015 and it shows that the average river-flow-rate for these years is about 10,000 cubic feet per second (cfs). However, recently, there has been a downward trend in these data with an average measured flow rate of just 7,237 cfs during the past 10 years.

For 2015, SRS used an estimated Savannah River flow rate of 5,972 cfs in the dose calculations. The 2015 estimated flow rate is 30% less than the 2014 estimated flow rate of 8,531 cfs. This estimated flow rate (based on actual measured tritium concentrations in the river) is more conservative than the 2015 USGS measured flow rate of 8,833 cfs. By using a conservative method, the estimates assume a lower dilution of radioactive material, and therefore over-estimate the potential impact. This is done to reflect the public health risks under a worst case scenario.

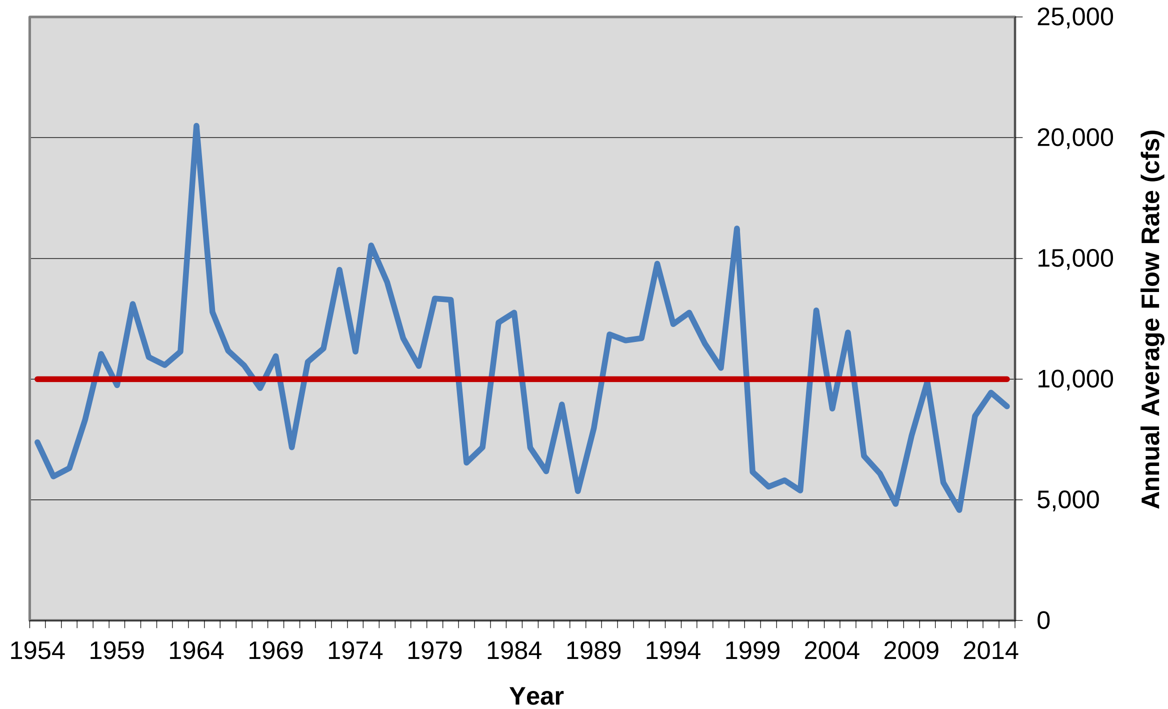

Figure 6-3 Savannah River Annual Average Flow Rates at River Mile 118.8

6.4 OFFSITE REPRESENTATIVE PERSON DOSE CALCULATION RESULTS

6.4.1 Liquid Pathway

6.4.1.1 Liquid Release Source Terms

Table 6-2 shows, by radionuclide, the amount of radioactive liquid released in 2015. This is used as the source of the type and amount of radioactive material released in SRS dose calculations. Discussions of the sources of these data are in Chapter 5, "Radiological Environmental Monitoring Program."

Tritium accounts for more than 99% of the total amount of radioactivity released from the Site to the Savannah River. In 2015, SRS released a total of 786 curies of tritium to the river, a 12% increase from the 2014 amount of 699 curies.

In 2015, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 1,709 curies of tritium to the Savannah River and 70 curies migrated from the Barnwell Low-Level Disposal Facility (BLLDF) for an overall total of 2,565 curies of tritium (SRS plus VEGP plus BLLDF). This is a 13% decrease from the combined total of 2,933 curies in 2014.

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

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

Radionuclide Concentrations in River Water and Treated Drinking Water —Table 6-2 shows the measured concentrations of tritium in the Savannah River near RM 118.8 and at the BJWSA Purrysburg water treatment facility, which is representative of the BJWSA Chelsea and the City of Savannah I&D water treatment plants. These downriver tritium concentrations include tritium releases from SRS and the VEGP and BLLDF. Also provided in Table 6-2 are the calculated concentrations for the other released radionuclides and a comparison of these concentrations to the Safe Drinking Water Act, 40 CFR 141 (EPA, 2000) maximum contaminant level (MCL) for each radionuclide.

In 2015, the 12-month average tritium concentration measured in Savannah River water near RM 118.8 was 481 picocuries per liter (pCi/L). This reflects a 25% increase from the 385 pCi/L measured in 2014. SRS attributes this increase to the 30% decrease in the estimated 2015 Savannah River flow, which caused less dilution to occur in the river.

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

Because of this high bioaccumulation factor, SRS can detect cesium-137 more easily in fish flesh than in river water. Therefore, when conservative to do so, SRS will base the fish pathway dose from cesium-137 directly on the analysis of the fish collected near RM 118.8, the assumed location of the hypothetical representative person. In 2015, the cesium-137 release value of 0.0468 Ci is based on analysis of fish in the river.

Table 6-2 2015 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the EPA's Drinking Water Maximum Contaminant Levels (MCL)

Nuclide	Curies Released	12-Month Average Concentration (pCi/L)		
		Below SRS [(a)]	at BJWSA Purrysburg Plant [(b)]	EPA MCL[(d)]
H-3[(c)]	7.86E+02	4.81E+02	4.03E+02	2.00E+04
C-14	5.33E-03	9.99E-04	8.37E-04	2.00E+03
Sr-90	2.43E-02	4.56E-03	3.82E-03	8.00E+00
Tc-99	1.30E-02	2.44E-03	2.04E-03	9.00E+02
I-129	1.44E-02	2.70E-03	2.26E-03	1.00E+00
Cs-137	4.68E-02	8.77E-03	7.35E-03	2.00E+02
U-234	6.77E-02	1.27E-02	1.06E-02	1.03E+01
U-235	2.50E-03	4.69E-04	3.93E-04	4.67E-01
U-238	7.55E-02	1.42E-02	1.19E-02	1.00E+01
Np-237	3.21E-07	6.02E-08	5.04E-08	1.50E+01
Pu-238	5.13E-04	9.62E-05	8.06E-05	1.50E+01
Pu-239	1.10E-04	2.06E-05	1.73E-05	1.50E+01
Am-241	1.79E-04	3.36E-05	2.81E-05	1.50E+01
Cm-244	1.21E-04	2.27E-05	1.90E-05	1.50E+01
Alpha	8.60E-03	1.61E-03	1.35E-03	1.50E+01
Beta	9.53E-02	1.79E-02	1.50E-02	8.00E+00

a. Near Savannah River Mile 118.8, downriver of SRS at the U.S. Highway 301 bridge

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

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

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

6.4.1.3 Dose to the Representative Person

The 2015 dose to the representative person from all liquid pathways including irrigation was estimated at 0.15 mrem (0.0015 mSv), which was 25% more than the comparable dose in 2014 of 0.12 mrem (0.0012 mSv). SRS attributes this increase to the 30% decrease in estimated Savannah River flow rate during 2015. Table 6-3 shows that this total dose is 0.15% of DOE's public dose standard of 100 mrem/yr (1 mSv/yr).

Table 6-3 Potential Dose to the Representative Person from SRS Liquid Releases in 2015

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.053		
Irrigation Pathways	0.093		
Total Liquid Pathways	0.15	100[a]	0.15%
[a]**DOE dose standard: 100 mrem/yr (DOE Order 458.1)**			

Over 64% of the 2015 total dose to the representative person resulted from consuming meat, milk, and vegetables. The fish consumption pathway accounted for 23% and the drinking water pathway accounted for 13%. As shown in Figure 6-4, cesium-137 (23%) and unidentified beta emitters (19%) were the major contributors to the total dose.

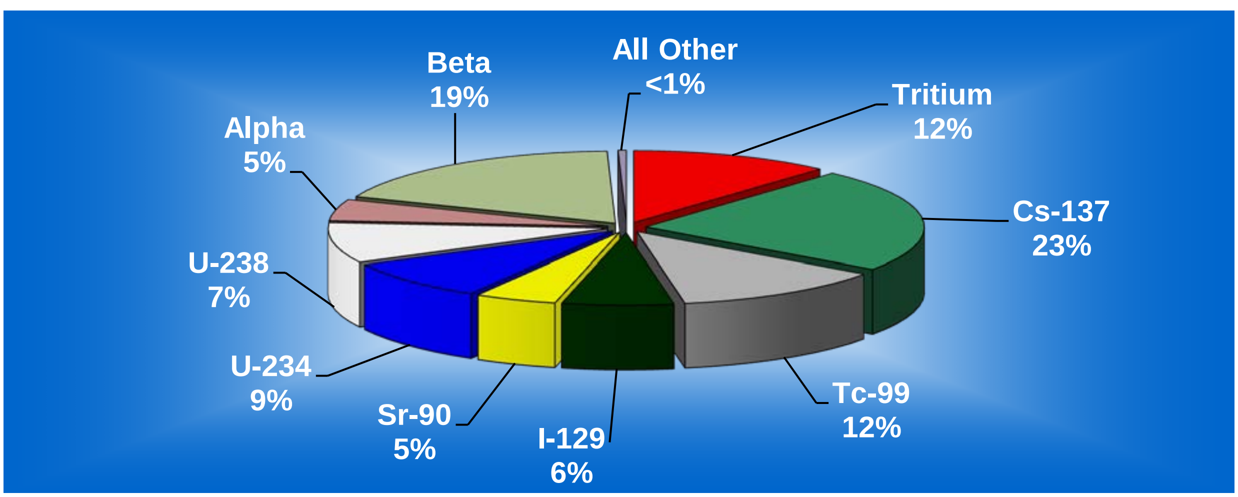

Figure 6-4 Radionuclide Contributions to the 2015 SRS Total Liquid Pathway Dose of 0.15 mrem (0.0015 mSv)

6.4.1.4 Drinking Water Pathway Dose

People living downriver of SRS may receive some dose by consuming drinking water that contains radioactive releases from the Site. Tritium in downriver drinking water represented the highest percentage of the dose (about 49%) received by customers of the three downriver water treatment plants.

In 2015 SRS-only releases were responsible for a maximum potential drinking water dose of 0.016 mrem (0.00016 mSv). This dose is 45% more than the 2014 dose of 0.011 mrem (0.00011 mSv). Again, this increase is mainly attributed to the decrease in the estimated Savannah River flow rate during 2015. There is not a separate drinking water dose standard, but the EPA Maximum Contamination Level (MCL), defined in 40 CFR 141 (EPA 2000), assume a potential dose of about 4 mrem/yr for beta and gamma emitters.

6.4.1.5 Collective (Population) Dose

SRS calculates the collective drinking water consumption dose for the separate population groups served by the BJWSA and City of Savannah I&D water treatment plants. Calculations of collective doses from agricultural irrigation assume that 1,000 acres of land are used for each of the major food types grown in the SRS area (vegetables, milk, and meat), with the population within 50 miles of SRS consuming all the food produced on these 1,000-acre parcels.

In 2015, the collective dose from all liquid pathways was 2.6 person-rem (0.026 person-Sv). Person-rem is calculated as the average dose per person multiplied by the number of people exposed. This is 30% more than the comparable 2014 collective dose of 2.0 person-rem (0.020 person-Sv). SRS attributes this increase to the 30% decrease in in the estimated Savannah River flow rate during 2015.

6.4.2 Air Pathway

6.4.2.1 Atmospheric Release Source Terms

Chapter 5 (“Radiological Environmental Monitoring Program”) documents the 2015 radioactive atmospheric release quantities used as the source term in SRS dose calculations. Tritium accounts for a majority of the dose from SRS atmospheric releases. As discussed in Chapter 5, tritium releases decreased about 30% from 2014 to 2015, which caused a decrease in the 2015 SRS air pathway doses.

6.4.2.2 Atmospheric Concentrations

SRS uses calculated radionuclide concentrations instead of measured concentrations for dose determinations because most radionuclides released from SRS were not detected (using conventional analytical methods) in the air samples collected at the Site perimeter and offsite locations. However, SRS can routinely measure the concentrations of tritium at locations along the site perimeter and compares these results with the calculated concentrations to confirm the dose models. In 2015, this comparison showed that the dose models used at SRS were about 1.5 to 2 times more conservative than the actual measured tritium concentrations.

6.4.2.3 Dose to the Representative Person

The 2015 estimated dose from atmospheric releases to the representative person was 0.032 mrem (0.00032 mSv), 0.32% of the EPA 40 CFR 61 air pathway standard of 10 mrem per year. Table 6-4 compares the representative person dose with the EPA standard. The 2015 dose was about 27% less than the 2014 dose of 0.044 mrem (0.00044 mSv). SRS attributes this decrease to the 30% decrease in tritium releases during 2015 (see Chapter 5, "Radiological Environmental Monitoring Program").

Table 6-4 Potential Doses to the Representative Person and to the MEI from SRS Atmospheric Releases in 2015 and Comparison to the Applicable Dose Standard

	MAXDOSE-SR	CAP88-PC (EPA NESHAP)
Calculated dose (mrem)	0.032	0.022
Applicable Standard (mrem)	10[a]	10[b]
Percent of Standard (%)	0.32	0.22
[a] DOE: DOE Order 458.1 [b] EPA: (NESHAP) 40 CFR 61, Subpart H		

As shown in Figure 6-5, tritium releases accounted for nearly 96% of the dose to the representative person. Iodine-129 accounted for about 2%. No other individual radionuclide accounted for more than 1% of the representative person dose.

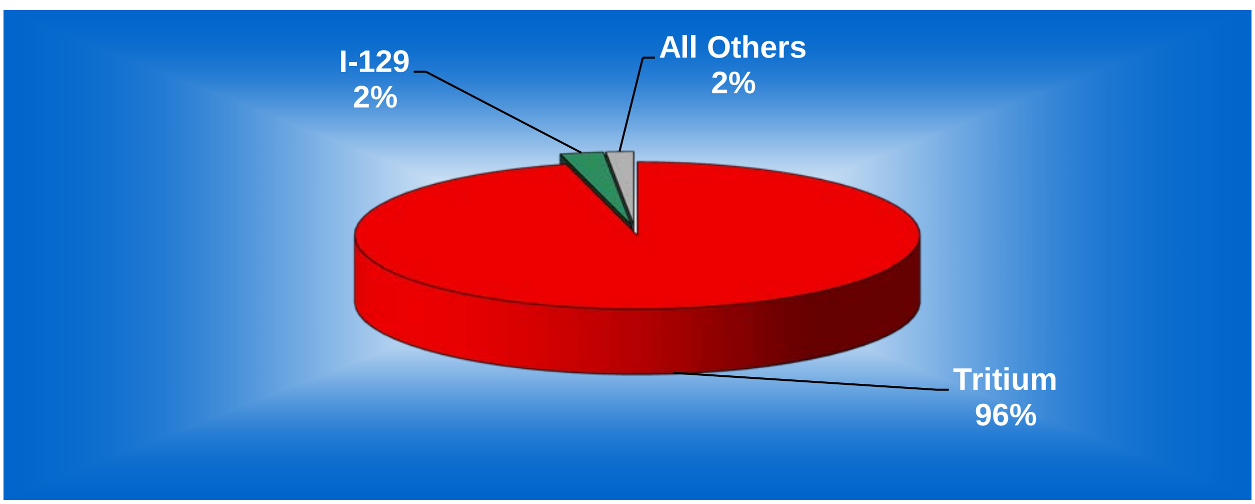

Figure 6-5 Radionuclide Contributions to the 2015 SRS Air Pathway Dose of 0.032 mrem (0.00032 mSv)

The major ways a representative person received radioactivity from atmospheric releases were inhalation (38%), vegetable consumption (37%), and cow milk consumption (25%).

6.4.2.4 Collective (Population) Dose

SRS calculates the air-pathway collective dose for the entire 781,060 population living within 50 miles of the center of the Site. In 2015, SRS estimated the airborne-pathway collective dose at 1.1 person-rem

(0.011 person-Sv), less than 0.01% of the annual collective dose received from natural sources of radiation (about 234,000 person-rem).

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

To demonstrate compliance with NESHAP regulations (EPA 2002), SRS calculated Maximally Exposed Individual (MEI) and collective doses using:

1) The CAP88 PC version 4.0.1.17 computer code,
2) The 2015 airborne-release source term, and
3) Site-specific input parameters.

EPA requires the use of the MEI concept and does not allow use of the reference person concept at this time. EPA specifies most of the input parameters in the CAP88 PC program and they cannot be changed without specific EPA approval.

For 2015, SRS used CAP88 PC (version 4.0.1.17, dated September 2014) to demonstrate compliance with EPA's 10 mrem/yr (0.1 mSv/yr) public dose standard for airborne emissions from DOE sites. For 2015, the MEI dose was estimated at 0.022 mrem (0.00022 mSv), or 0.22% of the 10-mrem/yr EPA standard, as shown in Table 6-4.

Tritium oxide releases accounted for about 87% of the MEI dose and elemental tritium accounted for 11%. The 2015 NESHAP compliance dose (MEI dose) was about 27% less than the 2014 dose of 0.031 mrem (0.00031 mSv). Again, SRS attributes this decrease to the 30% decrease in tritium oxide releases during 2015 (see Chapter 5, "Radiological Environmental Monitoring Program").

6.4.3 All-Pathway Dose

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

For 2015, the potential representative person all-pathway dose was 0.18 mrem (0.0018 mSv), calculated as 0.032 mrem from air pathways plus 0.15 mrem from liquid pathways. The all-pathway dose is 0.18% of the 100 mrem/yr (1 mSv/yr) DOE dose standard. The 2015 all-pathway dose is about 13% more than the 2014 total dose of 0.16 mrem (0.0016 mSv). SRS attributes this increase to the 30% decrease in in the estimated Savannah River flow rate during 2015.

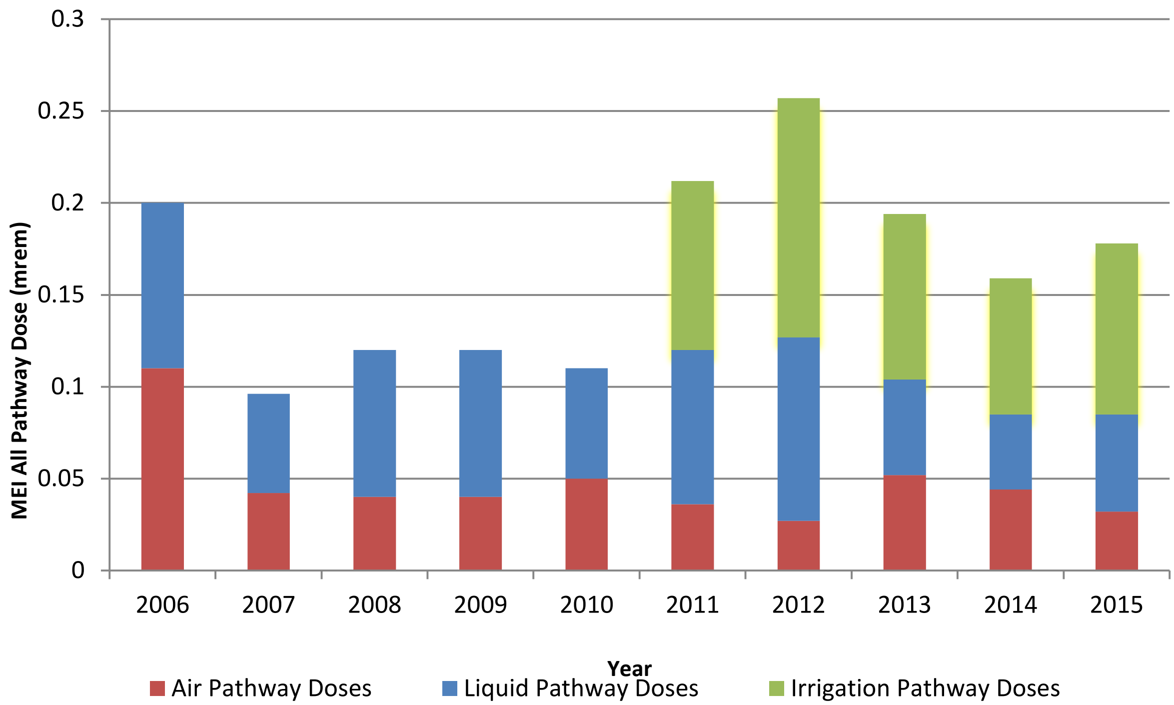

Figure 6-6 Ten-Year History of SRS Maximum Potential All-Pathway Doses

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

Figure 6-6 shows a ten-year history of SRS's all-pathway (airborne pathways plus liquid pathways) doses to the MEI/representative person. Figure 6-7 graphically shows a comparison of SRS's 2015 all pathway dose to the DOE dose standard of 100 mrem/yr by equating 1 mrem to 1 yard on a football field.

6.5 SPORTSMAN DOSE CALCULATION RESULTS

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

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

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

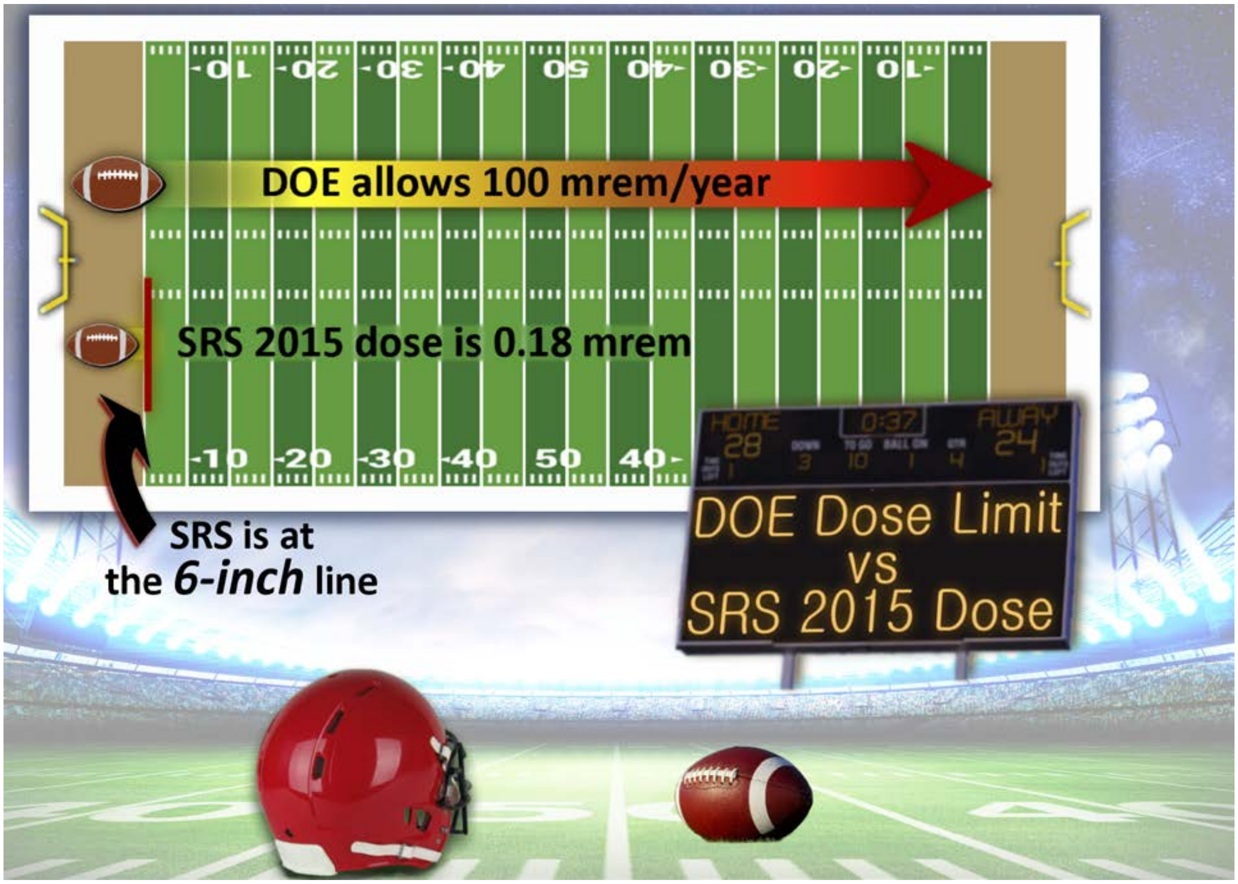

Figure 6-7 Comparison of DOE's 100 mrem/yr Dose Standard to SRS's 2015 All-Pathway Dose of 0.18 mrem

6.5.1 Onsite Hunter Dose

Deer and Hog Consumption Pathway — Annual hunts, which are open to the public, are conducted at SRS to control the Site's deer and feral hog populations and to reduce animal-vehicle accidents. The estimated dose from the consumption of harvested deer or hog meat is determined for every onsite hunter. During 2015, the maximum dose that could have been received by an onsite hunter was estimated at 12.9 mrem (0.129 mSv), or 12.9% of DOE's 100 mrem/yr dose standard (Table 6-5). This dose was determined for an actual hunter who harvested 1 hog during the 2015 hunts. For the hunter-dose calculation, SRS conservatively assumes that this hunter individually consumed the entire edible portion, about 45 kilogram (kg) (99 pounds).

Turkey Consumption Pathway — SRS hosts a special turkey hunt during April for hunters with mobility impairments. Hunters harvested 27 turkeys in 2015. SRS measured all of the turkeys for radiation. Since none of them measured above background, no dose was assigned to these hunters.

6.5.2 Hypothetical Offsite Hunter Dose

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

Based on these unlikely assumptions and on the measured average concentration of cesium-137 in all deer (1.71 pCi/g) and hogs (0.91 pCi/g) harvested from SRS during 2015, the potential maximum doses from this pathway were estimated at 4.9 mrem (0.049 mSv) for the offsite deer hunter and 1.7 mrem (0.017 mSv) for the offsite hog hunter.

Savannah River Swamp Hunter Soil Exposure Pathway — SRS estimated the potential dose to a recreational hunter exposed to SRS legacy contamination on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman hunted for 120 hours during the year (8 hours per day for 15 days) at the location of maximum radionuclide contamination.

As shown in Table 6-5, the offsite deer consumption pathway and the Savannah River Swamp hunter soil exposure pathway were conservatively added together to obtain a total offsite hunter dose of 7.8 mrem (0.078 mSv). This potential dose is 7.8% of the DOE 100 mrem/yr dose standard.

6.5.3 Hypothetical Offsite Fisherman Dose

Creek-Mouth Fish Consumption Pathway — For 2015, analyses were conducted on three species of fish (panfish, catfish, and bass) taken from the mouths of four SRS streams. Using these concentrations, SRS estimated the maximum potential dose from fish consumption at 0.28 mrem (0.0028 mSv) from bass collected at the mouth of Lower Three Runs. SRS bases this hypothetical dose on the low probability scenario that, during 2015, a fisherman consumed 24 kg (53 lb) of bass caught exclusively from the mouth of Lower Three Runs. About 65% of this potential dose was from cesium-137.

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

Using the radionuclide concentrations measured at this location, SRS estimated the potential dose to a fisherman from a combination of 1) external exposure to the contaminated soil, 2) incidental ingestion of the soil, and 3) incidental inhalation of renewed suspension soil to be 0.67 mrem (0.0067 mSv).

As shown in Table 6-5, the maximum Steel Creek fish consumption dose (0.28 mrem) and the Savannah River Swamp fisherman soil exposure pathway were conservatively added together to obtain a total offsite fisherman dose of 0.95 mrem (0.0095 mSv). This potential dose is 0.95% of the DOE 100 mrem/yr dose standard.

Table 6-5 2015 Sportsman Doses Compared to the DOE Dose Standard

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
Sportsman Dose			
Onsite Hunter	12.9	100	12.9
Creek-Mouth Fisherman[b]	0.28	100	0.28
Savannah River Swamp Hunter			
Offsite Hog Consumption	1.67		
Offsite Deer Consumption	4.93		
Soil Exposure[c]	2.90		
Total Offsite Deer Hunter Dose	7.83	100	7.83
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.28		
Soil Exposure[d]	0.67		
Total Offsite Fisherman Dose	0.95	100	0.95

[a] DOE dose standard; 100 mrem/yr (DOE Order 458.1)
[b] In 2015, the maximum dose to a hypothetical fisherman resulted from the consumption of bass from the mouth of Lower Three Runs
[c] Includes the dose from a combination of external exposure to and incidental ingestion and inhalation of the worst-case Savannah River swamp soil
[d] Includes the dose from a combination of external exposure and incidental ingestion and inhalation of Savannah River swamp soil near the mouth of Steel Creek

6.5.4 Potential Risk from Consumption of SRS Creek-Mouth Fish

During 1991 and 1992, in response to a U.S. House of Representatives Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed a fish monitoring plan in conjunction with EPA, the Georgia Department of Natural Resources (GDNR), and SCDHEC. This plan includes the assessment of radiological risk from the consumption of Savannah River fish, and requires that SRS present a summary of the results in the Annual SRS Environmental Report. For 2015, SRS estimated the maximum potential lifetime risk of developing fatal and non-fatal cancer from the consumption of SRS creek-mouth fish to be 1.9E-07. That is, if 10 million people each received a dose of 0.28 mrem, there is a potential for 1.9 excess cancer incidents.

6.6 RELEASE OF MATERIAL CONTAINING RESIDUAL RADIOACTIVITY

DOE Order 458.1 provides for the establishment of authorized surface contamination limits, which in turn allow unconditional release of personal and real property. This order defines personal property as "*property of any kind, except for real property*" and defines real property as "*land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures, or other such items, that would be personal property if not attached.*" SRS handles unconditional release of real property on a case-by-case basis, which requires specific approval from DOE. SRS did not release any real property in 2015, so the following discussion is associated with release of personal property from SRS. DOE Order 458.1 specifies that an annual summary of cleared property must be prepared and submitted to the Field Element Manager (i.e., DOE-SR Manager).

6.6.1 Property Release Methodology

SRS governs the unconditional release of equipment and material by procedures. Following a radiological survey, SRS can unconditionally release an item if it meets specific documented limits. For items meeting unconditional release criteria, SRS generates a form and electronically attaches it to the applicable radiological survey via the Visual Survey Data System. SRS subsequently compiled these electronic forms and coordinated a site-wide review to determine the amount of material and equipment released from SRS facilities in 2015. These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 458.1.

SRS unconditionally released a total of 10,124 items of personal property from radiological areas in 2015. Most of these items did not leave the Site. However, all of these items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria (the recently implemented DOE Order 458.1 allows the use of DOE Order 5400.5 derived supplemental limits for unconditional release of equipment and materials).

In 2003, DOE approved a SRS request to use supplemental limits for releasing material from the Site with no further DOE controls. These supplemental release limits, provided in Table 31 of *Radiological Environmental Dose Assessment Methods and Compliance Dose Results for 2015 Operations at the Savannah River Site* (Jannik and Dixon 2016), are dose-based, and are such that if any member of the public received any exposure, it would be less than 1 mrem/yr. The supplemental limits include both surface and volume concentration criteria. The surface criteria are very similar to those used in previous years. The volume criteria allow SRS the option to dispose of potentially volume-contaminated material in Three Rivers Landfill, an onsite sanitary waste facility. In 2015, SRS did not release any material from the Site using the supplemental release limits volume concentration criteria.

6.7 RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

DOE Order 458.1 requires that SRS conduct Site operations in a manner that protects the local biota from adverse effects due to radiation and radioactive material releases. To demonstrate compliance with this requirement, SRS uses the approved DOE Standard, DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2002).

The biota dose rate limits specified in this standard are:

- Aquatic Animals 1.0 rad/day (0.01 gray/day),
- Riparian Animals 0.1 rad/day (0.001 gray/day),
- Terrestrial Plants 1.0 rad/day (0.01 gray/day), and
- Terrestrial Animals 0.1 rad/day (0.001 gray/day).

6.7.1 DOE Biota Concentration Guides

SRS conducts evaluations of plant and animal doses for water and land systems using the RESRAD Biota model (version 1.5) (SRS EDAM 2012), which directly implements the DOE (2002) guidance.

For water systems (animals who live in the water or along river banks), the RESRAD Biota model performs a combined water-plus-sediment evaluation. SRS performed initial screenings in 2015 using maximum radionuclide concentration data from SRS's 13 stream and sediment sampling locations that are located within SRS. These screenings determine the biota concentration guide by adding the fractions for each of the 13 assessed aquatic systems. A sum of the fractions less than 1.0 indicates the sampling site has passed its initial pathway screening, which means that the biota dose rate limits were not exceeded and no further assessments are needed. For 2015, all SRS aquatic system locations passed the initial screening and no further assessments were required.

For the land based systems evaluation, SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2015, all land based locations passed their initial pathway screenings.

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7 GROUNDWATER MANAGEMENT PROGRAM

The groundwater management program at the Savannah River Site (SRS) achieves the following objectives:

- Ensuring future groundwater contamination does not occur,
- Monitoring groundwater to identify areas of contamination,
- Remediating groundwater contamination as needed, and
- Conserving groundwater.

This chapter describes the site-wide programs in place at the SRS for protecting, monitoring, remediating, and using groundwater.

2015 Highlights

Drinking Water Standards

The 2015 data show no exceedances of drinking water standards (maximum contaminant limit [MCLs] or regional screening levels [RSLs]) in the SRS Boundary wells near A/M Area.

Removal of Groundwater Contaminants

In 2015, SRS removed 8,775 lbs of volatile organic compounds (VOCs) from groundwater and the vadose zone, and prevented 113 curies of tritium from reaching SRS streams.

Offsite Groundwater Monitoring (GA)

For more than 15 years, detections of tritium in Georgia groundwater monitoring wells have been well below the MCL for tritium (20 pCi/mL). This data supports the conclusions drawn from a groundwater model developed by the U.S. Geological Survey (USGS) that indicates there is no mechanism by which groundwater could flow under the Savannah River and contaminate Georgia wells (Cherry 2006).

7.1 INTRODUCTION

In the past, some Savannah River Site (SRS) operations released chemicals and radionuclides into the soil and contaminated the groundwater around hazardous waste management facilities and waste disposal sites. Because of these past releases, SRS operates extensive groundwater monitoring and groundwater remediation programs.

The SRS groundwater monitoring program consists of wells for sampling and monitoring groundwater contaminants. Wells are monitored regularly to meet sampling requirements in the Federal Facility Agreement (FFA) for the Savannah River Site (FFA 1993) approved monitoring plans and Resource Conservation and Recovery Act (RCRA) permits. SRS uses laboratories certified by the South Carolina Department of Health and Environmental Control (SCDHEC) to analyze groundwater samples.

Chapter 7 Key Terms

Aquifer *is an underground water supply – one found in porous rock, sand, gravel, etc.*

Attenuation *is a reduction of groundwater contaminants over time due to naturally occurring physical, chemical, and biological processes.*

Confining unit *is the opposite of an aquifer. It is a layer of rock or sand that limits the movement of groundwater in and out of an aquifer.*

Contaminants of Concern *are contaminants found at the unit that have undergone detailed analysis and have been found to present a potential threat to human health and the environment.*

Groundwater *is water found underground in cracks and spaces in soil, sand, and rocks.*

Maximum Contaminant Level (MCL) *is the highest level of a contaminant allowed in drinking water.*

Plume *is a volume of contaminated water originating at a waste source (e.g., a hazardous waste disposal site). It extends downward and outward from the waste source.*

Regional Screening Level (RSL) *is the risk-based concentration derived from standardized equations combining exposure assumptions with toxicity data.*

Remediation *is the assessment and cleanup of sites contaminated with waste due to historical activities.*

Surface water *is water found above ground (e.g. streams, lakes, wetlands, reservoirs, and oceans).*

Waste unit *refers to a particular area that is, or may be, posing a threat to human health or the environment. They range in size from a few square feet to tens of acres and include basins, pits, piles, burial grounds, landfills, tank farms, disposal facilities, process facilities, and groundwater contamination.*

The monitoring data show that the majority of contaminated groundwater is located in the central areas of the SRS, and does not extend beyond the SRS boundary. Groundwater contamination at the SRS is primarily limited to the Upper Three Runs/Steed Pond Aquifers and the Gordon/Lost Lake Aquifers (Figure 7-1). SRS submits summaries of groundwater data to regulatory agencies and, if necessary, takes appropriate action (i.e., remediation or removal activities).

SRS uses several technologies to remediate groundwater that exceeds the maximum contaminant levels [MCLs] or the regional screening levels [RSLs]). Remediation strategies include closing waste units to reduce the potential for contaminants to reach groundwater, actively treating contaminated water, and employing passive and natural (attenuation) groundwater remedies. The U.S. Department of Energy (DOE) and the regulatory agencies must agree on the appropriate final disposition of the waste units.

Major groundwater remediation activities at SRS focus on volatile organic compounds (VOCs) and tritium. VOCs in groundwater, mainly trichloroethylene (TCE) and tetrachloroethylene (PCE), originated from use as degreasing agents in industrial operations at SRS. Tritium in groundwater stemmed from reactor operations, which ceased in 1991. Examples of SRS groundwater corrective action operations include surface water management and using trees and plants to remove or break down contaminants (phytoremediation). These operations are successfully removing VOCs from the groundwater and effectively reducing tritium releases into SRS streams and the Savannah River.

7.2 GROUNDWATER AT SRS

The groundwater flow system at SRS consists of four major aquifers separated by confining units: Upper Three Runs/Steed Pond, Gordon/Lost Lake, Crouch Branch, and McQueen Branch. Groundwater flow in recharge areas generally migrates downward and laterally. It eventually flows into the Savannah River and its tributaries, or migrates into the deeper regional flow system. Figure 7-1 is a three-dimensional block diagram of these units at SRS and the generalized groundwater flow patterns within those units.

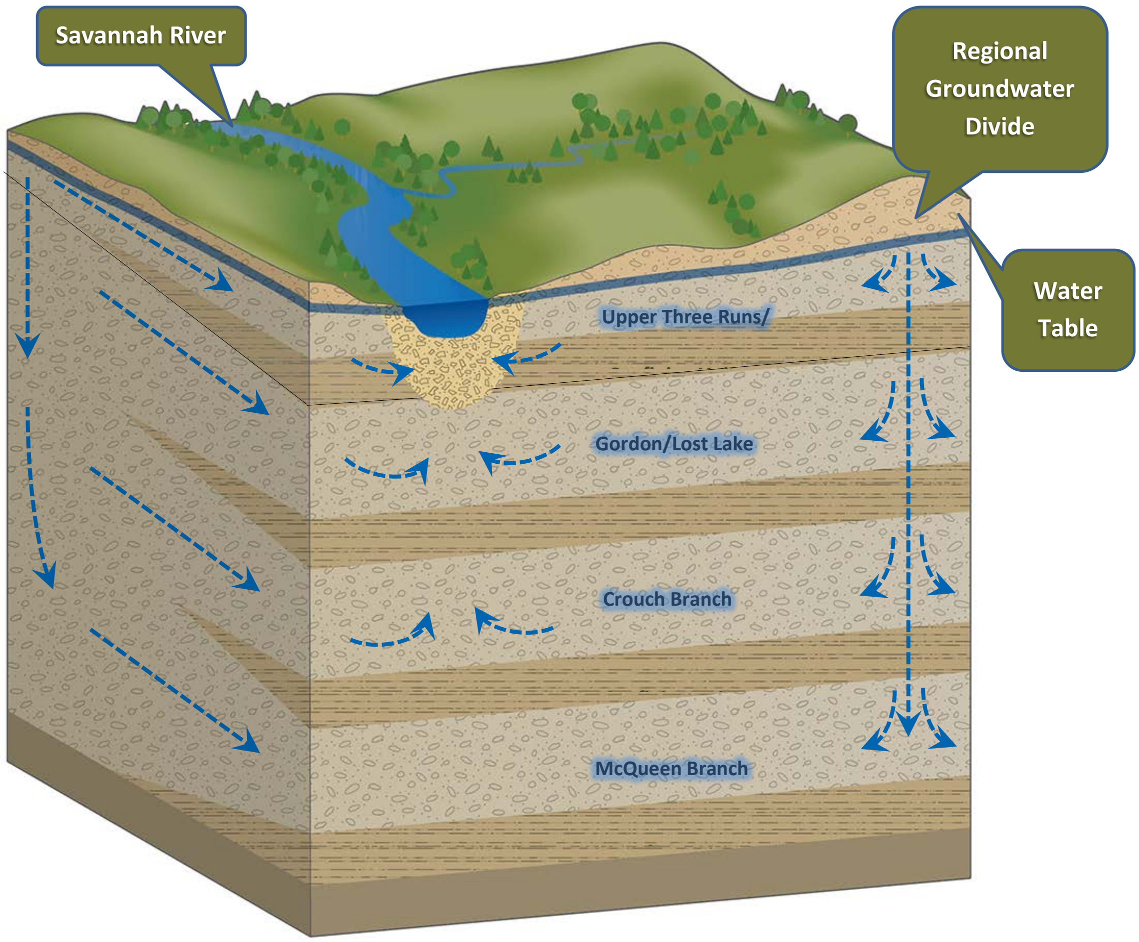

Figure 7-1 Groundwater at SRS

7.3 GROUNDWATER PROTECTION PROGRAM AT SRS

SRS has designed and implemented a groundwater protection program to prevent any new releases to groundwater, and remediate groundwater contamination to meet federal and state laws and regulations, DOE orders, and SRS policies and procedures. It contains the following elements:

- Protecting SRS groundwater,
- Monitoring SRS groundwater,
- Remediating contaminated SRS groundwater, and
- Conserving SRS groundwater.

7.3.1 Protecting SRS Groundwater

SRS groundwater-related activities focus on preventing and monitoring groundwater contamination, protecting the public and environment from contamination, and protecting groundwater quality for future use. Groundwater protection is performed through the following activities:

- Preventing or controlling groundwater contamination sources from construction sites, hazardous waste management facilities, and waste units;
- Monitoring groundwater and surface water to detect contaminants; and
- Reducing contaminants via a groundwater cleanup program.

7.3.2 Monitoring SRS Groundwater

The purpose of monitoring groundwater is to observe and evaluate the changes in the groundwater quality over time, and to establish, as accurately as possible, the baseline quality of the groundwater occurring naturally in the aquifers. The SRS groundwater monitoring program includes two primary components: groundwater contaminant source monitoring, and groundwater surveillance monitoring. SRS evaluates groundwater-monitoring data frequently to identify whether new groundwater contamination exists or if current monitoring programs require modification in order to maintain an optimal monitoring program.

SRS uses groundwater monitoring data to determine the effects of Site operations on groundwater quality. The program supports several critical activities:

- Compliance with environmental regulations and DOE directives,
- Evaluation of the current status of groundwater plumes,
- Evaluation of the suitability of a new facility being located near or within the groundwater plume footprint, and
- Basic and applied research projects to enhance groundwater remediation.

The movement of water from the ground's surface into the aquifers can carry contamination along with it, resulting in underground plumes of contaminated water (Figure 7-2). Monitoring the groundwater around SRS facilities and known waste disposal sites and associated surface waters is the best way to detect and track contaminant migration. Through careful monitoring and analysis, SRS implements appropriate remedial or corrective actions. Figure 7-3 shows the groundwater plumes associated with SRS.

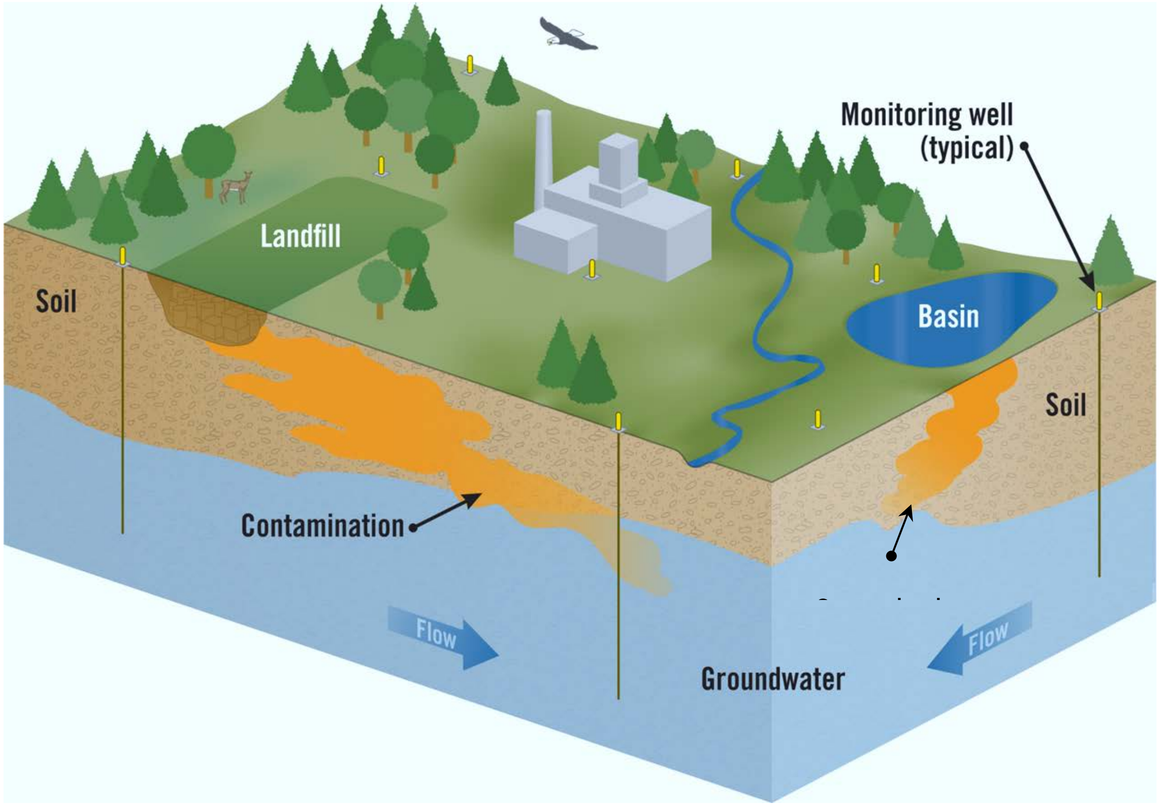

Figure 7-2 How Contamination Gets to Soil and Groundwater

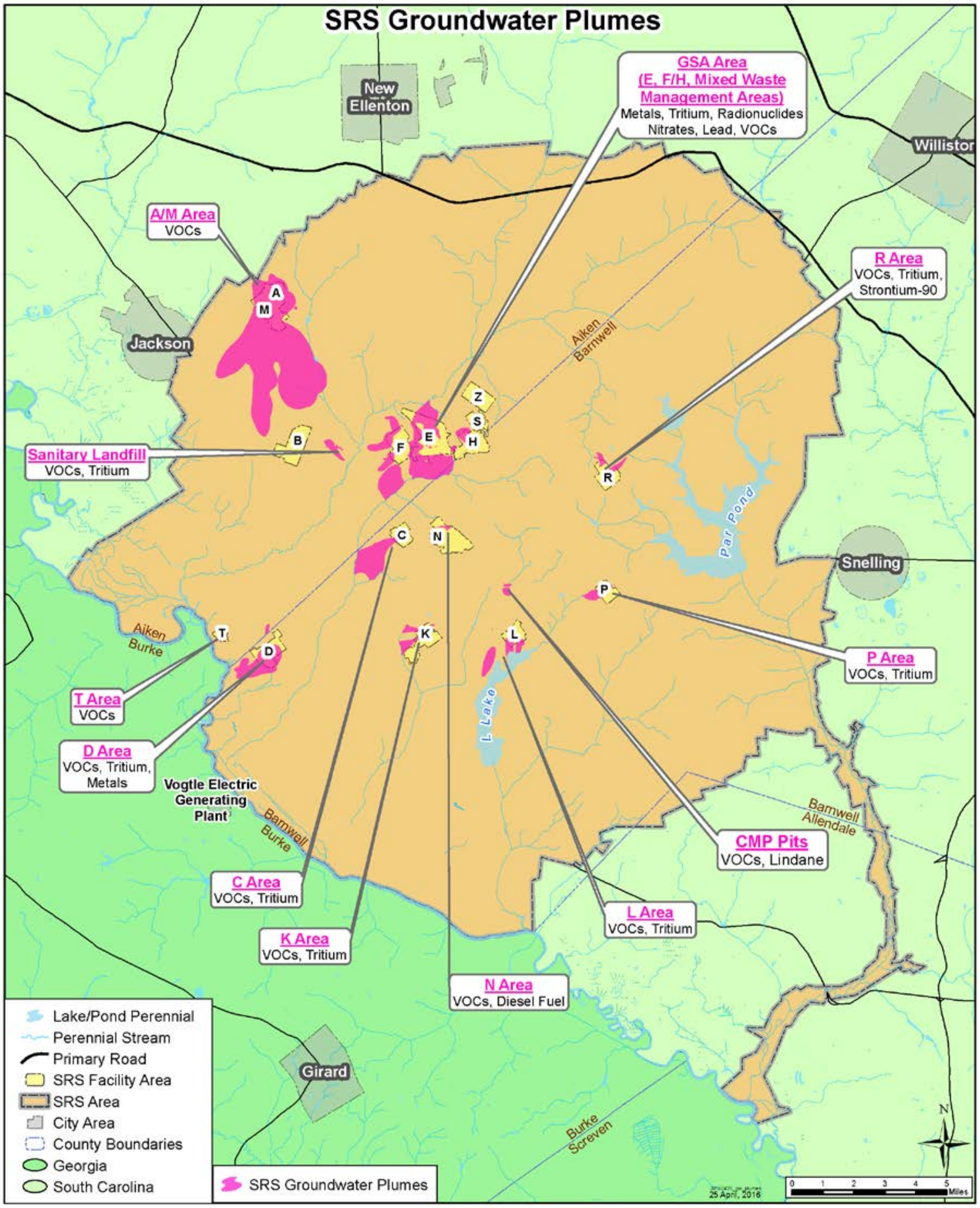

Figure 7-3 Groundwater Plumes at SRS

7.3.2.1 Groundwater Surveillance Monitoring

Surveillance monitoring efforts at SRS focus on the collection and analysis of data to characterize the groundwater flow and the presence or absence of contaminants. Characterization efforts at SRS include the following activities:

- Collecting soil and groundwater samples to determine the extent of contamination;
- Obtaining geologic soil cores or seismic profiles to better determine underground structural features, as warranted;
- Installing wells for periodic collection of water-level measurements and groundwater samples;
- Developing maps to help define groundwater flow;
- Performing calculations based on water elevation data in order to estimate groundwater velocities;
- Analyzing regional groundwater to provide a comprehensive understanding of SRS groundwater movement, and specifically the transport of contaminants near facilities and individual waste units; and
- Characterizing regional surface water flow to assess contaminant risk to perennial streams, which are the receptors of groundwater flow.

7.3.2.2 2015 Groundwater Data Summary

A significant plume exists beneath A/M Areas. SRS uses more than 150 wells to monitor this plume. Some of these monitoring wells lie within a half-mile of the northwestern boundary of SRS. The direction of groundwater flow in the area parallels the Site boundary; however, groundwater flow direction can fluctuate. Because of this pattern, SRS pays particular attention to the groundwater results from these wells located along the Site boundary, as well as between the A/M Areas and the nearest population center, Jackson, South Carolina (Figure 7-4). The 2015 data show no exceedances of drinking water standards (MCLs or RSLs) in the SRS Boundary Wells near A/M Area. In the majority of these SRS boundary wells, no detectable contamination exists.

Although most of the SRS contaminated groundwater plumes do not approach the Site boundary, the potential to affect Site streams does exist when contaminated groundwater flows into nearby streams. SRS monitors and evaluates groundwater contamination that flows into Site streams, and remediates as appropriate. In conjunction with stream monitoring, SRS conducts extensive monitoring near SRS waste units and operating facilities, regardless of their proximity to the boundary. Details concerning groundwater monitoring and conditions at individual sites can be found in the *Savannah River Site Groundwater Management Strategy and Implementation Plan* (SRNS 2011) and the *Environmental Monitoring Program Management Plan*, SRS Manual 3Q1, Procedure 101, Revision 7 (SRS EM Plan 2015).

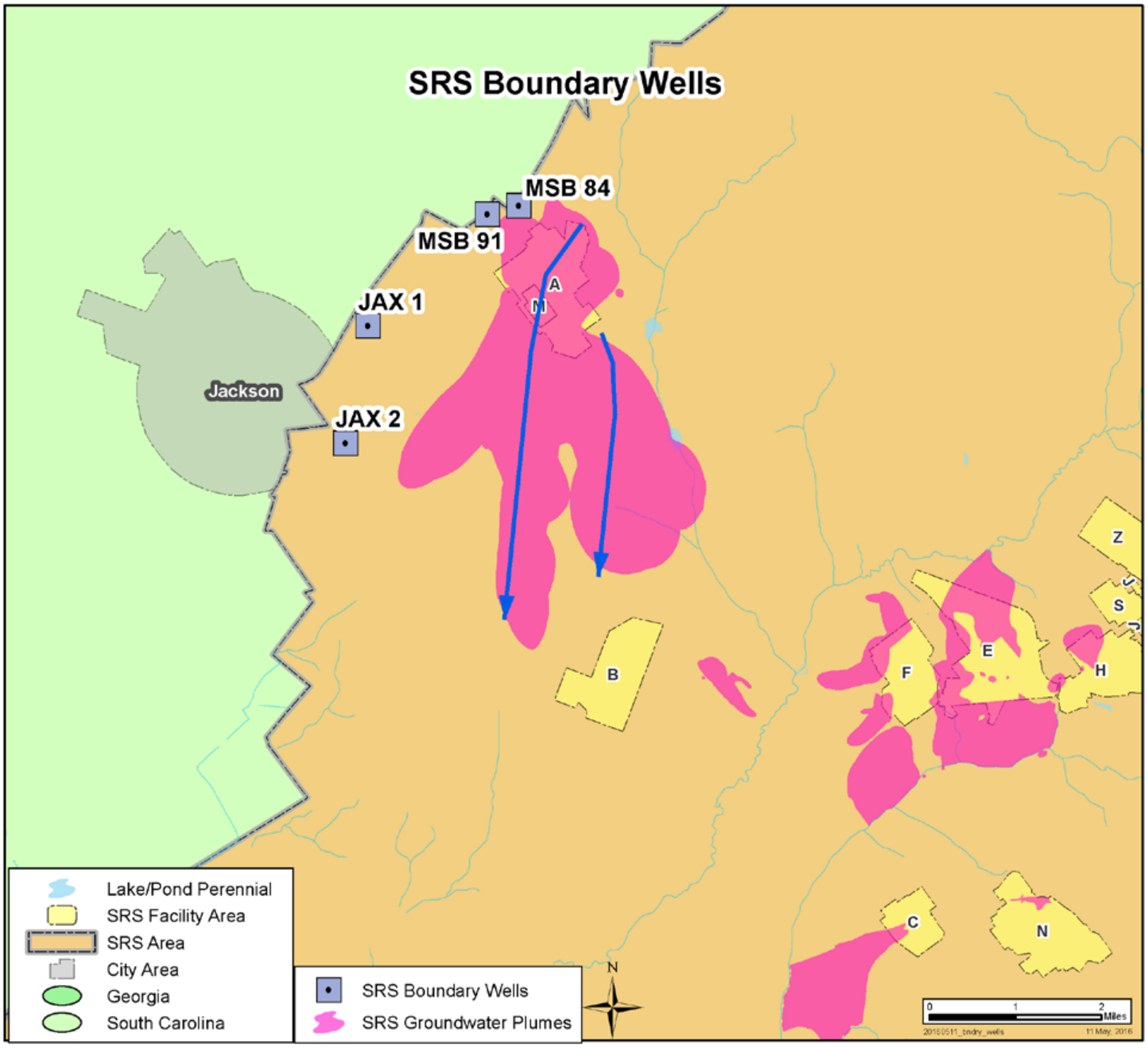

Figure 7-4 Location of Site Boundary Wells at SRS - Between A/M Areas and Jackson, South Carolina

Table 7-1 identifies the typical contaminants of concern (COCs) found in SRS groundwater and their significance. These COCs are a result of SRS operations that released chemicals and radionuclides into the soil and groundwater around hazardous waste management facilities and waste disposal sites. Table 7-2 presents a general summary of the most common contaminants found in groundwater at SRS facility areas, based on 2015 monitoring data, and compares the maximum concentrations to the appropriate drinking water standards. As shown in Table 7-2, major COCs in the groundwater include common degreasers (TCE and PCE) and radionuclides (tritium, gross alpha, and nonvolatile beta emitters).

Since the early 1990s, SRS has directed considerable effort toward assessing the likelihood of flow beneath the Savannah River from South Carolina to Georgia. A groundwater model developed by the U.S. Geological Survey (USGS) indicates there is no mechanism by which groundwater could flow under the Savannah River and contaminate Georgia wells (Cherry 2006). SRS continues to monitor for tritium in groundwater

Table 7-1 Typical Contaminants of Concern at SRS

Contaminants	Sources	Limits and Exposure Pathways
Gross Alpha	Alpha radiation is the emission of positively charged particles from the disintegration (radioactive decay) of certain elements including uranium, thorium, and radium. Alpha radiation in drinking water can be in the form of dissolved minerals, or in the case of radon, as a gas.	MCL is 15 pCi/L. An alpha particle cannot penetrate a piece of paper or human skin. Causes increased risk of cancer through ingestion or inhalation.
Nonvolatile Beta	Beta decay commonly occurs among neutron-rich fission byproducts produced in nuclear reactors.	MCL for beta particles is 4 mrem/yr. Causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
Tritium	Radioactive isotope of hydrogen with a half-life of 12.3 years. It emits a very weak beta particle and behaves like water.	MCL is 20 pCi/mL. It primarily enters the body when people swallow tritiated water. Causes increased risk of cancer through ingestion, inhalation or dermal exposure.
TCE/PCE	VOCs used primarily to remove grease from fabricated metal parts.	MCL is 5 µg/L. Causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
Vinyl Chloride	VOC; degradation product of TCE/PCE.	MCL is 2 µg/L. Causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
1,4-Dioxane	Synthetic industrial chemical used as a stabilizer for VOCs to reduce degradation	RSL for Tap Water is 0.46 µg/L. Causes increased risk of cancer through ingestion, inhalation, or dermal exposure.

Table 7-2 Summary of the Maximum Contaminant Concentrations for Major Areas within SRS

Location	Major Contaminant	Units	2015 Maximum Concentration	Well	MCL or RSL	Likely Stream Endpoints
A/M Area	Tetrachloroethylene	µg/L	99,000	MSB002BR	5	Tims Branch/Upper Three Runs in Swamp in West
	Trichloroethylene	µg/L	35,000	MSB107B	5	
	1,4-Dioxane	µg/L	300	ARP 1A	6.1[c]	
C Area	Tetrachloroethylene	µg/L	7.1	CRP 5C	5	Fourmile Branch and Castor Creek
	Trichloroethylene	µg/L	321	CRW020D	5	
	Vinyl chloride	µg/L	209	CRP 50B	2	
	cis-1,2-Dichloroethne	µg/L	181	CRP 50B	70	
	Tritium	pCi/mL	3,500	CTA003D	20	
CMP Pits (G Area)	Tetrachloroethylene	µg/L	483	CMP 45D	5	Pen Branch
	Trichloroethylene	µg/L	263	CMP 10C	5	
	1,4-Dioxane	µg/L	80	CMP 11D	0.46	
	Lindane	µg/L	4.88	CMP 35D	0.2	
D Area	Tetrachloroethylene	µg/L	16	DOB 11	5	Savannah River Swamp
	Trichloroethylene	µg/L	237	DCB 62	5	
	Vinyl Chloride	µg/L	19	DOB 15	2	
	Tritium	pCi/mL	274	DCB 26AR	20	
E-Area MWMF	Trichloroethylene	µg/L	280	BSW 4D2	5	Upper Three Runs/ Crouch Branch in North; Fourmile Branch in South
	1,4-Dioxane	µg/L	700	BSW 6C3	6.1[c]	
	Tritium	pCi/mL	19,200	BSW 8C1	20	
	Gross Alpha	pCi/L	26.2	BSW 3D2	15	
	Nonvolatile Beta	pCi/L	71.1	HSP-097A	50[a]	

Location	Major Contaminant	Units	2015 Maximum Concentration	Well	MCL or RSL	Likely Stream Endpoints
F-Area HWMF	Trichloroethylene	µg/L	16.3	FSB 95CR	5	Fourmile Branch
	Tritium	pCi/mL	1,990	FSB 94C	20	
	Gross Alpha	pCi/L	388	FSB 94C	15	
	Nonvolatile Beta	pCi/L	1,190	FSB 95DR	50[a]	
F-Area Tank Farm	Tritium	pCi/mL	16.7	FTF030D	20	Fourmile Branch / Upper Three Runs
	Nonvolatile Beta	pCi/L	827	FTF 28	50[a]	
	Manganese	µg/L	395	FTF009R	430	
H Area	Trichloroethylene	µg/L	4.3	HGW 3D	5	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
	Gross Alpha	pCi/L	12.9	HR3 16DU	15	
	Nonvolatile Beta	pCi/L	50.4	HAA 12A	50[a]	
	Tritium	pCi/mL	29.6	HGW2D	20	
H-Area HWMF	Trichloroethylene	µg/L	86.5	HSB120C	5	Fourmile Branch
	Tritium	pCi/mL	1,650	HSB113DR	20	
	Gross Alpha	pCi/L	78.7	HSB102D	15	
	Nonvolatile Beta	pCi/L	1,080	HSB102D	50[a]	
H-Area Tank Farm	Tritium	pCi/mL	67.4	HAA 12C	20	Fourmile Branch / Upper Three Runs
	Gross Alpha	pCi/L	7.6	HAA 4D	15	
	Manganese	µg/L	539	HAA017C	430	
K Area	Tetrachloroethylene	µg/L	5.4	KRP 9	5	Indian Grave Branch
	Trichloroethylene	µg/L	5.5	KRP 9	5	
	Tritium	pCi/mL	5,420	KRB 19D	20	
L Area	Tetrachloroethylene	µg/L	56	LSW 25DL	5	L-Lake
	Trichloroethylene	µg/L	4	LSW030DL	5	
	Tritium	pCi/mL	645	LSW 25DL	20	
P Area	Trichloroethylene	µg/L	7,100	PGW025B	5	Steel Creek
	Tritium	pCi/mL	16,200	PSB002C	20	
R Area	Trichloroethylene	µg/L	13.2	RAG008B	5	Mill Creek in Northwest; Tributaries of PAR Pond
	Tritium	pCi/mL	575	RPS004C	20	
	1,4 Dioxane	µg/L	3.3	RPS004C	0.46	
	Strontium-90[b]	pCi/L	111	RSE 10	8	
Sanitary Landfill	1,4-Dioxane	µg/L	201	LFW 62C	6.1[c]	Upper Three Runs
	Trichloroethylene	µg/L	7.7	LFW 32	5	
	Mercury	µg/L	3.4	LFW 44D	2	
TNX	Trichloroethylene	µg/L	113	TBG 3	5	Savannah River Swamp
Z Area	Technetium-99	pCi/L	238	ZBG 2	50[a]	Upper Three Runs
	Nonvolatile Beta	pCi/L	158	ZBG 2	50[a]	
	Gross Alpha	pCi/L	23.3	ZBG002D	15	
	Nitrate-Nitrite as Nitrogen	mg/L	9.9	ZBG 2	10	

a The MCL for nonvolatile beta activity (pCi/L or pCi/mL) equivalent to 4 mrem/yr varies according to which specific beta emitters are present in the sample. At SRS this value equates to 50 pCi/L.

b At R Area, strontium-90 is sampled for every five years per agreement with state and federal regulators.

C RCRA Permitted Groundwater Protection Standard (GWPS) for 1,4-Dioxane

Note: MWMF is the Mixed Waste Management Facility; HWMF is the Hazardous Waste Management Facility; TNX is the 678-T facilities, CMP is the Chemicals, Metals and Pesticides Pits wells in Georgia (Figure 7-5) by collecting samples annually during the second half of the year. Detections of tritium in groundwater in these Georgia offsite wells have been below 1.5 pCi/mL since 1999 (Figure 7-6). The MCL, or drinking water standard, for tritium is 20 pCi/mL. The results are consistent with aquifer recharge from rainfall in the Central Savannah River Area. The overall groundwater data trend continues to show a gradual decline in the levels of tritium in the Georgia wells.

SRS collected groundwater samples from 40 of the 44 offsite wells in Georgia during 2015. Three wells could not be sampled because they were dry (i.e., no water available) and one well could not be sampled due to damage to the well casing. All samples collected in 2015 had no detectable concentrations of tritium.

7.3.3 Remediating SRS Groundwater

SRS's environmental remediation program has been in place for more than 20 years. The remediation and monitoring of contaminated groundwater is regulated under RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as specified in the Federal Facility Agreement (FFA) for the Savannah River Site (FFA 1993). The remediation efforts focus on removing mass, reducing contaminant levels, and reducing exposure to humans and the environment for those contaminants that exceed either MCLs or RSLs as identified in Table 7-2.

For each remediation project, SRS determines the degree and extent of groundwater contamination through characterization. After completing characterization, SRS and the regulatory agencies decide upon a strategy for remediating the groundwater.

SRS often applies remedial actions to the groundwater contamination source. For instance, soil vapor extraction (pulling contaminated soil vapor from the vadose zone), is widely used at SRS to remove VOCs from the unsaturated (vadose) zone above the water table.

SRS implements several groundwater remedial technologies. These technologies manage the rate of contaminant movement and reduce contaminant exposure risk to human health and ecological receptors. Thirty-seven remediation systems are currently operating. Eighteen groundwater treatment systems are no longer in use. In 2015, SRS removed 8,775 lbs of VOCs from the groundwater and the vadose zone, and prevented 113 curies of tritium from reaching SRS streams (SRNS 2016b). SRS has worked to reduce the tritium flux to Fourmile Branch for over two decades. Since 2000, SRS has reduced the tritium flux to Fourmile Branch by almost 70% using groundwater remedial technologies (subsurface barriers and water capture with irrigation). The largest reductions are associated with the MWMF Phytoremediation Project which reduced the release to the Branch by approximately 113 Curies in 2015. Overall, the size, shape, and volume of most SRS groundwater plumes are shrinking since the majority of the contaminant sources have remediation systems in place. You will find additional information concerning the SRS remediation systems in the *Soil and Groundwater Closure Projects Technology Descriptions* (WSRC 2007).

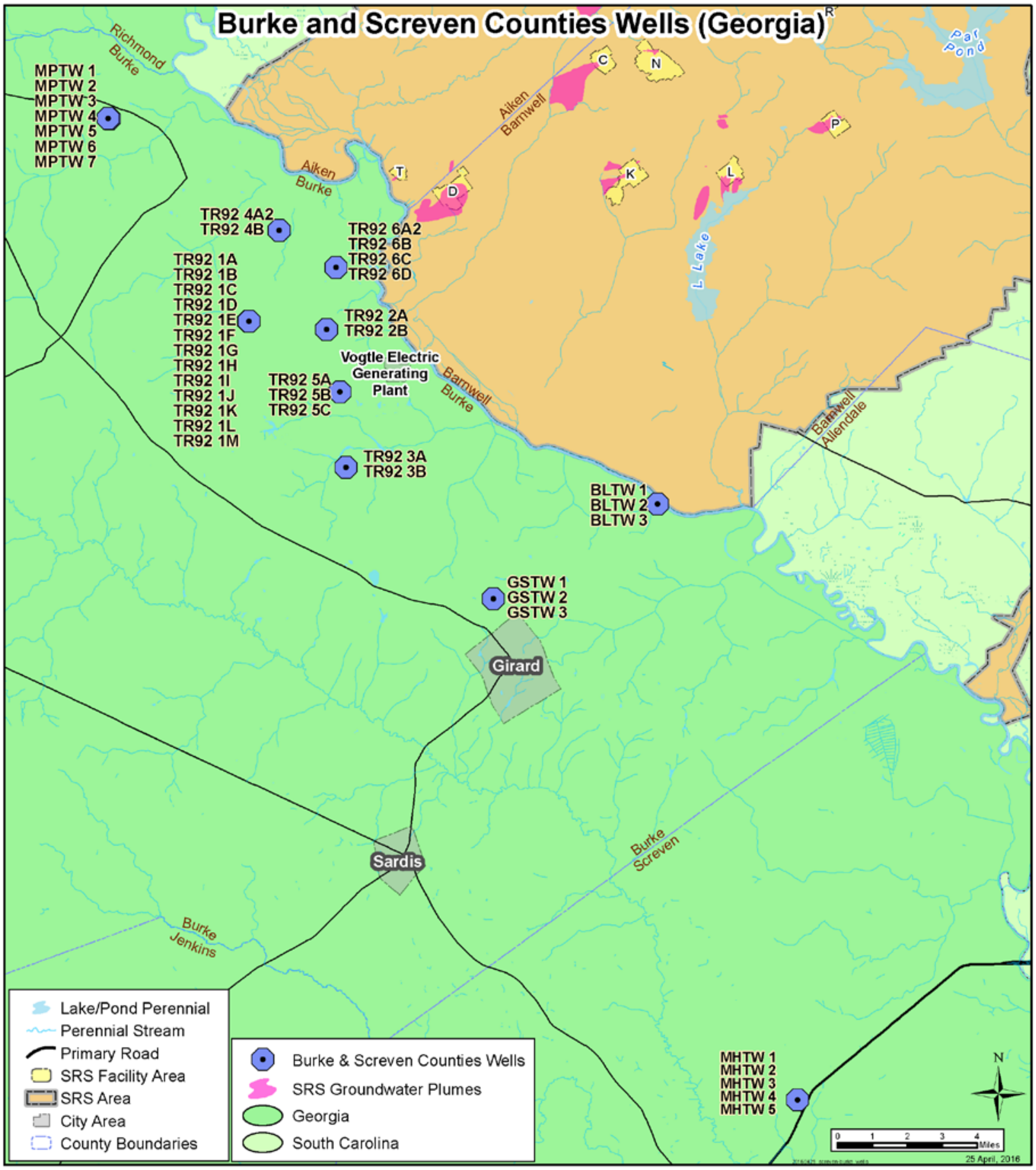

Figure 7-5 Location of Monitoring Wells Sampled for Tritium in Burke and Screven Counties, Georgia

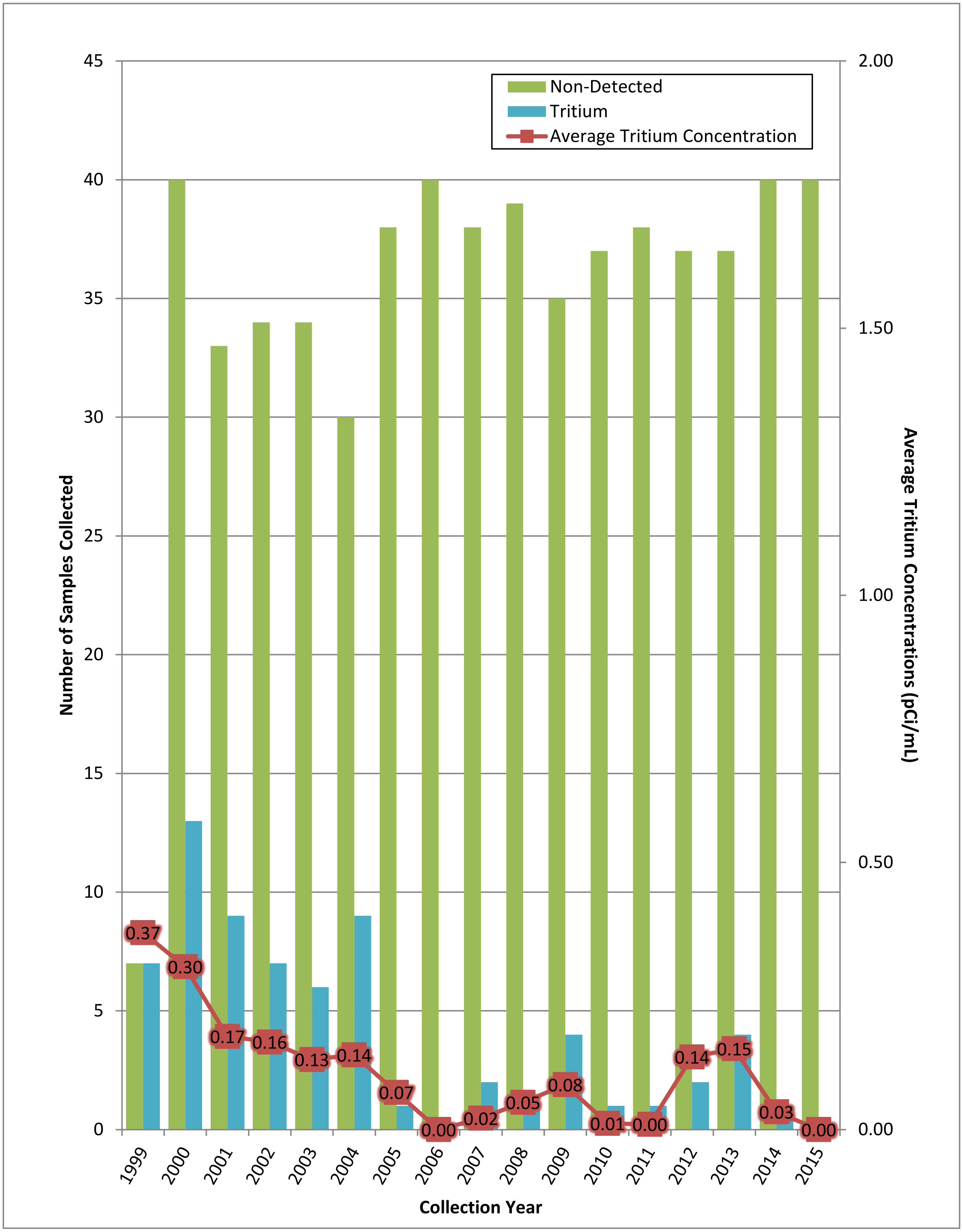

Figure 7-6 Tritium Concentration in Wells Sampled in Burke and Screven Counties, Georgia

7.3.4 Conserving SRS Groundwater

As in the past, SRS continues to report its drinking and process water usage to SCDHEC. In 2015, SRS used 2.65 million gallons of water per day. You will find information on SRS water conservation efforts in Chapter 2, "Environmental Management System."

SRS manages its own drinking and process water supply from groundwater located beneath the SRS. Approximately 40 production wells in widely scattered locations across the Site supply SRS domestic and process water systems. Eight of these wells are domestic water systems that supply drinking water. The other 32 wells provide water for all SRS facility operations. A map of the SRS domestic water system can be found under the "Environmental Maps" heading on the *SRS Environmental Report for 2015* webpage.

The A-Area domestic water system now supplies treated water to most Site areas. The system is comprised of a treatment plant, distribution piping, elevated storage tanks, and a well network. The wells range in capacity from 200 to 1,500 gallons per minute. Remote facilities, such as field laboratories, barricades, and pump houses, utilize small drinking water systems and bottled water. The SRS domestic water systems meet state and federal drinking water quality standards. SCDHEC samples the systems quarterly for chemical analyses. Monitoring the A-Area water system for bacteria occurs monthly. SCDHEC performs sanitary surveys every two years on the A-Area system and inspects the smaller systems every three years. All 2015 water samples complied with SCDHEC and EPA water quality standards.

The process water systems are located in A, F, H, and S Areas. These systems meet the SRS demands for boiler feedwater; equipment cooling water; facility washdown water; and makeup water for cooling towers, fire storage tanks, chilled-water-piping loops, and Site test facilities. Process water wells ranging in capacity from 100 to 1,500 gallons per minute supply water to these systems. In K Area, L Area, and Z Areas, the domestic water system supplies the process water system. At some locations, the process water wells pump to ground level storage tanks, where SRS implements corrosion control measures. At other locations, the wells directly pressurize the process water distribution piping system without supplemental treatment.

8 QUALITY ASSURANCE

The Savannah River Site (SRS) Quality Assurance (QA)/Quality Control (QC) program objectives are to ensure that SRS products and services meet or exceed customers' requirements and expectations. The SRS QA/QC objectives associated with the Environmental Monitoring program are to ensure the environmental data collected through the program accurately represent SRS discharges and the surrounding environment. The SRS QA program is implemented and is conducted to comply with DOE Order 414.1D, "Quality Assurance", ASME NQA-1-2008 with the NQA-1a-2009 Addenda, "QA Requirements for Nuclear Facility Applications, and with 10CFR830 Nuclear Safety Management. In addition, specific programs may have additional QA requirements from outside organizations. For example, under the tank closure program and area closure projects, EPA and the State of South Carolina require DOE to develop and follow a project specific sampling and analysis plan and quality assurance program plan. The Environmental Monitoring program has multiple QA requirements representing sample collection, analyses and reporting, and data management. DOE has other QA programs in place to verify the integrity of analyses determined by onsite and subcontracted offsite environmental laboratories, and to ensure compliance with the quality control program requirements. It is important to ensure that sample results are accurate so that SRS can assess with confidence the impacts SRS activities may have on human health and the environment.

2015 Highlights

Analytical Laboratory Quality Assurance

SRS uses laboratories certified by the South Carolina Department of Health and Environmental Control (SCDHEC) Office of Environmental Laboratory Certification for those environmental monitoring program parameters that are reportable to SCDHEC.

In 2015, the U.S. Department of Energy Consolidated Audit Program (DOECAP) conducted audits at three SRS subcontract laboratories, resulting in no findings of sufficient magnitude to render the audited facility unacceptable to provide service to the DOE.

Quality Control Activities

The results of the 2015 quality control samples identified no defects affecting the analytical results of the surveillance and monitoring programs. Onsite and subcontract laboratories reported acceptable proficiency and maintained SCDHEC certification for all analyses.

8.1 INTRODUCTION

The environmental monitoring QA/QC program is a process designed to improve the methods and techniques used to collect and analyze the environmental data that are the basis for this annual report and to prevent errors in the generation of those data. The QA/QC program includes continuous assessment activities, precision checks, and accuracy checks, as shown in Figure 8-1. The results of activities in one area provide input to assessments or checks conducted in the other two areas in an ongoing process resulting in high quality data. By combining continuous assessment of field, laboratory, and data management performance with checks for accuracy and precision, SRS ensures that all monitoring and surveillance data accurately represent conditions at the SRS. The glossary contains definitions for each term presented in Figure 8-1.

Chapter 8 - Key Terms

Quality assurance is an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure quality in the processes by which products are developed. The goal of QA is to improve processes so that defects do not arise when the product is produced. It is proactive.

Quality control is a set of activities for ensuring quality in products by identifying defects in the actual products. The goal of QC is to identify and correct defects in the finished product before it is made available to the customer. QC is a reactive process.

Stated another way, Quality Assurance makes sure you are doing the right things, the right way. Quality Control makes sure the results of what you have done are what you expected.

Some elements of the QA/QC program are inherent within environmental monitoring standard procedures and practices. SRS personnel assess these elements as part of the continuous assessment process. The DOECAP focuses on the assessment of specific QA/QC program elements. Those elements of Figure 9-1 discussed in this chapter are highlighted in bold text.

8.2 BACKGROUND

DOE Order 414.1D, “Quality Assurance,” requires an integrated system of management activities to ensure that the results of the environmental monitoring program meet the requirements of federal and state regulations and DOE Order 458.1, “Radiation Protection of the Public and the Environment.” SRS uses field and laboratory procedures to guide activities such as sample collection, laboratory analysis, data evaluation, and reporting. SRS uses an integrated testing system to ensure the integrity of analyses performed by SRS and offsite laboratories. In addition, SRS uses QA and QC procedures to verify and control environmental monitoring activities to ensure the resulting data provides a representative evaluation of SRS operational impacts on the health and safety of the public, workers, and the environment.

8.3 QUALITY ASSURANCE PROGRAM SUMMARY

The environmental monitoring QA/QC program focuses on minimizing errors through ongoing assessment and control of the program components. The QA and QC activities are interdependent.

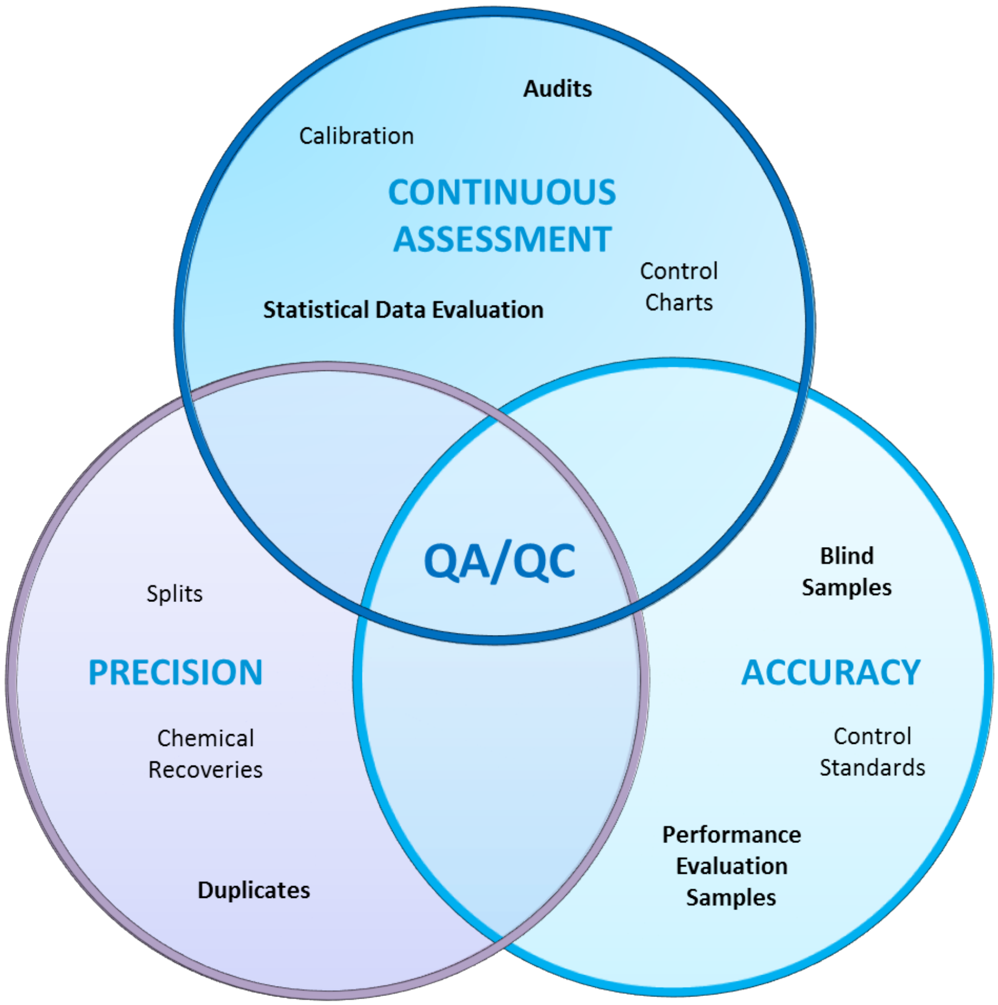

Figure 8-1 Interrelationship between QA/QC Activities

For example, QC detects an ongoing problem with the quality of the product and provides feedback to QA personnel that there is a problem in the process. QA determines the root cause and extent of the problem and changes the process to eliminate the problem, prevent reoccurrences, and improve product quality.

QA activities focus on the processes implemented to produce the data presented in this report. In 2015, QA efforts associated with the environmental monitoring program that resulted in program improvements were:

- Implementing monitoring changes,
- Recertification of three of the SRS onsite laboratories, and
- DOECAP audits of laboratories that support SRS environmental monitoring.

QC activities are those tests and checks that ensure compliance with defined standards. In 2015, these QC activities associated with the environmental monitoring program included:

- Participation in the Mixed Analyte Performance Evaluation Program (MAPEP) by laboratories that perform analytical measurements on SRS samples,
- Participation in proficiency testing for laboratories performing National Pollutant Discharge Elimination System (NPDES) analyses, and
- Collection and analysis of QC samples (duplicates and blind samples) associated with field sampling activities.

8.4 ENVIRONMENTAL MONITORING PROGRAM QA ACTIVITIES

In 2015, SRS continued to transition to the use of the SonTek RiverSurveyor® device for measuring flows in more SRS stream sampling locations. This device, as first discussed in the 2012 Annual Site Environmental Report, provides reliable average stream velocity measurements in either two or three dimensions, has built-in calibrations that are performed during each field use, and is simple to operate.

Other program quality improvements implemented in 2015 included the installation of wireless rain and flow real time modems at nine NPDES industrial stormwater locations, and installation of area velocity sensors at two surface water sampling locations. The modem devices provide immediate notifications of rain or flow events at stormwater outfalls and are programmed with automated samplers for immediate sampling during a flow event.

SRS uses SCDHEC certified laboratories for those environmental monitoring program parameters that are reportable to SCDHEC. SCDHEC certifies the SRS onsite laboratories and offsite subcontract laboratories for a large variety of environmental analyses.

In 2015, SCDHEC performed recertification evaluations of the Environmental Bioassay Laboratory, Environmental Analysis Laboratory, and the Domestic Water Plant Laboratory. These evaluations include a review of QA and QC practices and procedures. SCDHEC renewed the certification for these three onsite laboratories for another three years.

8.4.1 Department of Energy Consolidated Audit Program (DOECAP)

The DOECAP is a comprehensive audit program of contract and subcontract laboratories that provide analytical services to DOE Operations and Field Offices. The DOECAP conducts consolidated audits to reduce the number of audits conducted independently by DOE field sites and standardize audit methodologies, processes, and procedures.

DOECAP performs an annual audit of each subcontract laboratory used by SRS to ensure the laboratories demonstrate technical capability and proficiency and compliance with DOE QA program requirements. The audit evaluates laboratory performance including sample receipt, instrument calibration, analytical procedures, data verification, data reports, records management, nonconformance and corrective actions, preventive maintenance, and sample disposal. Within these topic areas, auditors evaluate the proper use of control charts, control standards, chemical recoveries, performance evaluation samples, and adherence to laboratory procedures.

In 2015, DOECAP conducted audits at three SRS subcontract laboratories used for analyzing environmental samples documented in this annual report, resulting in no findings of sufficient magnitude to render the audited facility unacceptable to provide service to DOE or SRS. There were 40 Priority II findings related to deficiencies in procedures, practices, or non-requirement-based issues. There were no Priority I findings affecting either SRS samples or analyses requested by SRS in 2015. Additionally, during the 2015 audit, the audit team was able to verify that the corrective actions that addressed most of the findings identified during the 2014 audit were satisfactory, thereby closing 24 of the 30 Priority II findings. Six Priority II findings from the 2014 audits remain open. These open findings are in the areas related to deficiencies in procedures, practices, or non-requirement-based issues. These remaining open Priority II findings did not affect the SRS samples or analyses requested by SRS in 2015. Auditors will address these open findings during the 2016 audit.

Priority Definitions

A Priority I finding documents a deficiency that is of sufficient magnitude to render the audited facility unacceptable to provide the affected service to DOE.

A Priority II finding documents a deficiency that is not of sufficient magnitude to render the audited facility unacceptable to provide services to DOE. Each affected laboratory submits corrective action responses to DOECAP that auditors review and approve prior to the next year's audit.

8.5 ENVIRONMENTAL MONITORING PROGRAM QC ACTIVITIES

8.5.1 QC Sampling

SRS personnel collect several types of QC samples, including blinds, field duplicates, trip blanks, and field blanks throughout the year to determine the source of any measurement error. SRS personnel routinely conduct blind sample analyses for field measurements of pH to assess the quality and reliability of field data measurements. For 2015, all 24 blind sample analyses (a blind sample is a sample with a composition known to the submitter, but not to the analyst) were within the acceptable limit of less than a 0.4 pH unit difference between the original and blind samples. Analysis of blind samples tests the analyst's proficiency in performing the specified analysis.

Table 8-1 summarizes the results of blind and duplicate sample analyses associated with the NPDES program. This table addresses analyses conducted at both onsite SRS and offsite subcontract laboratories. The duplicate samples test the samplers' proficiency in collecting the samples. The eight blind and nine duplicate samples with a difference greater than 20% represent six and eight different parameters, respectively. This indicates that in 2015 there were no consistent problems with the laboratory sample analyses.

SRS's water quality (nonradiological) program requires collection of duplicates for 10% of the samples to verify analytical results. SRS onsite and subcontract laboratories continued to analyze duplicate samples from SRS streams and the Savannah River in 2015, as summarized in Table 8-1.

Table 8-1 Summary of Laboratory Blind and Duplicate Sample Analyses

Program and Sample Type	Number of Samples Analyzed	Number of Samples within Acceptable Limits (Percent difference between results < 20%)	Number of Samples Outside Acceptable Limits (Percent difference between results > 20%)
NPDES Blind	94	86	8
NPDES Duplicate	116	107	9
Water Quality River/Stream Duplicate	699	679	20

Though results for the water quality field duplicate sampling program indicate there were some differences between duplicates, there was no impact on conclusions made with the data. Reasons for duplicate results to differ include analytical uncertainties associated with the measurements such as the precision of the analytical instruments and detection limits of the analytical instruments.

The results of field and trip blank analyses associated with the NPDES program are summarized in Table 8-2. Field blanks determine whether the field sampling and sample processing procedures and environments have contaminated the sample. A trip blank is used to document contamination associated with shipping and field handling procedures. The analytical results indicate neither sampling processes nor shipping activities are contributing factors to contaminants found in the actual samples as discussed in Chapter 4, "Nonradiological Environmental Monitoring Program."

Table 8-2 Summary of Trip and Field Blank Sample Analyses

Program and Sample Type	Number of Samples Analyzed	Number of Samples with Results Below Detection Limits
NPDES Trip Blank	29	29
NPDES Field Blank	12	12

8.5.2 Laboratory Proficiency Testing

SRS laboratories performing NPDES analyses maintained state certification for all analyses after achieving acceptable results in SCDHEC-required proficiency testing.

Proficiency testing is also known as comparative testing and is an evaluation of a laboratory's performance against pre-established criteria by means of inter-laboratory comparisons.

The proficiency testing is required per state regulation 61-81 "State Environmental Laboratory Certification Program." All laboratories used proficiency-tested providers approved by SCDHEC. During 2015, the onsite and subcontract laboratories participated in various water pollution performance evaluation studies, and each reported proficiency in 100% of the parameters tested. Therefore, both onsite and subcontract laboratories maintained SCDHEC certification for all analyses performed for SRS.

All laboratories with licenses to handle radioactive materials that perform environmental analytical measurements in support of the DOE Environmental Management activities are required to participate in MAPEP, a laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE. One SRS laboratory continues to participate in MAPEP, analyzing MAPEP performance evaluation samples including water, soil, air filter, and vegetation matrices all with environmentally important stable inorganic, organic, and radioactive constituents. MAPEP offered two separate studies in 2015. In the second study, MAPEP provided an “unknown” sample. The SRS Environmental Laboratory participated in the two studies receiving 98.6% acceptable results in each. For the unknown sample in the second study, which was concrete, all 13 analytical results provided were acceptable. MAPEP results for SRS subcontract laboratories were also satisfactory, with an average percent of passing parameters of 94% for water matrix and 98% for soil matrix. For the failed analyses the laboratories develop corrective actions. The objective of the corrective actions is to prevent a recurrence of failed analyses. These corrective actions may include modification to sample preparation or analytical procedures.

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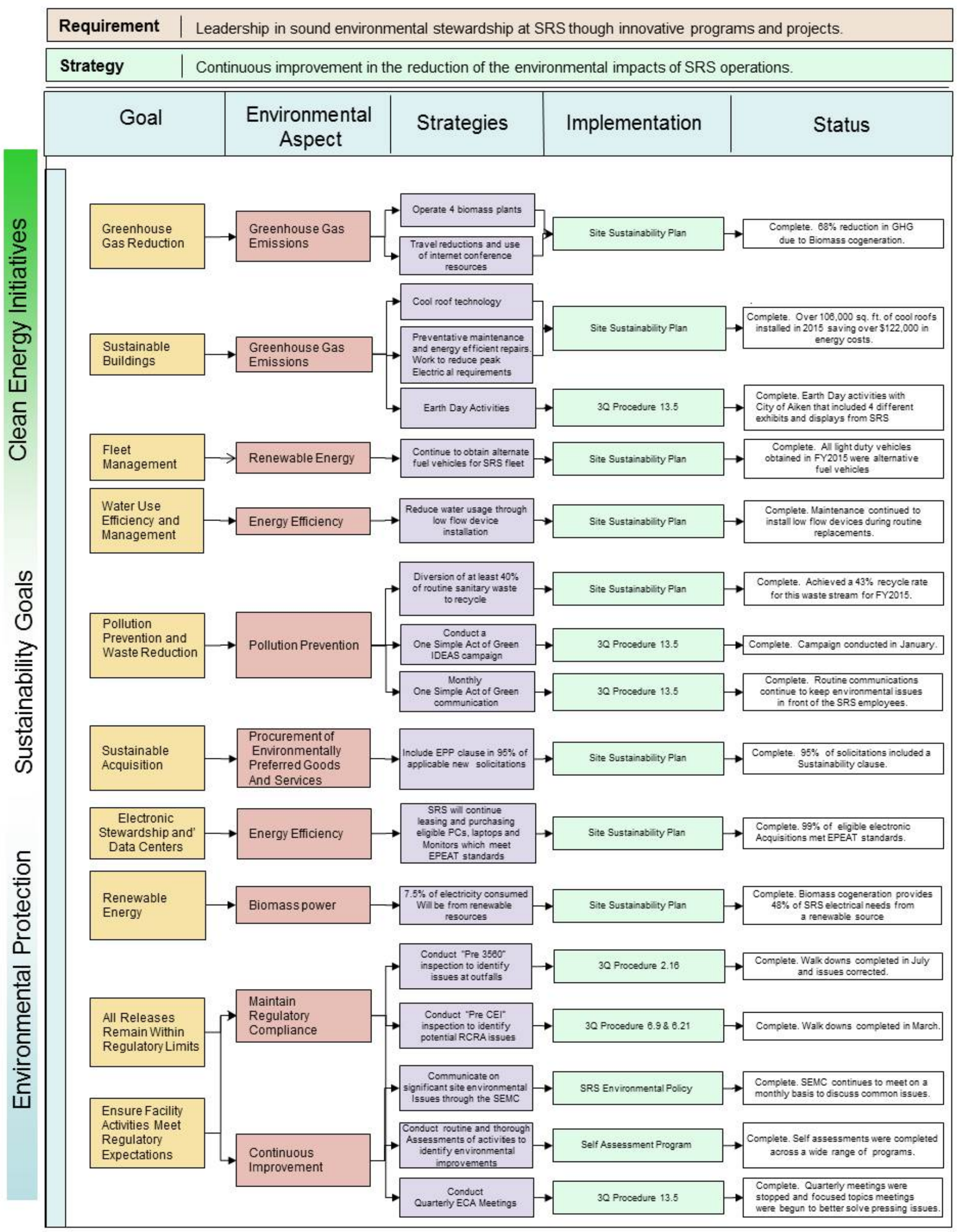
APPENDIX A: ENVIRONMENTAL MANAGEMENT SYSTEM

FY15 EMS Goals and Objectives



APPENDIX B: ERRATA

The following entries correct information that was reported inaccurately in the Savannah River Site Environmental Report for 2014 (SRNS-RP-2015-00008):

Chapter 3, page 3-14, under the National Environmental Policy Act (NEPA).

Environmental Assessments for the Acceptance and Disposition of Used Nuclear Fuel Containing U.S.-Origin Highly Enriched Uranium from the Federal Republic of Germany [DOE/EA-1977] and a Proposal to permit 750 Acres at the Savannah River Site for Use by the State of South Carolina Military Department [DOE/EA-1999] are in progress.

Chapter 3, Page 3-13, Table 3-3.

Number of EA’s is 1, Total number of NEPA reviews is 361.

APPENDIX C: ENVIRONMENTAL SURVEILLANCE MEDIA AND SAMPLING FREQUENCIES

Appendix Table C-1 SRS Radiological Surveillance Media and Sampling Frequencies

Media		Sampling Frequency				
		Weekly	Bi-Weekly	Monthly	Quarterly	Annually
Air	Airborne particulate matter		✓			
	Gaseous state of radioiodine		✓			
	Tritiated water vapor		✓			
	Tritium in rainwater			✓		
	Wet and dry deposition			✓		
Soil	Airborne pathway for radioactive deposition into the environment					✓
Food Products (Collard, Meats, Fruit)	Radiological contaminants in the food chain					✓
Vegetation	Monitor for trends in radionuclide mobility and uptake by plants					✓
TLDs	Ambient gamma radiation monitoring				✓	
Water	Onsite drinking water				✓	✓
	Offsite drinking water			✓		
	Onsite surface water (Streams and basins)	✓	✓	✓		✓
	Savannah River	✓				✓
Sediment	Measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed					✓

Media		Sampling Frequency				
		Weekly	Bi-Weekly	Monthly	Quarterly	Annually
Fish and Shellfish	Bass, catfish, bream, mullet, redfish, sea trout, oysters and crabs					✓
Wildlife	Field and lab monitoring of onsite deer, feral hogs, turkey, and coyotes during Site sponsored controlled hunts					✓

Appendix Table C-2 SRS Nonradiological Media and Sampling Frequencies

Media		Sampling Frequency		
		Monthly	Quarterly	Annually
Surface Water	Water quality downstream of NPDES outfalls (stream and river)	✓		
Sediment	Surveillance for existence and possible buildup of the inorganic contaminants			✓
Fish	Bioaccumulation of nonradiological contaminants in fish			✓
Drinking Water	Safe Drinking Water Act compliance	✓	✓	✓

APPENDIX D: NONRADIOLOGICAL ENVIRONMENTAL PROGRAM SUPPLEMENTAL INFORMATION

Appendix Table D-1 Water Quality Summary Results

Location	Metals Detected	# Detected	Max Value	Min Value	Avg
FMC-2	Aluminum	11	0.3440	0.0200	0.1791
	Copper	8	0.0041	< 0.0010	0.0018
	Iron	12	6.0100	0.6940	2.6838
	Mercury	1	0.0242	< 0.0200	0.0204
	Manganese	12	0.5710	0.0310	0.2123
	Thallium	1	0.0135	< 0.0100	0.0103
	Zinc	12	0.0482	0.0100	0.0241
FM-2B	Aluminum	12	0.7860	0.0410	0.2184
	Cadmium	1	0.0006	< 0.0005	0.0005
	Chromium	1	0.0014	< 0.0010	0.0010
	Copper	6	0.0037	< 0.0010	0.0015
	Iron	12	17.7000	0.7390	3.4019
	Lead	1	0.0053	< 0.0050	0.0050
	Mercury	1	0.0234	< 0.0200	0.0203
	Manganese	12	1.5400	0.0169	0.3098
	Zinc	12	0.0326	0.0089	0.0189
FM-6	Aluminum	11	0.7130	< 0.0200	0.2023
	Copper	8	0.0018	< 0.0010	0.0013
	Iron	12	1.6600	0.4900	1.0290
	Lead	1	0.0059	< 0.0050	0.0051
	Manganese	12	0.1020	0.0395	0.0607
	Zinc	11	0.0328	< 0.0010	0.0155
L3R-2	Aluminum	11	0.2510	< 0.0200	0.1041
	Cadmium	1	0.0007	< 0.0005	0.0005
	Chromium	2	0.0012	< 0.0010	0.0010
	Copper	1	0.0016	< 0.0010	0.0010
	Iron	12	0.9380	0.3000	0.5820
	Manganese	12	0.1560	0.0235	0.0727
	Thallium	1	0.0106	< 0.0100	0.0101
	Zinc	11	0.0377	< 0.0010	0.0186

Location	Metals Detected	# Detected	Max Value	Min Value	Avg
PB-3	Aluminum	11	0.5390	< 0.0200	0.2457
	Cadmium	1	0.0006	< 0.0005	0.0005
	Chromium	1	0.0018	< 0.0010	0.0011
	Copper	3	0.0026	< 0.0010	0.0012
	Iron	12	2.1700	0.5460	0.9198
	Manganese	12	0.1340	0.0331	0.0637
	Thallium	1	0.0169	< 0.0100	0.0106
	Zinc	11	0.0702	< 0.0010	0.0229
RM-118.8	Aluminum	11	0.5890	< 0.0200	0.2800
	Chromium	1	0.0010	< 0.0010	0.0010
	Copper	8	0.0023	< 0.0010	0.0014
	Iron	12	1.6000	0.2660	0.6899
	Lead	1	0.0070	< 0.0050	0.0052
	Manganese	12	0.1690	0.0543	0.0953
	Zinc	5	0.0109	< 0.0010	0.0037
RM-129.1	Aluminum	11	2.2000	< 0.0200	0.3585
	Chromium	1	0.0057	< 0.0010	0.0014
	Copper	4	0.0036	< 0.0010	0.0014
	Iron	12	4.8600	0.3750	0.9975
	Mercury	1	0.0288	< 0.0200	0.0207
	Manganese	12	1.0000	0.0192	0.1673
	Nickel	1	0.0015	< 0.0010	0.0010
	Thallium	2	0.0145	< 0.0100	0.0104
	Zinc	6	0.0233	< 0.0010	0.0061
RM-141.5	Aluminum	11	0.6640	< 0.0200	0.2564
	Chromium	1	0.0013	< 0.0010	0.0010
	Copper	8	0.0026	< 0.0010	0.0013
	Iron	12	1.2100	0.2410	0.6219
	Manganese	12	0.1680	0.0509	0.0876
	Zinc	7	0.1080	< 0.0010	0.0145
RM-150.4	Aluminum	12	0.9210	0.1360	0.2941
	Copper	5	0.0020	< 0.0010	0.0013
	Iron	12	1.3300	0.3140	0.5813
	Lead	1	0.0053	< 0.0050	0.0050
	Manganese	12	0.1720	0.0558	0.0973
	Zinc	6	0.0251	< 0.0010	0.0068

Location	Metals Detected	# Detected	Max Value	Min Value		Avg
RM-160	Aluminum	11	1.4100	<	0.0200	0.2721
	Chromium	1	0.0013	<	0.0010	0.0010
	Copper	8	0.0029	<	0.0010	0.0014
	Iron	12	1.4700		0.2170	0.4790
	Lead	1	0.0052	<	0.0050	0.0050
	Manganese	12	0.1710		0.0491	0.0884
	Thallium	1	0.0120	<	0.0100	0.0102
	Zinc	8	0.0134	<	0.0010	0.0057
SC-4	Aluminum	11	0.2720	<	0.0200	0.1389
	Copper	2	0.0027	<	0.0010	0.0012
	Iron	12	0.7440		0.2810	0.5311
	Lead	1	0.0064	<	0.0050	0.0051
	Manganese	12	0.0670		0.0230	0.0460
	Thallium	1	0.0141	<	0.0100	0.0103
	Zinc	10	0.0256	<	0.0010	0.0117
TB-5	Aluminum	11	0.1660	<	0.0200	0.0974
	Cadmium	1	0.0005	<	0.0005	0.0005
	Copper	1	0.0023	<	0.0010	0.0011
	Iron	12	5.7600		1.6200	3.3233
	Manganese	12	0.5230		0.0681	0.1554
	Nickel	7	0.0062	<	0.0010	0.0025
	Zinc	8	0.0271	<	0.0010	0.0096
TC-1	Aluminum	11	0.2360	<	0.0200	0.1150
	Iron	12	1.0600		0.3060	0.6412
	Manganese	12	0.0740		0.0129	0.0306
	Thallium	1	0.0143	<	0.0100	0.0104
	Zinc	8	0.0282	<	0.0010	0.0084
U3R-1A	Aluminum	11	0.2340	<	0.0200	0.1177
	Copper	1	0.0100	<	0.0010	0.0018
	Iron	12	0.6010		0.2490	0.4163
	Manganese	12	0.0208		0.0070	0.0120
	Zinc	9	0.0287	<	0.0010	0.0117
U3R-4	Aluminum	11	0.7690	<	0.0200	0.2588
	Cadmium	1	0.0006	<	0.0005	0.0005
	Copper	1	0.0017	<	0.0010	0.0011
	Iron	12	1.4600	0	0.3920	0.7046
	Manganese	12	0.0675	0	0.0179	0.0328
	Thallium	1	0.0102	<	0.0100	0.0100
	Zinc	9	0.0264	<	0.0010	0.0129

*metals detected in monthly samples

** if metal not detected, data were removed from table

Appendix Table D-2 Summary of Detected Metal Results for Freshwater Fish[1] Tissue Collected from the Savannah River

Analyte	Number of Detections (above the MDC)	Number of Estimated Values (above the MDC, below the SQL)	Maximum Concentration (ug/g)	SQL (ug/g)	MDC (ug/g)	Fish Type with Maximum Concentration	Location of Maximum Concentration
Mercury	125	41	11.8	0.2	0.02	Catfish	Highway 301
Arsenic	13	13	1.26	9.44	0.944	Catfish	Four Mile Creek Mouth
Cadmium	1	1	0.399	0.726	0.073	Catfish	New Savannah Bluff Lock & Dam (control location)
Chromium	101	99	1.07	0.717	0.072	Bass	Steel Creek Mouth
Copper	95	95	0.781	1.32	0.132	Panfish	Four Mile Creek Mouth
Manganese	87	84	1.88	0.946	0.095	Panfish	Highway 301
Nickel	7	7	0.292	1.81	0.181	Catfish	Upper Three Runs Creek Mouth
Zinc	126	0	11.8	1.36	0.136	Panfish	Highway 301

NOTES

1: 126 freshwater tissue samples were collected and analyzed for metals and mercury.

Appendix Table D-3 Summary of Detected Metal Results for Saltwater Fish[1] Tissue Collected from the Savannah River between River Miles 0-8, Near Savannah, GA

Analyte	Number of Detections (above the MDC)	Number of Estimated Values (above the MDC, below the SQL)	Maximum Concentration (ug/g)	SQL (ug/g)	MDC (ug/g)	Fish Type with Maximum Concentration
Mercury	9	9	0.115	0.20	0.02	Red Drum
Arsenic	2	2	1.21	9.28	0.928	Red Drum
Chromium	10	10	0.128	0.793	0.079	Red Drum
Copper	14	14	0.484	1.93	0.193	Mullet
Manganese	9	9	0.222	0.849	0.085	Red Drum
Zinc	14	0	6.17	1.93	0.193	Mullet

NOTES

1: 14 saltwater tissue samples were collected and analyzed for metals and mercury.

Appendix Table D-4 Precipitation Results of SRS National Trends Network Station for Calendar Year 2014

Analyte	Precipitation Weighted Concentration	Deposition
Calcium (Ca^{2+})	0.061 mg/L	0.72 kg/ha
Magnesium (Mg^{2+})	0.019 mg/L	0.225 kg/ha
Potassium (K^{+})	0.016 mg/L	0.189 kg/ha
Sodium (Na^{+})	0.126 mg/L	1.490 kg/ha
Ammonium (NH_4^{+})	0.154 mg/L	1.87 kg/ha
Nitrate (NO_3^{-})	0.562 mg/L	6.65 kg/ha
Chloride (Cl^{-})	0.226 mg/L	2.67 kg/ha
Sulfate (SO_4^{2-})	0.562 mg/L	6.65 kg/ha
pH (free acidity H^{+})	4.95	0.130 kg/ha

ha = hectare – a metric unit of area defined as 10,000 square meters.

APPENDIX E: RADIOLOGICAL ENVIRONMENTAL PROGRAM SUPPLEMENTAL INFORMATION

Appendix Table E-1. Summary of Radioactive Atmospheric Releases by Source

All values under the “Calculated” column through “Totals” column are reported in Curies.

Radionuclide	Half-Life		Calculated (b)	Reactors	Separations (c)	SRNL(d)	Total	Percentage of Sum
Gases and Vapors								
H-3 (oxide)	12.35	y	2.08E+03	9.20E+02	1.36E+04		**1.66E+04**	
H-3 (elemental)	12.35	y			2.47E+03		**2.47E+03**	
H-3 Total	12.35	y	2.08E+03	9.20E+02	1.61E+04		**1.91E+04**	87.26
C-14	5730	y	1.30E-06		1.37E-02		**1.37E-02**	0.00
Kr-85	10.72	y			2.78E+03		**2.78E+03**	12.74
I-129	1.57E+07	y	5.38E-05		1.87E-03	1.15E-06	**1.93E-03**	0.00
Particles								
Ag-110m	249.9	d	1.48E-11				**1.48E-11**	0.00
Am-241	432.2	y	1.12E-05	8.06E-11	2.07E-06		**1.33E-05**	0.00
Am-243	7380	y	5.26E-09				**5.26E-09**	0.00
Ce-141	32.501	d	4.94E-11				**4.94E-11**	0.00
Ce-144	284.3	d	2.00E-08				**2.00E-08**	0.00
Cm-242	162.8	d	1.89E-16				**1.89E-16**	0.00
Cm-244	18.11	y	2.79E-07	0.00E+00	1.82E-08		**2.97E-07**	0.00
Co-60	5.271	y	4.37E-07	0.00E+00	0.00E+00	0.00E+00	**4.37E-07**	0.00
Cs-134	2.062	y	4.31E-07				**4.31E-07**	0.00
Cs-137	30	y	1.16E-03	0.00E+00	1.42E-05	4.53E-07	**1.18E-03**	0.00
Eu-152	13.33	y	5.01E-08				**5.01E-08**	0.00
Eu-154	8.8	y	3.55E-07				**3.55E-07**	0.00
Eu-155	4.96	y	1.18E-07				**1.18E-07**	0.00
F-18	109.77	m	4.00E-02				**4.00E-02**	0.00
Nb-94	2.03E+04	y	2.42E-07				**2.42E-07**	0.00
Nb-95	35.15	d	3.63E-07				**3.63E-07**	0.00

Radionuclide	Half-Life	Calculated [b]	Reactors	Separations [c]	SRNL[d]	Total	Percentage of Sum
Ni-59	7.50E+04 y	5.76E-11				**5.76E-11**	0.00
Ni-63	96 y	5.62E-09				**5.62E-09**	0.00
Np-237	2.14E+06 y	1.61E-06	0.00E+00	0.00E+00		**1.61E-06**	0.00
Pa-233	27 d	1.42E-06				**1.42E-06**	0.00
Pb-212	10.64 h	8.43E-07				**8.43E-07**	0.00
Pm-147	2.6234 y	2.89E-06				**2.89E-06**	0.00
Pm-148m	41.3 d	1.90E-12				**1.90E-12**	0.00
Pr-144	17.28 m	2.00E-08				**2.00E-08**	0.00
Pu-236	2.851 y	5.75E-10				**5.75E-10**	0.00
Pu-238	87.74 y	3.15E-05	4.08E-09	4.06E-06		**3.55E-05**	0.00
Pu-239	2.41E+04 y	4.32E-05	1.07E-10	3.94E-06		**4.72E-05**	0.00
Pu-240	6537 y	7.73E-06				**7.73E-06**	0.00
Particles							
Pu-241	14.4 y	2.07E-04				**2.07E-04**	0.00
Pu-242	3.76E+05 y	1.78E-08				**1.78E-08**	0.00
Ra-226	1600 y	2.76E-07				**2.76E-07**	0.00
Ra-228	5.75 y	2.62E-07				**2.62E-07**	0.00
Rh-106	29.9 s	1.19E-08				**1.19E-08**	0.00
Ru-103	39.28 d	5.11E-10				**5.11E-10**	0.00
Ru-106	368.2 d	3.04E-06				**3.04E-06**	0.00
Sb-125	2.77 y	1.18E-06				**1.18E-06**	0.00
Sb-126	12.4 d	1.70E-07				**1.70E-07**	0.00
Se-79	6.50E+04 y	4.90E-09				**4.90E-09**	0.00
Sm-151	90 y	2.89E-06				**2.89E-06**	0.00
Sn-123	129.2 d	6.66E-12				**6.66E-12**	0.00
Sn-126	1.00E+05 y	1.70E-07				**1.70E-07**	0.00
Sr-89	50.5 d	6.02E-10				**6.02E-10**	0.00
Sr-90	29.12 y	3.32E-05	2.26E-09	1.12E-05		**4.44E-05**	0.00
Tc-99	2.13E+05 y	3.87E-07				**3.87E-07**	0.00
Te-127	9.35 h	1.04E-11				**1.04E-11**	0.00
Te-129	69.6 m	1.05E-12				**1.05E-12**	0.00

Radionuclide	Half-Life		Calculated (b)	Reactors	Separations (c)	SRNL(d)	Total	Percentage of Sum
Th-228	1.9131	y	7.26E-10	1.38E-10			**8.64E-10**	0.00
Th-229	7340	y	1.56E-09				**1.56E-09**	0.00
Th-230	7.70E+04	y	1.55E-10	9.20E-09			**9.36E-09**	0.00
Th-231	25.52	h	2.12E-04				**2.12E-04**	0.00
Th-232	1.41E+10	y	1.07E-11	2.42E-09			**2.43E-09**	0.00
Tl-208	3.07	m	1.41E-06				**1.41E-06**	0.00
U-232	72	y	6.56E-09				**6.56E-09**	0.00
U-233	1.59E+05	y	5.78E-09				**5.78E-09**	0.00
U-234	2.45E+05	y	6.08E-07	1.50E-09	6.41E-06		**7.02E-06**	0.00
U-235	7.04E+08	y	6.99E-09	0.00E+00	8.19E-07		**8.26E-07**	0.00
U-236	2.34E+07	y	3.01E-08				**3.01E-08**	0.00
U-238	4.47E+09	y	2.10E-07	1.66E-09	8.48E-06		**8.69E-06**	0.00
Y-90	64	h	3.32E-05	2.26E-09	1.12E-05		**4.44E-05**	0.00
Y-91	58.51	d	7.98E-10				**7.98E-10**	0.00
Zr-95	63.98	d	1.22E-07				**1.22E-07**	0.00
Unidentified alpha	N/A		1.79E-05	1.27E-05	2.09E-07	0.00E+00	**3.08E-05**	0.00
Unidentified beta	N/A		1.43E-03	3.57E-05	6.31E-04	2.55E-06	**2.09E-03**	0.00
SUM =							**2.18E+04**	100.00

Note: (a) One curie equals 3.7E+10 becquerels
Note: (b) Estimated releases form unmonitored sources
Note: (c) Includes separations, waste management, and tritium facilities
Note: (d) Savannah River National Laboratory

Appendix Table E-2 Summary of Air Effluent DOE DCS Sum of Fractions for 2015

Facility (Sampling Location)	Radionuclides Included in the DCS Sum of Fractions	DCS Sum of Fractions
A-Area (791-A Sandfilter Discharge)	I-129, Cs-137	1.23E-04
C-Area (C-Area Main Stack (148'))	H-3 (oxide)	1.76E+00
F-Area (235-F Sandfilter Discharge)	U-234, U-235, U-238, Pu-238, Am-241	1.01E-03
F-Area (291-F Stack Isokinetic)	Sr-89/90, I-129, U-234, U-235, U-238, Pu-238, Pu-239, Am-241, Cm-244	5.60E-02
F-Area (772-4F Stack)	U-234, U-238, Pu-238, Pu-239, Am-241	1.92E-03
H-Area (291-H Stack Isokinetic)	Sr-89/90, I-129, Cs-137, U-234, U-238, Pu-238, Pu-239, Am-241, C-14, Kr-85, H-3 (oxide)	2.82E-01
K-Area (K-Area Main Stack (148'))	H-3 (oxide)	1.70E+00
K-Area (KIS Facility)	Sr-89/90, Th-228, Th-230, Th-232, U-234, U-238, Pu-238, Pu-239, Am-241	9.87E-03
L-Area (L-Area Disassembly)	H-3 (oxide)	1.72E+00
L-Area (L-Area Main Stack (148'))	H-3 (oxide)	1.79E+00
Tritium (232-H (200ft))	H-3 (elemental), H-3 (oxide)	2.51E+01
Tritium (233-H)	H-3 (elemental), H-3 (oxide)	1.79E+00
Tritium (234-H)	H-3 (elemental), H-3 (oxide)	1.75E+01
Tritium (238-H)	H-3 (oxide)	2.21E+01
Tritium (264-H)	H-3 (elemental), H-3 (oxide)	3.71E+00

Note: *DOE-STD-1196-2011, Derived Concentration Technical Standard

Appendix Table E-3 Summary of Tritium in Environmental Air

All concentrations are in pCi/m^3. Bolded values are detected results. Values not bolded indicate the result was less than the analytical method detection limit or the uncertainty (standard deviation) is large.

Location	Number of Samples	Mean Conc. (std. dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	23	1.69E+02 (1.44E+00)	**2.59E+01 (4.50E+00)**	**4.24E+02 (1.03E+01)**
Site Perimeter				
Allendale Gate	25	2.82E+00 (6.52E-01)	-8.81E+00 (4.61E+00)	1.74E+01 (3.49E+00)
Barnwell Gate	25	3.47E+00 (6.22E-01)	-2.89E+00 (4.32E+00)	**1.38E+01 (2.23E+00)**
D-Area	25	7.52E+00 (6.49E-01)	-3.78E+00 (3.13E+00)	**3.54E+01 (3.12E+00)**
Darkhorse @ Williston Gate	25	3.91E+00 (6.06E-01)	-2.89E+00 (3.19E+00)	**1.38E+01 (2.26E+00)**
East Talatha	25	4.32E+00 (6.39E-01)	-5.05E+00 (4.23E+00)	**1.72E+01 (3.80E+00)**
Green Pond	25	4.32E+00 (5.94E-01)	-8.97E-01 (3.24E+00)	**2.14E+01 (2.48E+00)**
Highway 21/167	25	2.65E+00 (6.51E-01)	-5.27E+00 (3.38E+00)	**1.45E+01 (2.28E+00)**
Jackson	25	3.48E+00 (6.60E-01)	-5.92E+00 (2.82E+00)	**1.26E+01 (3.35E+00)**
Patterson Mill Road	25	1.99E+00 (6.37E-01)	-4.89E+00 (3.03E+00)	**1.41E+01 (2.01E+00)**
Talatha Gate	25	5.70E+00 (7.06E-01)	-6.78E-01 (2.99E+00)	**1.81E+01 (2.11E+00)**
25-Mile Radius				
Aiken Airport	25	2.13E+00 (6.86E-01)	-4.46E+00 (2.65E+00)	**9.46E+00 (2.95E+00)**
Augusta Lock and Dam 614	24	2.12E+00 (6.42E-01)	-5.43E+00 (3.61E+00)	**1.31E+01 (2.77E+00)**
Control Location (Highway 301 @ State Line)	25	3.46E+00 (6.70E-01)	-3.59E+00 (3.02E+00)	**1.77E+01 (3.55E+00)**

Appendix Table E-4 Summary of Radionuclides in Rain Ion Columns

All concentrations are in pCi/m^2. Bolded values are detected results. Values not bolded indicate the result was less than the analytical method detection limit or the uncertainty (standard deviation) is large.

Location	Sr-89/90			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (1)	2.53E+00 (4.60E-01)	-1.77E+00 (1.2E+00)	6.08E+00 (1.77E+00)
Site Perimeter				
D-Area	11 (0)	8.86E-01 (4.19E-01)	-9.16E-01 (1.60E+00)	2.38E+00 (1.52E+00)
Darkhorse @ Williston Gate	11 (0)	3.31E-01 (3.94E-01)	-1.53E+00 (1.21E+00)	1.89E+00 (1.32E+00)
Green Pond	11 (0)	4.55E-01 (3.96E-01)	-3.08E-01 (1.38E+00)	1.42E+00 (1.42E+00)
Patterson Mill Road	11 (1)	6.07E-01 (3.70E-01)	1.82E+00 (1.01E+00)	2.54E+00 (6.38E-01)
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (0)	4.97E-01 (3.98E-01)	-5.46E-01 (1.31E+00)	2.05E+00 (1.55E+00)

Location	U-234			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (5)	6.79E-02 (9.83E-03)	7.14E-03 (1.89E-02)	**1.17E-01 (4.26E-02)**
Site Perimeter				
D-Area	11 (7)	8.40E-02 (1.06E-02)	7.86E-03 (2.05E-02)	**1.73E-01 (4.77E-02)**
Darkhorse @ Williston Gate	11 (4)	5.74E-02 (9.06E-03)	1.18E-02 (2.49E-02)	**9.32E-02 (3.60E-2)**
Green Pond	11 (5)	8.67E-02 (1.02E-02)	1.99E-02 (2.40E-02)	**2.35E-01 (5.43E-02)**
Patterson Mill Road	11 (5)	6.57E-02 (9.24E-03)	-8.32E-03 (8.17E-03)	**1.49E-01 (4.63E-02)**
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (3)	7.05E-02 (9.94E-03)	1.62E-02 (1.93E-02)	**1.70E-01 (4.98E-02)**

Location	U-235			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (0)	1.63E-02 (7.63E-03)	-4.59E-02 (2.66E-02)	6.43E-02 (5.34E-02)
Site Perimeter				
D-Area	11 (0)	2.33E-02 (7.17E-03)	-9.27E-03 (9.28E-03)	7.46E-02 (3.95E-02)
Darkhorse @ Williston Gate	11 (0)	1.77E-02 (6.66E-03)	-4.97E-03 (1.42E-02)	6.54E-02 (3.35E-02)
Green Pond	11 (1)	3.09E-02 (7.13E-03)	-1.96E-02 (1.39E-02)	**7.30E-02 (3.35E-03)**
Patterson Mill Road	11 (0)	1.63E-02 (5.98E-03)	-9.30E-03 (9.32E-03)	3.32E-02 (2.40E-02)
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (0)	2.52E-02 (7.09E-03)	-2.34E-02 (1.64E-02)	6.92E-02 (3.17E-02)

Location	U-238			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (4)	6.62E-02 (9.54E-03)	3.08E-03 (1.35E-02)	**1.54E-01 (4.49E-02)**
Site Perimeter				
D-Area	11 (7)	8.55E-02 (1.04E-02)	3.65E-03 (1.44E-02)	**1.39E-01 (4.55E-02)**
Darkhorse @ Williston Gate	11 (3)	4.37E-02 (8.08E-03)	-8.11E-03 (7.84E-03)	**1.19E-01 (4.12E-02)**
Green Pond	11 (7)	6.69E-02 (9.45E-03)	1.65E-02 (1.97E-02)	**9.19E-02 (3.36E-02)**
Patterson Mill Road	11 (1)	4.95E-02 (8.55E-03)	2.11E-02 (2.63E-02)	**1.33E-01 (4.01E-02)**
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (6)	7.05E-02 (9.89E-03)	-4.54E-03 (1.75E-02)	**1.65E-01 (4.59E-02)**

Location	Pu-238			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (1)	1.82E-02 (5.65E-03)	-1.16E-02 (1.74E-02)	**7.81E-02 (3.02E-02)**
Site Perimeter				
D-Area	11 (1)	1.80E-02 (5.41E-03)	-7.76E-03 (7.62E-03)	**8.38E-02 (3.23E-02)**
Darkhorse @ Williston Gate	11 (0)	1.15E-02 (5.13E-03)	-1.51E-02 (1.07E-02)	5.73E-02 (3.13E-02)
Green Pond	11 (1)	1.38E-02 (4.82E-03)	-8.43E-03 (8.17E-03)	**8.62E-02 (3.48E-02)**
Patterson Mill Road	11 (0)	6.56E-03 (4.98E-03)	-9.46E-03 (9.28E-03)	2.66E-02 (1.90E-02)
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (1)	2.44E-02 (5.75E-03)	-2.32E-02 (1.34E-02)	8.22E-02 (3.17E-02)

Location	Pu-239			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (0)	1.08E-02 (5.30E-03)	-1.86E-02 (1.82E-02)	4.32E-02 (2.89E-02)
Site Perimeter				
D-Area	11 (0)	1.84E-02 (5.49E-03)	-1.19E-02 (1.82E-02)	4.43E-02 (2.30E-02)
Darkhorse @ Williston Gate	11 (0)	9.59E-03 (4.83E-03)	-1.49E-02 (1.06E-02)	4.38E-02 (2.92E-02)
Green Pond	11 (0)	9.45E-03 (4.76E-03)	-1.90E-02 (1.89E-02)	3.86E-02 (2.52E-02)
Patterson Mill Road	11 (0)	-1.50E-03 (4.88E-03)	-3.97E-02 (1.76E-02)	2.11E-02 (1.51E-03)
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (2)	2.01E-02 (5.61E-03)	-4.32E-03 (1.60E-02)	**7.05E-02 (2.92E-02)**

Location	Am-241			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (4)	5.84E-02 (8.59E-03)	2.64E-02 (2.24E-02)	**1.18E-01 (3.91E-02)**
Site Perimeter				
D-Area	11 (4)	5.93E-02 (9.37E-03)	2.38E-02 (1.83E-03)	**1.01E-01 (3.74E-02)**
Darkhorse @ Williston Gate	11 (5)	6.85E-02 (9.72E-03)	3.27E-02 (2.04E-02)	**1.65E-01 (4.81E-02)**
Green Pond	11 (5)	5.38E-02 (8.27E-03)	3.78E-03 (1.56E-02)	**1.23E-01 (4.02E-02)**
Patterson Mill Road	11 (4)	4.81E-02 (8.17E-03)	2.95E-03 (1.44E-02)	**7.86E-02 (3.53E-02)**
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (4)	4.75E-02 (7.77E-03)	3.35E-03 (1.51E-02)	**1.09E-01 (4.00E-02)**

Location	Cm-244			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (2)	1.43E-02 (4.88E-03)	-8.41E-03 (8.12E-03)	**5.89E-02 (2.66E-02)**
Site Perimeter				
D-Area	11 (0)	9.87E-03 (4.63E-03)	-9.68E-03 (9.67E-03)	5.81E-02 (2.64E-02)
Darkhorse @ Williston Gate	11 (0)	1.18E-02 (5.20E-03)	-1.72E-02 (1.18E-02)	3.73E-02 (2.25E-02)
Green Pond	11 (1)	1.57E-02 (4.72E-03)	-1.61E-04 (6.99E-04)	**6.32E-02 (2.63E-02)**
Patterson Mill Road	11 (1)	7.92E-03 (4.58E-03)	-8.19E-03 (8.19E-03)	**5.32E-02 (2.97E-02)**
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (0)	1.25E-02 (4.96E-03)	-1.61E-04 (7.05E-04)	4.08E-02 (2.38E-02)

Location	Gross B			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (10)	4.00E+01 (1.49E+00)	7.41E+00 (3.12E+00)	**6.32E+01 (6.24E+00)**
Site Perimeter				
D-Area	11 (11)	7.68E+01 (1.95E+00)	**2.73E+01 (4.50E+00)**	**1.33E+02 (6.09E+00)**
Darkhorse @ Williston Gate	11 (11)	3.37E+01 (1.39E+00)	**1.61E+01 (3.63E+00)**	**5.27E+01 (4.05E+00)**
Green Pond	11 (11)	3.33E+01 (1.37E+00)	**9.51E+00 (3.14E+00)**	**6.95E+01 (4.55E+00)**
Patterson Mill Road	11 (10)	2.60E+01 (1.29E+00)	-5.97E-01 (2.41E+00)	**4.81E+01 (5.48E+00)**
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (10)	3.01E+01 (1.35E+00)	7.57E+00 (3.17E+00)	6.38E+01 (6.17E+00)

Location	Gross A			
	# of Samples (# of detects)	Mean Conc. (std.dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	11 (1)	1.52E+00 (4.48E-01)	-7.49E-01 (3.78E-01)	**5.57E+00 (2.45E+00)**
Site Perimeter				
D-Area	11 (1)	1.79E+00 (4.53E-01)	-1.14E-01 (1.04E+00)	**6.84E+00 (1.91E+00)**
Darkhorse @ Williston Gate	11 (0)	7.70E-01 (3.51E-01)	-7.57E-01 (2.81E-01)	3.05E+00 (1.34E+00)
Green Pond	11 (1)	9.42E-01 (3.60E-01)	-6.65E-01 (4.36E-01)	**4.81E+00 (1.61E+00)**
Patterson Mill Road	11 (0)	8.72E-01 (3.74E-01)	-6.49E-01 (5.13E-01)	3.08E+00 (1.94E+00)
25-Mile Radius				
Control Location (Highway 301 @ State Line)	11 (0)	5.54E-01 (3.39E-01)	-6.84E-01 (3.53E-01)	2.11E+00 (1.64E+00)

All Co-60 and Cs-137 results were non-significant and thus, not reported on this table.

Appendix Table E-5 Summary of Tritium in Rainwater

Samples were collected approximately every 4 weeks at each of 13locations. All concentrations are in pCi/L. Bolded values are detected results. Values not bolded indicate the result was less than the analytical method detection limit or the uncertainty (standard deviation) is large.

The results at the following locations were all not detected: Site Perimeter (Allendale Gate, Barnwell Gate, Darkhorse @ Williston Gate, Highway 21/167, Jackson, Patterson Mill Road) and 25-Mile Radius (Aiken Airport, Augusta Lock and Dam 614 and Highway 301 @ State Line). The Highway 301 @ State Line location is the control location.

Location	# of Detected Results	Mean Conc. (std. dev.)	Minimum Conc. (std. dev.)	Maximum Conc. (std. dev.)
Onsite				
Burial Ground North	13	3.43E+03 (6.08E+1)	**1.30E+03 (1.59E+02)**	**5.54E+03 (2.70E+02)**
Site Perimeter				
D-Area	2	1.70E+02 (3.82E+01)	-2.43E+02 (1.50E+02)	**6.51E+02 (1.41E+02)**
East Talatha	1	3.98E+01 (3.71E+01)	-2.97E+02 (1.50E+02)	**5.05E+02 (1.40E+02)**
Green Pond	1	6.99E+01 (3.72E+01)	-2.86E+02 (1.22E+02)	**6.78E+02 (1.40E+02)**
Talatha Gate	1	4.82E+01 (3.70E+01)	-1.17E+02 (1.54E+02)	**4.16E+02 (1.30E+02)**

Appendix Table E-6 Summary of Radionuclides in Soil

Bolded values are detected results. Values not highlighted indicate the result was less than the analytical method detection limit or the uncertainty is large.

The following locations are sampled: F-Area (2000 feet West), H-Area (2000 ft East), Z-Area (#3), Burial Ground Locations (643-26E-2 and Burial Ground North), Plant Perimeter Locations (Allendale Gate, Barnwell Gate, D-Area, Darkhorse @ Williston Gate, East Talatha, Green Pond, Highway 21/167, Jackson, Patterson Mill Road, and Talatha Gate) and 25-Miles Radium Locations (Aiken Airport, August Lock and Dam 614, and Highway 301 @ State Line). The Highway 301 @ State Line is the control Location.

Radionuclide	# of Detected Results	Control - HWY 301 Conc. (pCi/g)	Location of Minimum Conc.	Minimum Conc. (pCi/g)	Location of Maximum Conc.	Maximum Conc. (pCi/g)
Cs-137	17 of 18	**1.51E-01**	Burial Ground (643-26E-2)	-1.85E-02	Darkhorse @ Williston Gate	**3.70E-01**
Sr-89/90	1 of 18	1.68E-02	Green Pond	-4.57E-02	D-Area	**1.34E-01**
U-234	18 of 18	**1.79E+00**	Aiken Airport	**4.81E-01**	Burial Ground (643-26E-2)	**3.73E+00**
U-235	16 of 18	**8.38E-02**	Barnwell Gate	3.08E-03	Burial Ground (643-26E-2)	**1.82E-01**
U-238	18 of 18	**1.76E+00**	Allendale Gate	**4.38E-01**	Burial Ground (643-26E-2)	**3.73E+00**
Pu-238	6 of 18	5.03E-04	Darkhorse @ Williston Gate	0.00E+00	F-Area (2000 Feet West)	**3.03E-02**
Pu-239	18 of 18	**5.73E-03**	Burial Ground (643-26E-2)	**1.29E-03**	H-Area (2000 Feet East)	**1.04E-01**
Am-241	10 of 12	**2.76E-03**	Burial Ground North	8.22E-04	Burial Ground (643-26E-2)	**1.62E-01**
Cm-244	1 of 12	0.00E+00	Talatha Gate	-1.65E-04	Burial Ground (643-26E-2)	**2.81E-02**
Gross Beta	16 of 18	**1.04E+01**	F-Area	2.57E+00	Burial Ground (643-26E-2)	**1.74E+01**
Gross Alpha	15 of 18	**1.14E+01**	Aiken Airport	8.89E-01	Burial Ground (643-26E-2)	**2.17E+01**

Appendix Table E-7 Summary of Radionuclides in Grassy Vegetation

Bolded values are detected results. Values not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. All results for Co-60, Np-237, and Cm-244 were not detected; thus, not reported in this table.

The following locations are sampled: Control (Highway 301 at the SC/GA State line), Onsite location (Burial Ground North), Site Perimeter locations (Allendale Gate, Barnwell Gate, D-Area, Darkhorse @ Williston Gate, East Talatha, Green Pond, Highway 21/167, Jackson, Patterson Mill Road, Talatha Gate), and 25-Mile Radius locations (Aiken Airport and the Augusta Lock and Dam 614). Samples are collected annually, except as noted in the table.

Radionuclide	# of Detected Results	Control (Highway 301) Conc. (pCi/g)	Location of Minimum Conc.	Minimum Conc. (pCi/g)	Location of Maximum Conc.	Maximum Conc. (pCi/g)
H-3	4 of 14	**4.19E-02**	Jackson	-1.09E-02	Patterson Mill Road	**1.76E-01**
Cs-137	10 of 14	**2.56E-01**	Burial Ground North	-9.76E-03	Allendale Gate	**5.00E-01**
Sr-89/90	14 of 14	**1.05E-01**	Darkhorse @ Williston Gate	**1.01E-01**	East Talatha	**5.11E-01**
U-234	14 of 14	**4.11E-03**	Highway 21/167	**6.19E-04**	Burial Ground North	**1.26E-02**
U-235	1 of 14	2.45E-04	East Talatha	0.00E+00	Burial Ground North	**1.08E-03**
U-238	14 of 14	**3.41E-03**	Barnwell Gate	**6.78E-04**	Burial Ground North	**1.19E-02**
Pu-238	1 of 14	-1.21E-04	Green Pond	-1.62E-04	D-Area	**5.57E-04**
Pu-239	1 of 14	8.49E-05	Jackson	-1.34E-04	Highway 21/167	**2.30E-03**
Am-241	1 of 14	-6.19E-06	Aiken Airport	-6.57E-05	Highway 21/167	**6.92E-04**
Tc-99	14 of 14	**1.69E-01**	Highway 301	**1.69E-01**	Green Pond	**1.49E+00**
Gross Beta	15 of 15	8.59E+00	East Talatha* (December 2015)	**6.78E+00**	East Talatha* (April 2015)	**2.06E+01**
Gross Alpha	1 of 15	2.34E-01	Aiken Airport	-1.39E-01	East Talatha* (April 2015)	**2.20E+00**

NOTE: * Samples were collected from all locations in April 2015. A sample was collected from the East Talatha gate location in December 2015 and analyzed for gross alpha and gross beta, only.

Appendix Table E-8 Summary of Radionuclides in Foodstuffs

Units are in pCi/g. Highlighted concentration boxes were reported as detected. Boxes not highlighted indicate the result was less than the analytical method detection limit or the uncertainty is large.

Food Type	Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Sample Conc.	Minimum Sample Conc.	Maximum Sample Conc.
Beef	U-234	3	3	6.53E-05	**5.35E-05**	**7.57E-05**
	U-238	3	3	1.13E-04	**8.49E-05**	**1.45E-04**
	Gross Beta	3	3	2.14E+00	**1.42E+00**	**2.55E+00**
H-3, Cs-137, Co-60, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-90, U-235, Tc-99 and Gross Alpha were not detected in Beef						
Greens	H-3	5	1	3.06E-02	-8.05E-03	**1.05E-01**
	Cs-137	5	1	1.77E-02	3.27E-03	**3.97E-02**
	Sr-90	5	4	1.14E-01	1.79E-02	**1.84E-01**
	U-234	5	5	1.36E-02	**9.70E-04**	**3.03E-02**
	U-235	5	2	6.46E-04	1.14E-04	**1.25E-03**
	U-238	5	5	1.28E-02	**1.09E-03**	**2.84E-02**
	Tc-99	5	5	3.95E-01	**1.87E-01**	**7.43E-01**
	Gross Beta	5	5	1.87E+01	**9.00E+00**	**2.64E+01**
	Gross Alpha	5	2	4.07E-01	6.14E-02	**1.15E+00**
Co-60, Np-237, Pu-238, Pu-239, Am-241 and Cm-244 were not detected in Greens						
Fruit (watermelon)	Tc-99	5	1	2.49E-02	1.58E-02	**3.41E-02**
	Gross Beta	5	5	5.99E-01	**4.51E-01**	**8.78E-01**
H-3, Cs-137, Co-60, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-90, U-234, U-235, U-238 and Gross Alpha were not detected in Fruit						
Corn	H-3	5	1	-2.40E-01	-3.35E+01	**4.35E+01**
	Cs-137	5	1	2.12E+00	1.24E+00	**5.49E+00**
	U-234	5	1	2.89E-01	7.43E-02	**8.73E-01**
	Gross Beta	5	5	7.67E+03	**6.81E+03**	**9.08E+03**
Co-60, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-90, U-235, U-238, Tc-99 and Gross Alpha were not detected in Corn						
Pecans	Cs-137	5	2	7.10E+00	1.23E+00	**1.46E+01**
	Sr-90	5	1	2.81E+01	2.68E+00	**7.03E+01**
	U-234	5	1	5.61E-01	2.06E-01	**1.22E+00**
	U-238	5	1	3.64E-01	1.20E-01	4.95E-01
	Gross Beta	5	5	4.63E+03	**3.59E+03**	**6.89E+03**
	Gross Alpha	5	2	1.71E+02	9.19E+01	**2.78E+02**
H-3, Co-60, Np-237, Pu-238, Pu-239, Am-241, Cm-244, U-235 and Tc-99 were not detected in Pecans						

Appendix Table E-9 Summary of Radionuclides in Cow's Milk

The dairies that are sampled are locations in communities surround SRS. The number listed in parentheses after the state in which the dairies are located, indicates the number of dairies that provide samples to SRS.

Bolded results were reported as detected. Results not highlighted indicate the result was less than the analytical method detection limit or the uncertainty is large. All tritium and Co-60 results were not detected; thus, not reported in this table.

Location	Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Sample Conc. (pCi/L)	Minimum Sample Conc. (pCi/L)	Maximum Sample Conc. (pCi/L)
SC-Dairies (4)	Cs-137	16	1	8.47E-01	-8.00E-01	**3.54E+00**
GA-Dairies (4)	Cs-137	16	1	9.98E-01	-8.92E-01	**3.68E+00**
SC-Dairies (4)	Sr-90	16	2	6.77E-01	-6.78E-01	**2.81E+00**
GA-Dairies (4)	Sr-90	16	0	1.36E-01	-1.01E+00	1.05E+00

Appendix Table E-10 Radiation in Liquid Release Sources

All values under the three Areas columns and the "Totals" column are reported in Curies.

Radionuclide	Half-Life	Reactor Areas C,K,L,P,R	Separations Areas F,H,S,Z, Tritium	SRNL Area A	Totals	Percentage of Sum
H-3[a]	12.35y	2.39E+02	4.98E+02	1.23E-02	**7.37E+02**	99.96%
C-14	5730y		2.56E-03	2.04E-03	**4.60E-03**	0.00%
Sr-90	29.12y	0.00E+00	2.43E-02		**2.43E-02**	0.00%
Tc-99	2.13E+05y		1.30E-02	0.00E+00	**1.30E-02**	0.00%
I-129	1.57E+07y		1.44E-02	0.00E+00	**1.44E-02**	0.00%
Cs-137[b]	30.0y	0.00E+00	1.08E-02	0.00E+00	**1.08E-02**	0.00%
U-234	2.45E+05y		6.77E-02	3.88E-05	**6.77E-02**	0.01%
U-235	7.04E+08y		2.50E-03	1.23E-06	**2.50E-03**	0.00%
U-238	4.47E+09y		7.55E-02	2.64E-05	**7.55E-02**	0.01%
Np-237	2.14E+06y		3.21E-07		**3.21E-07**	0.00%
Pu-238	87.74y		5.11E-04	2.03E-06	**5.13E-04**	0.00%
Pu-239	2.41E+04y		1.10E-04	0.00E+00	**1.10E-04**	0.00%
Am-241	432.2y		1.79E-04		**1.79E-04**	0.00%
Cm-244	18.11y		1.21E-04		**1.21E-04**	0.00%
Alpha[c]	N/A	6.41E-03	1.79E-03	3.92E-04	**8.60E-03**	0.00%
Beta-Gamma[d]	N/A	8.81E-02	6.63E-03	5.61E-04	**9.53E-02**	0.01%
				Sum	**7.37E+02**	100.00%

NOTE: (a) The tritium release total, which includes direct + migration releases, is used in the dose calculations for SRS impacts.

NOTE: (b) Depending on which value is higher, the Cs-137 release total is based on concentrations measured in RM 118.8 fish or on the actual measured effluent release total from the site. Refer to chapter 6 (Dose) for more information.

NOTE: (c,d) For dose calculations, unidentified alpha and beta/gamma releases are assumed to be Pu-239 and Sr-90, respectively.

Appendix Table E-11 Summary of Liquid Effluent DOE DCS Sum of Fractions by Facility for 2015

Facility (sampling location)	Radionuclides Included in the Sum of Fractions	DCS Sum of Fractions
A-Area (TB-2 Outfall at Road 1A)	H-3, C-14, Co-60, I-129, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Tc-99	8.70E-04
F-Area (F-013 200-F Cooling Basin)	H-3, Co-60, Sr-89/90, I-129, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244, Tc-99	3.50E-03
F-Area (F-05)	H-3, C-14, Co-60, Sr-89/90, I-129, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244, Tc-99	6.54E-03
F-Area (FM-3 F-Area Effluent)	H-3, C-14, Co-60, Sr-89/90, I-129, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244, Tc-99	3.04E-03
F-Tank Farm (F-012 281-8F Retention Basin)	H-3, Co-60, Sr-89/90, I-129, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244, Tc-99	6.20E-03
H-Area (FM-1C H-Area Effluent)	H-3, C-14, Co-60, Sr-89/90, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244	3.13E-03
H-Area (H-004)	H-3, Co-60, Sr-89/90, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239	6.30E-03
H-ETP (U3R-2A ETP Outfall at Road C)	H-3, C-14, Co-60, Sr-89/90, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244	6.91E-01
H-Tank Farm (H-017 281-8H Retention Basin)	H-3, Co-60, Sr-89/90, I-129, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244, Tc-99	2.61E-02
H-Tank Farm (HP-52 H-Area Tank Farm)	H-3, Co-60, Sr-89/90, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Am-241, Cm-244	2.44E-03
K-Area (K Canal)	H-3, Co-60, Sr-89/90, Cs-137	3.00E-04
L-Area (L-07)	H-3, Co-60, Sr-89/90, Cs-137	3.52E-04
S-Area (S-004)	H-3, Co-60, Sr-89/90, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239	3.51E-03
Tritium (HP-15 Tritium Facility Outfall)	H-3, Co-60, Sr-89/90, Cs-137	4.20E-03

Appendix Table E-12 Summary of Radionuclides in Sediments

This table presents each analysis for the sediment samples collected at the river, stream and basin locations where results were detected. Each table includes the respective control location concentration, whether detected or not, as well as the maximum value of the river, stream, and basin samples. Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. All results for Co-60 were not detectable. Np-237 was not detected in all river and basin samples. Thus, these radionuclides are not reported in the tables below.

The following location are the sampling locations: Controls (River Mile 160.5 and Upper Three Runs Creek (U3R)-1A Treadway Bridge RD 8-1), Savannah River Locations (River Miles 118.7, 129, 134.0, 150.2, 151, 152.1, and 157.2), SRS Basin locations (E-05, E-06, EAV Basin North, EAV Basin South, POND 400, SWDF Basin North, SWDF Basin South, Z-01 Outfall and Z Basin), and SRS Stream locations (FM-2 at Road 4, FM-3A Below F-Area Effluent, Four Mile A-7A (Beaver Pond), Four Mile Creek Swamp Discharge, Four Mile Creek at Road A-7, L3R-1A at Road B, L3R-2 Sediment, McQueens Branch (MCQBR) at Monroe Road, MCQBR downstream of Z-Basin, Pen Branch Swamp Discharge, SC-2A 1 mile above Road B, SC-4 Steel Creek at Road A, TB-5 Near Road C, Tinker Creek 1, U3R-4 Sediment, RM 150.4 Sediment, River Mile 160.0 Sediment, R-Area Sediment, U3R-Road-4, Four Mile Creek (FMC)-Road-A, U3R-3, Meyers-Branch, and Pen Branch at Road A).

River Sediment Results			
Radionuclide	Control Conc. (pCi/g)	Location of Maximum Result	Maximum Conc. (pCi/g)
Cs-137	**5.81E-02**	RM-129 Lower 3 Runs Mouth	**5.78E-01**
Sr-89/90	1.16E-01	RM-118.7 Highway 301	**2.45E-01**
U-234	1.22E+00	RM-152.1 Beaver Dam Creek	**1.96E+00**
U-235	**6.24E-02**	RM-129 Lower 3 Runs Mouth	**5.78E-01**
U-238	**1.15E+00**	RM-152.1 Beaver Dam Creek	**1.92E+00**
Pu-238	3.24E-04	RM-157.2 Upper 3 Runs Mouth	**3.00E-03**
Pu-239	8.81E-04	RM-157.2 Upper 3 Runs Mouth	**5.81E-03**
Am-241	**2.33E-03**	RM-129 Lower 3 Runs Mouth	**1.04E-02**
Cm-244	3.24E-04	RM-129 Lower 3 Runs Mouth	**6.24E-03**
Gross B	**2.07E+01**	RM-118.7 Highway 301	**2.89E+01**
Gross A	**3.95E+00**	RM-157.2 Upper 3 Runs Mouth	**2.14E+01**

Stream Sediment Results			
Radionuclide	**Control Conc. (pCi/g)**	**Location of Maximum Result**	**Maximum Conc. (pCi/g)**
Cs-137	5.86E-02	R-Area Sediment	**1.62E+01**
Sr-89/90	9.92E-02	Four Mile A-7A (Beaver Pond)	**2.95E-01**
U-234	**1.08E+00**	TB-5 Near Road C	**3.32E+00**
U-235	**5.68E-02**	SC-2A 1 mile above Road B	**1.92E-01**
Np-237	0.00E+00	FM-2 at Road 4	**1.62E-02**
U-238	**1.14E+00**	TB-5 Near Road C	**3.65E+00**
Pu-238	1.11E-03	FM-2 at Road 4	**6.65E-01**
Pu-239	**3.84E-03**	FM-2 at Road 4	**6.05E-02**
Am-241	**1.76E-03**	Four Mile Creek at Road A-7	**5.84E-02**
Cm-244	1.98E-04	Four Mile Creek at Road A-7	**5.24E-02**
Gross B	**2.78E+01**	SC-2A 1 mile above Road B	**3.54E+01**
Gross A	**3.51E+01**	MCQBR downstream of Z-Basin	**3.27E+01**

Storm Basin Sediment Results			
Radionuclide	**Control Conc. (pCi/g)**	**Location of Maximum Result**	**Maximum Conc. (pCi/g)**
Cs-137	5.86E-02	Z Basin	**8.12E+02**
Sr-89/90		POND 400	**1.46E-01**
U-234		Z-01 Outfall	**2.75E+00**
U-235		POND 400	**1.17E-01**
U-238		POND 400	**2.48E+00**
Pu-238		SWDF Basin South (E-001)	**2.17E-01**
Pu-239	**3.84E-03**	POND 400	**2.92E-01**
Am-241	**1.76E-03**	EAV Basin South (E-003)	**1.02E-01**
Cm-244		POND 400	**1.18E-02**
Gross B	**2.78E+01**	Z Basin	**1.06E+03**
Gross A	**3.51E+01**	Z-01 Outfall	**2.54E+01**

Appendix Table E-13 Summary of Radionuclides in Drinking Water

Units are in pCi/L. Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large.

Samples at the Treatment Plants are collected monthly. One onsite location is collected quarterly. All other onsite locations are collected annually. For the annual and quarterly samples, all results for tritium, Co-60, Cs-137, Sr-89/90, Pu-238, Pu-239 and Cm-244 were below detection limits. The treatment plant samples are analyzed for tritium, Co-60, Cs-137, gross alpha and gross beta.

Treatment Plants – Finished Water Summary

	Nuclides	Tritium			Co-60		
Locations	Number of Samples	Mean Conc.	Minimum Conc.	Maximum Conc.	Mean Conc.	Minimum Conc.	Maximum Conc.
BJWSA Purrysburg WTP	12	4.02E+02	**1.62E+02**	**8.11E+02**	1.34E+00	-1.63E+00	4.97E+00
N. Augusta Public Water Works	12	9.39E+01	-1.07E+01	**3.19E+02**	1.01E+00	-3.89E+00	4.19E+00

	Nuclides	Cs-137		
Locations	Number of Samples	Mean Conc.	Minimum Conc.	Maximum Conc.
BJWSA Purrysburg WTP	12	-8.90E-01	-3.38E+00	1.63E+00
N. Augusta Public Water Works	12	-8.27E-02	-3.70E+00	3.11E+00

	Nuclides	Gross Beta			Gross Alpha		
Locations	Number of Samples	Mean Conc.	Minimum Conc.	Maximum Conc.	Mean Conc.	Minimum Conc.	Maximum Conc.
BJWSA Purrysburg WTP	12	1.78E+00	**1.54E+00**	**2.11E+00**	7.99E-02	1.29E-02	1.91E-01
N. Augusta Public Water Works	12	1.99E+00	**1.52E+00**	**2.78E+00**	9.90E-02	-7.89E-03	**3.05E-01**

Onsite Location Summary – Quarterly Samples

	Nuclides	Gross Beta			Gross Alpha		
Location	Number of Samples	Mean Conc.	Minimum Conc.	Maximum Conc.	Mean Conc.	Minimum Conc.	Maximum Conc.
782-3A quarterly	4	1.26E+00	**9.76E-01**	**1.60E+00**	1.43E+00	**7.38E-01**	**2.02E+00**

Onsite Location Summary – Annual Samples

	Nuclides	U-234	U-235	U-238	Am-241	Gross Beta	Gross Alpha
Location	Number of Samples	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
617-G	1	4.86E-03	-6.78E-07	1.62E-03	**1.11E-02**	**1.24E+00**	6.27E-02
681-3G Dom. Water Faucet	1	2.13E-03	6.57E-04	3.19E-03	3.97E-03	**3.19E+00**	**7.08E-01**
704-16G	1	3.76E-03	5.95E-03	**9.62E-03**	**1.46E-02**	**1.40E+00**	**1.03E+00**
709-1G	1	4.86E-04	1.81E-03	0.00E+00	**1.18E-02**	**1.50E+00**	**2.81E-01**
737-G	1	6.32E-03	-6.78E-07	1.58E-03	2.40E-03	**1.40E+00**	**3.43E-01**
782-3A (annual)	1	**1.88E-02**	-6.78E-07	**2.86E-02**	1.79E-03	Quarterly, See above	Quarterly, see above
905-112G Well	1	**2.46E-02**	2.97E-03	**2.89E-02**	3.89E-03	**1.32E+00**	**1.08E+00**
905-113G Well	1	**2.09E-02**	4.08E-03	**3.62E-02**	**1.19E-02**	**1.03E+00**	**9.59E-01**
905-125B	1	**4.57E-02**	**9.97E-03**	**6.62E-02**	**1.13E-02**	**1.92E+00**	**1.90E+00**
905-67B	1	9.86E-03	4.05E-03	**1.31E-02**	5.19E-03	**4.41E-01**	**5.05E-01**

Appendix Table E-14 Summary of Radionuclides in Freshwater Fish

Units are in pCi/g. Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit(MDL) or the uncertainty is large.

The analyte mean is set to zero if all composite values per fish species at a single location are less than the MDL or the uncertainty is large. Three composite samples were analyzed for each fish type from each location.

Tritium (H-3) (Edible)									
	Bass			Catfish			Panfish		
Location	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Augusta L&D	0.00E+00	-3.14E-02	-8.03E-03	2.72E-02	1.48E-02	**4.95E-02**	0.00E+00	9.49E-03	6.19E-02
Upper Three Runs Creek River Mouth	1.05E-01	**7.43E-02**	**1.34E-01**	0.00E+00	-1.02E-02	6.41E-02	9.57E-02	**8.35E-02**	**1.17E-01**
Four Mile Creek River Mouth	5.32E-02	4.38E-02	**7.00E-02**	0.00E+00	1.14E-02	3.43E-02	3.11E-01	6.62E-02	**7.78E-01**
Steel Creek River Mouth	0.00E+00	2.38E-02	5.54E-02	9.14E-02	6.16E-02	**1.31E-01**	0.00E+00	3.51E-02	4.86E-02
Lower Three Runs Creek River Mouth	0.00E+00	-1.29E-02	3.08E-03	0.00E+00	-1.67E-02	3.68E-02	1.29E-01	7.32E-02	**1.72E-01**
Hwy 301 Bridge Area	9.84E-02	4.73E-02	**1.26E-01**	2.85E-01	**1.90E-01**	**4.03E-01**	1.99E-01	**1.64E-01**	**2.46E-01**

Cs-137 (Edible)									
	Bass			Catfish			Panfish		
Location	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Augusta L&D	0.00E+00	-3.78E-03	1.88E-02	0.00E+00	5.57E-03	3.62E-02	0.00E+00	-2.45E-03	2.76E-02
Upper Three Runs Creek River Mouth	0.00E+00	2.40E-02	4.89E-02	0.00E+00	4.62E-03	3.73E-02	0.00E+00	1.28E-02	1.67E-02
Four Mile Creek River Mouth	6.32E-02	**4.57E-02**	**9.11E-02**	0.00E+00	4.65E-03	3.22E-02	7.52E-02	4.89E-02	**1.23E-01**
Steel Creek River Mouth	1.54E-01	**1.38E-01**	**1.79E-01**	7.31E-02	3.08E-02	**1.02E-01**	0.00E+00	1.90E-02	5.84E-02
Lower Three Runs Creek River Mouth	1.54E-01	**6.95E-02**	**3.11E-01**	4.37E-02	2.63E-02	**6.86E-02**	0.00E+00	1.59E-02	5.46E-02
Hwy 301 Bridge Area	2.51E-02	**1.95E-02**	**2.95E-02**	2.75E-02	1.57E-02	**3.89E-02**	2.63E-02	2.09E-02	**3.57E-02**

Sr-89/90 (Edible)									
	Bass			**Catfish**			**Panfish**		
Location	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Augusta L&D	0.00E+00	1.14E-03	3.49E-03	0.00E+00	4.92E-04	2.11E-03	0.00E+00	3.43E-03	6.00E-03
Upper Three Runs Creek River Mouth	2.72E-03	1.00E-03	**3.62E-03**	1.91E-03	4.14E-04	**4.54E-03**	0.00E+00	1.67E-03	4.54E-03
Four Mile Creek River Mouth	2.48E-03	1.45E-03	**4.41E-03**	0.00E+00	1.73E-03	2.51E-03	3.18E-03	1.66E-03	**4.68E-03**
Steel Creek River Mouth	0.00E+00	2.56E-04	1.96E-03	0.00E+00	9.14E-04	1.50E-03	5.68E-03	3.76E-03	**6.89E-03**
Lower Three Runs Creek River Mouth	2.10E-03	1.52E-03	**3.19E-03**	1.65E-03	9.24E-04	**2.84E-03**	3.82E-03	1.21E-04	**7.24E-03**
Hwy 301 Bridge Area	0.00E+00	9.03E-04	1.56E-03	0.00E+00	9.30E-04	1.56E-03	3.87E-03	2.36E-03	**5.73E-03**

Sr-89/90 (Non-Edible)									
	Bass			**Catfish**			**Panfish**		
Location	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Augusta L&D	9.51E-01	**8.92E-01**	**1.07E+00**	1.01E+00	**9.16E-01**	**1.13E+00**	8.26E-01	**5.97E-01**	**9.84E-01**
Upper Three Runs Creek River Mouth	8.34E-01	**8.05E-01**	**8.68E-01**	7.45E-01	**5.76E-01**	**8.70E-01**	9.75E-01	**8.14E-01**	**1.11E+00**
Four Mile Creek River Mouth	6.98E-01	4.86E-01	**9.38E-01**	6.72E-01	**6.03E-01**	**7.49E-01**	1.38E+00	**1.07E+00**	**1.88E+00**
Steel Creek River Mouth	7.43E-01	**5.73E-01**	**8.38E-01**	6.85E-01	**5.38E-01**	**8.49E-01**	7.85E-01	**6.65E-01**	**8.86E-01**
Lower Three Runs Creek River Mouth	7.54E-01	**5.97E-01**	**8.70E-01**	1.16E+00	**9.05E-01**	**1.59E+00**	1.01E+00	**9.08E-01**	**1.21E+00**
Hwy 301 Bridge Area	6.05E-01	**4.51E-01**	**7.08E-01**	9.23E-01	**6.59E-01**	**1.25E+00**	9.41E-01	**8.81E-01**	**1.06E+00**

I-129 (Edible)									
	Bass			**Catfish**			**Panfish**		
Location	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Augusta L&D	0.00E+00	-1.42E-02	1.39E-02	0.00E+00	-1.04E-02	9.11E-03	0.00E+00	-1.61E-03	2.44E-02
Upper Three Runs Creek River Mouth	0.00E+00	-1.69E-02	2.62E-02	0.00E+00	-5.68E-04	4.19E-02	0.00E+00	-5.19E-03	-3.59E-03
Four Mile Creek River Mouth	0.00E+00	-1.45E-02	1.12E-02	0.00E+00	-6.86E-03	1.56E-02	0.00E+00	6.84E-04	1.26E-02
Steel Creek River Mouth	0.00E+00	-1.23E-02	2.12E-02	1.77E-02	3.54E-03	**4.38E-02**	0.00E+00	-3.16E-03	1.57E-02
Lower Three Runs Creek River Mouth	7.78E-03	-1.02E-02	**3.81E-02**	0.00E+00	-1.23E-02	7.27E-03	0.00E+00	-9.38E-03	1.27E-03
Hwy 301 Bridge Area	0.00E+00	-1.01E-02	2.89E-02	0.00E+00	-1.53E-03	8.05E-03	0.00E+00	-2.55E-02	1.80E-02

Tc-99 (Edible)									
	Bass			**Catfish**			**Panfish**		
Location	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Augusta L&D	0.00E+00	1.55E-02	3.30E-02	0.00E+00	-3.86E-03	4.32E-02	0.00E+00	7.16E-03	2.31E-02
Upper Three Runs Creek River Mouth	6.70E-02	4.46E-02	**1.01E-01**	8.18E-02	**7.81E-02**	**8.84E-02**	0.00E+00	3.84E-02	4.59E-02
Four Mile Creek River Mouth	0.00E+00	-5.73E-04	5.68E-02	0.00E+00	1.43E-02	5.27E-02	0.00E+00	-1.72E-02	1.09E-02
Steel Creek River Mouth	0.00E+00	-6.86E-03	3.95E-02	0.00E+00	2.28E-03	6.22E-02	0.00E+00	1.96E-02	4.24E-02
Lower Three Runs Creek River Mouth	5.98E-02	3.43E-02	**9.76E-02**	6.89E-02	6.51E-02	**7.11E-02**	6.69E-02	5.35E-02	**8.27E-02**
Hwy 301 Bridge Area	0.00E+00	4.70E-02	6.65E-02	0.00E+00	2.68E-02	4.81E-02	0.00E+00	6.95E-03	6.51E-02

Gross Beta (Edible)									
	Bass			**Catfish**			**Panfish**		
Location	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Augusta L&D	2.04E+00	**1.64E+00**	**2.27E+00**	2.45E+00	**2.09E+00**	**2.76E+00**	2.06E+00	**1.87E+00**	**2.18E+00**
Upper Three Runs Creek River Mouth	2.19E+00	**1.99E+00**	**2.30E+00**	2.63E+00	**2.51E+00**	**2.69E+00**	1.82E+00	**1.65E+00**	**1.94E+00**
Four Mile Creek River Mouth	2.11E+00	**1.94E+00**	**2.29E+00**	2.34E+00	**2.25E+00**	**2.43E+00**	2.18E+00	**1.88E+00**	**2.60E+00**
Steel Creek River Mouth	2.59E+00	**2.41E+00**	**2.78E+00**	2.69E+00	**2.35E+00**	**2.95E+00**	1.94E+00	**1.78E+00**	**2.10E+00**
Lower Three Runs Creek River Mouth	3.01E+00	**2.57E+00**	**3.57E+00**	3.06E+00	**2.73E+00**	**3.46E+00**	2.68E+00	**2.51E+00**	**2.84E+00**
Hwy 301 Bridge Area	2.90E+00	**2.53E+00**	**3.27E+00**	2.33E+00	**2.12E+00**	**2.53E+00**	1.72E+00	**1.56E+00**	**1.81E+00**

All Co-60 and Gross Alpha results were non-significant and thus, not reported on this table.

Appendix Table E-15 Summary of Radionuclides in Saltwater Fish

Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large.

All saltwater fish ae collected at the location designated as River Miles 0-8 (mouth of Savannah River).

No sea trout were collected in 2015.

Fish Species	Marine Mullet				Red Drum			
Analyte	Number of Samples	Mean (pCi/g)	Minimum (pCi/g)	Maximum (pCi/g)	Number of Samples	Mean (pCi/g)	Minimum (pCi/g)	Maximum (pCi/g)
H-3	3	6.36E-02	4.78E-02	**8.08E-02**	3	8.03E-02	7.76E-02	**8.54E-02**
Sr 89/90 Non-Edible	3	2.11E-01	1.61E-01	**2.56E-01**	3	2.47E-01	4.97E-02	**4.38E-01**
Gross Beta	3	2.35E+00	**2.02E+00**	**2.81E+00**	3	2.07E+00	**1.55E+00**	**2.62E+00**

Results of all samples for Co-60, Cs-137, Tc-99, I-129, Sr-90 (in flesh), and gross alpha were below method detection limits.

Appendix Table E-16 Summary of Radionuclides in Shellfish

Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large.

All shellfish are collected at the location designated as River Miles 0-8 (at the mouth of Savannah River).

Nuclide	Number of Samples	Number of Results > Detection Limit	Concentration (pCi/g)
Co-60	1	0	-5.43E-03
Cs-137	1	0	9.49E-03
Sr-89/90	1	0	1.82E-03
I-129	1	0	-1.19E-03
Tc-99	1	0	2.14E-07
Gross B	1	1	**1.24E+00**
Gross A	1	1	**2.03E-01**

Appendix Table E-17 Summary of Radionuclides in Wildlife

Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large.

Sample Type	Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Sample Conc. (pCi/g)	Minimum Sample Conc. (pCi/g)	Maximum Sample Conc. (pCi/g)
Deer Flesh - Regular Hunts	Co-60	45	0	-7.30E-04	-4.11E-02	3.22E-02
Deer Flesh - Roadside Removal	Co-60	20	0	1.49E-03	-2.68E-02	2.62E-02
Hog Flesh	Co-60	12	0	9.38E-03	-6.11E-03	2.61E-02
Deer Flesh - Regular Hunts	Cs-137	45	45	2.46E+00	**3.11E-01**	**7.70E+00**
Deer Flesh - Roadside Removal	Cs-137	20	20	2.12E+00	1.32E-01	1.13E+01
Hog Flesh	Cs-137	12	11	1.60E+00	3.08E-02	**9.19E+00**
Deer Flesh - Regular Hunts	Sr-89/90	45	7	4.11E-03	-9.57E-04	**2.86E-02**
Deer Flesh - Roadside Removal	Sr-89/90	7	0	9.69E-02	2.17E-04	7.55E-01
Hog Flesh	Sr-89/90	12	1	2.88E-03	4.89E-04	**6.16E-03**
Deer Bone - Regular Hunts	Sr-89/90	45	45	3.49E+00	**4.73E-01**	**6.32E+00**
Hog Bone	Sr-89/90	12	12	4.17E+00	**7.41E-01**	**1.50E+01**

GLOSSARY

A

accuracy – Closeness of the result of a measurement to the true value of the quantity.

actinide – Group of elements of atomic number 89 through 103. Laboratory analysis of actinides by alpha spectrometry generally refers to the elements plutonium, americium, uranium, and curium but may also include neptunium and thorium.

activity – See radioactivity.

alpha particle – Positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (two protons and two neutrons)

ambient – Existing in the surrounding area. Completely enveloping.

ambient air – Surrounding atmosphere as it exists around people, plants, and structures.

analyte – Constituent or parameter that is being analyzed.

analytical detection limit – Lowest reasonably accurate concentration of an analyte that can be detected; this value varies depending on the method, instrument, and dilution used.

aquifer – Saturated, permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients.

Area Completion Project – U.S. Department of Energy program that directs the assessment and cleanup of inactive waste units and groundwater (remediation) contaminated as a result of nuclear-related activities.

Atomic Energy Agency – Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian application. It was abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration. Functions of the Energy Research and Development Administration eventually were taken over by the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission.

Audit – A systematic evaluation to determine the conformance to quantitative specifications of some operational function or activity.

B

background radiation – Naturally occurring radiation, fallout, and cosmic radiation. Generally, the lowest level of radiation obtainable within the scope of an analytical measurement, i.e., a blank sample.

best management practices – Sound engineering practices that are not required by regulation or by law.

beta particle – Negatively charged particle emitted from the nucleus of an atom. It has a mass and charge equal to those of an electron.

biota – Plant and animal life.

blind sample – A subsample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample, but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

C

calibration – Process of applying correction factors to equate a measurement to a known standard. Generally, a documented measurement control program of charts, graphs, and data that demonstrate that an instrument is properly calibrated.

canyon – Two facilities located at SRS where nuclear materials are chemically recovered and purified. They are called "canyons" because of their similarity to how a canyon looks, open space with high –wall – like mountains on either side of a valley.

Carolina bay – Type of shallow depression commonly found on the coastal Carolina plains. Carolina bays are typically circular or oval. Some are wet or marshy, while others are dry.

Central Savannah River Area – Eighteen-county area in Georgia and South Carolina surrounding Augusta, Georgia. The Savannah River Site is included in the Central Savannah River Area. Counties are Richmond, Columbia, McDuffie, Burke, Emanuel, Glascock, Jenkins, Jefferson, Lincoln, Screven, Taliaferro, Warren, and Wilkes in Georgia and Aiken, Edgefield, Allendale, Barnwell, and McCormick in South Carolina.

chlorocarbons – Compounds of carbon and chlorine, or carbon, hydrogen, and chlorine, such as carbon tetrachloride, chloroform, tetrachloroethylene, etc. They are among the most significant and widespread environmental contaminants. Classified as hazardous wastes, chlorocarbons may have a tendency to cause detrimental effects, such as birth defects.

cleanup – Actions taken to deal with release or potential release of hazardous substances. This may mean complete removal of the substance; it also may mean stabilizing, containing, or otherwise treating the substance so that it does not affect human health or the environment.

closure – Control of a hazardous waste management facility under Resource Conservation and Recovery Act requirements.

compliance – Fulfillment of applicable requirements of a plan or schedule ordered or approved by government authority.

composite – A blend of more than one portion to be used as a sample for analysis.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – This Act addresses the cleanup of hazardous substances and establishes a National Priority List of sites targeted for assessment and, if necessary, restoration (commonly known as "Superfund").

concentration – Amount of a substance contained in a unit volume or mass of a sample.

conductivity – Measure of water's capacity to convey an electric current. This property is related to the total concentration of the ionized substances in water and the temperature at which the measurement is made.

contamination – State of being made impure or unsuitable by contact or mixture with something unclean, bad, etc.

contaminant pathway - The way contaminants move and settle in the environment after release from operating facilities to the air and water.

continuous assessment – Evaluation of a program or employee carried out on a fixed interval (e.g. weekly, monthly, annually)

control chart – A graph of some measurement plotted over time or sequence of sampling, together with control limit(s) and, usually, a central line and warning limit(s). Control charts provide a graphical representation of accuracy and precision, a long-term mechanism for self-evaluation of analytical data, and an assessment of analytical capability of the laboratory analyst.

control standard – A standard prepared independently of and run with the calibration. It is used to verify the accuracy of the calibration.

criteria pollutant – Six common air pollutants found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur dioxide, nitrogen oxides, and lead. The Environmental Protection Agency is required by the Clean Air Act to set National Ambient Air Quality Standards for these six pollutants.

curie – Unit of radioactivity. One curie is defined as 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are commonly used:

- **kilocurie (kCi)** – 10^{3} Ci, one thousand curies; 3.7×10^{13} disintegrations per second.
- **millicurie (mCi)** – 10^{-3} Ci, one-thousandth of a curie; 3.7×10^{7} disintegrations per second.
- **microcurie (µCi)** – 10^{-6} Ci, one-millionth of a curie; 3.7×10^{4} disintegrations per second.
- **picocurie (pCi)** – 10^{-12} Ci, one-trillionth of a curie; 0.037 disintegrations per second.

D

DCS sum of fractions – The sum of the ratios of the average concentration of each radionuclide to its corresponding DCS value. (see below for definition of DCS – derived concentration standard)

decay (radioactive) – Spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide, or into a different energy state of the same radionuclide.

deactivation – The process of placing a facility in a stable and known condition, including the removal of hazardous and radioactive materials to ensure adequate protection of the worker, public health and safety, and the environment, thereby limiting the long-term cost of surveillance and maintenance.

decommissioning – Process that takes place after deactivation and includes surveillance and maintenance, decontamination, and/or dismantlement.

decontamination – The removal or reduction of residual radioactive and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.

derived concentration standard (DCS) – Concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in either an effective dose equivalent of 0.1 rem (1 mSv). The guides for radionuclides in air and water are given in U.S. Department of Energy Derived Concentration Technical Standard (DOE-STD-1196-2011) (DOE 2011).

detection limit – See analytical detection limit, lower limit of detection, minimum detectable concentration.

detector – Material or device (instrument) that is sensitive to radiation and can produce a signal suitable for measurement or analysis.

disposal – Permanent or temporary transfer of U.S. Department of Energy control and custody of real property to a third party, which thereby acquires rights to control, use, or relinquish the property.

disposition – Those activities that follow completion of program mission including, but not limited to, surveillance and maintenance, deactivation, and decommissioning.

dissolved oxygen – Desirable indicator of satisfactory water quality in terms of low residuals of biologically available organic materials. Dissolved oxygen prevents the chemical reduction and subsequent leaching of iron and manganese from sediments.

DOECAP – A comprehensive audit program for contract laboratories with the intent of conducting consolidated audits to eliminate redundant audits previously conducted independently by DOE field element sites and to achieve standardization in audit methodology, processes, and procedures.

dose – Energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram in any medium.

- **absorbed dose** – Quantity of radiation energy absorbed by an organ, divided by the organ's mass. Absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 Gy).
- **equivalent dose** – Product of the absorbed dose (rad) in tissue and a radiation weighting factor. Equivalent dose is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).
- **effective dose** – Sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate tissue weighting factor.
- **committed effective dose** – Is the effective dose integrated over time, usually 50-years. Committed effective dose is expressed in units of rem (or sievert).
- **collective dose** – Sum of the effective dose of all individuals in an exposed population within a 50-mile (80-km) radius, and expressed in units of person-rem (or person-sievert). The 50-mile distance is measured from a point located centrally with respect to major facilities or U.S. Department of Energy program activities.

dosimeter – Portable detection device for measuring the total accumulated exposure to ionizing radiation.

drinking water standards – Federal primary drinking water standards, both proposed and final, as set forth by the Environmental Protection Agency.

duplicate result – Result derived by taking a portion of a primary sample and performing the identical analysis on that portion as is performed on the primary sample.

E

effluent – A release of treated or untreated water or air from a pipe or a stack to the environment. Liquid effluent flows into a body of water such as a stream or lake. Airborne effluent (also called emission) discharges into the atmosphere.

effluent monitoring – Collection and analysis of samples or measurements of liquid and gaseous effluents for purpose of characterizing and quantifying the release of contaminants, assessing radiation exposures to members of the public, and demonstrating compliance with applicable standards.

environmental compliance – Actions taken in accordance with government laws, regulations, orders, etc., that apply to Site operations' effects on onsite and offsite natural resources and on human health; used interchangeably in this document with regulatory compliance.

environmental monitoring – Program at Savannah River Site that includes effluent monitoring and environmental surveillance with the dual purpose of 1) showing compliance with federal, state, and local regulations, as well as with U.S. Department of Energy orders, and 2) monitoring any effects of Site operations on onsite and offsite natural resources and on human health.

environmental surveillance – Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from U.S. Department of Energy sites and their environs and the measurement of external radiation for purpose of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

exception (formerly "exceedance") – Term used by the Environmental Protection Agency and the South Carolina Department of Health and Environmental Control that denotes a report value is more than the guide limit. This term is found on the discharge monitoring report forms that are submitted to the Environmental Protection Agency or the South Carolina Department of Health and Environmental Control.

exposure (radiation) – Incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is the exposure to ionizing radiation that takes place during a person's working hours. Population exposure is the exposure to the total number of persons who inhabit an area.

exposure pathway –The way that a person could be impacted from releases of radionuclides into the water and air.

F

fallout – The settling to the ground of airborne particles ejected into the atmosphere from the earth by explosions, eruptions, forest fires, etc. or from human production activities such as found at nuclear facilities.

Federal Facility Agreement (FFA) – Agreement negotiated among the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control, specifying how the Savannah River Site will address contamination or potential contamination to meet regulatory requirements at Site waste units identified for evaluation and, if necessary, cleanup.

feral hog – Hog that has reverted to the wild state from domestication.

field duplicate – An independent sample collected as closely as possible to the same point in space and time as the original sample. The duplicate and original are two separate samples taken from the same source, stored in separate containers, and analyzed independently.

G

global fallout – Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

grab sample – Sample collected instantaneously with a glass or plastic bottle placed below the water surface to collect surface water samples (also called dip samples).

gross alpha and beta releases - The total alpha-emitting and beta-emitting activity determined at each effluent location.

ground shine – Exposure to gamma radiation produced by radioactive materials on the ground surface is called ground shine and it contributes to external dose.

groundwater – Water found underground in cracks and spaces in soil, sand, and rocks.

H

half-life (radiological) – Time required for half of a given number of atoms of a specific radionuclide to decay. Each nuclide has a unique half-life.

hazardous waste – Any waste which is a toxic, corrosive, reactive, or ignitable material that could affect human health or the environment.

I

isotope – Each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass but not in chemical properties; in particular, a radioactive form of an element.

L

legacy – Anything handed down from the past; inheritance, as of nuclear waste.

low level waste – Waste that includes protective clothing, tools, and equipment that have become contaminated with small amounts of radioactive material.

lower limit of detection – Smallest concentration/amount of an analyte that can be reliably detected in a sample at a 95-percent confidence level.

M

manmade radiation – Radiation from sources such as consumer products, medical procedures, and nuclear industry.

MAPEP – A laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE.

maximally exposed individual – Hypothetical individual who remains in an uncontrolled area and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

maximum contaminant level – The maximum allowable concentration of a drinking water contaminant as legislated through the Safe Drinking Water Act.

mercury – Silver-white, liquid metal solidifying at -38.9°C to form a tin-white, ductile, malleable mass. It is widely distributed in the environment and biologically is a nonessential or non-beneficial element. Human poisoning due to this highly toxic element has been clinically recognized.

migration – Transfer or movement of a material through the soil or groundwater.

minimum detectable concentration (radionuclides) – Smallest amount or concentration of a radionuclide that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level.

minimum detectable concentration (chemicals) – Smallest amount or concentration of a chemical that can be distinguished in a sample by a given measurement system at a given confidence level.

mixed waste – Waste that has both hazardous and radioactive components.

monitoring – Process whereby the quantity and quality of factors that can affect the environment and/or human health are measured periodically to regulate and control potential impacts.

N

non-routine radioactive release – Unplanned or nonscheduled release of radioactivity to the environment.

nuclide – Atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

O

organic – Of, relating to, or derived from living organisms (plant or animal).

outfall – Place where treated or untreated water flows out of a pipe to mix with water from a water body, such as a stream or lake.

P

parameter – Analytical constituent; chemical compound(s) or property for which an analytical request may be submitted.

PCB bulk product waste – Waste derived from products manufactured to contain PCBs in a non-liquid state at 50 ppm or greater. Typical examples are caulk, pain, and sealants.

performance evaluation (PE) sample – A sample, the composition of which is unknown to the analyst, that is provided to test whether the analyst/laboratory can produce analytical results within specified performance limits.

person-rem – Collective dose to a population group. For example, a dose of one rem to 10 individuals results in a collective dose of 10 person-rem.

pH – Measure of the hydrogen ion concentration in an aqueous solution (acidic solutions, pH <7; basic solutions, pH>7; and neutral solutions, pH 7).

piezometer – Instrument used to measure the potentiometric surface of the groundwater. Also, a well designed for this purpose.

plume – Volume of contaminated water originating at a waste source (e.g., a hazardous waste disposal site). It extends downward and outward from the waste source.

plume shine – Exposure to gamma radiation from airborne radioactive materials is called plume shine (sometimes called cloud shine or sky shine) and it contributes to external dose.

point source – Any defined source of emission to air or water such as a stack, air vent, pipe, channel, or passage to a water body.

population dose – See collective dose equivalent under dose.

precision – A estimate of the degree to which a set of observations or measurements of the property, usually obtained under similar conditions agree. It is a data quality indicator.

priority I finding – Documents a deficiency that is of sufficient magnitude to render the audited facility unacceptable to provide the affected service to DOE.

priority II finding – Documents a deficiency that is not of sufficient magnitude to render the audited facility unacceptable to provide services to DOE.

process sewer – Pipe or drain, generally located underground, used to carry off process water and/or waste matter.

proficiency testing – An evaluation of a laboratory's performance against pre-established criteria by means of inter-laboratory comparison. It is also known as comparative testing.

purge – To remove water prior to sampling, generally by pumping or bailing.

Q

quality assurance (QA) – An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure quality in the processes by which products are developed.

quality control (QC) – A set of activities for ensuring quality in products by identifying defects in the actual products.

R

rad – Unit of absorbed dose deposited in a volume of material.

radioactivity – Spontaneous emission of radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

radioisotopes – Radioactive isotopes.

radionuclide – Unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

reference person – A hypothetical age and gender averaged individual that is a combination of human (male and female) physical and physiological characteristics arrived at by international consensus for the purpose of standardizing radiation dose calculations.

Regional Screening Level (RSL) - The risk-based concentration derived from standardized equations combining exposure assumptions with toxicity data.

regulatory compliance – Actions taken in accordance with government laws, regulations, orders, etc., that apply to Savannah River Site operations' effects on onsite and offsite natural resources and on human health; used interchangeably in this document with environmental compliance.

release – Any discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

rem – Unit of dose equivalent (absorbed dose in rads times the radiation quality factor). Dose equivalent frequently is reported in units of millirem (mrem), which is one thousandth of a rem.

remediation – Assessment and cleanup of sites contaminated with waste due to historical activities.

Representative person – A hypothetical individual receiving a dose that is representative of the more highly exposed individuals in the population.

Resource Conservation and Recovery Act (RCRA) – Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes. This act also requires corrective action for releases of hazardous waste at inactive waste units.

retention basin – Unlined basin used for emergency, temporary storage of potentially contaminated cooling water from chemical separations activities.

routine radioactive release – Planned or scheduled release of radioactivity to the environment.

S

seepage basin – Excavation that receives wastewater. Insoluble materials settle out on the floor of the basin and soluble materials seep with the water through the soil column, where they are removed partially by ion exchange with the soil. Construction may include dikes to prevent overflow or surface runoff.

sensitivity – Capability of methodology or instruments to discriminate between samples with differing concentrations or containing varying amounts of an analyte.

sievert – The International System of Units (SI) derived unit of dose equivalent. It attempts to reflect the biological effects of radiation as opposed to the physical aspects, which are characterized by the absorbed dose, measured in gray. One sievert is equal to 100 rem.

site stream – Any natural stream on the Savannah River Site. Surface drainage of the Site is via these streams to the Savannah River.

source – Point or object from which radiation or contamination emanates.

source term – Quantity of radioactivity (released in a set period of time) that is traceable to the starting point of an effluent stream or migration pathway.

spent nuclear fuel – Used fuel elements from reactors.

splits or split sample – Two or more representative portions taken from a single sample and analyzed by different analysts or laboratories. Split samples are used to replicate the measurement of the parameters of interest.

stable – Not radioactive or not easily decomposed or otherwise modified chemically.

stack – Vertical pipe or flue designed to exhaust airborne gases and suspended particulate matter.

standard deviation – Indication of the dispersion of a set of results around their average.

statistical data evaluation – A collection of methods used to process large amounts of data and report overall trends.

stormwater runoff – Surface streams that appear after precipitation.

Superfund – See Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

surface water – Water that has not penetrated below the surface of the ground.

T

tank farm – Interconnected underground tanks used for storage of high-level radioactive liquid wastes.

temperature – Thermal state of a body, considered with its ability to communicate heat to other bodies.

terrestrial – Living on or growing from the land.

thermoluminescent dosimeter (TLD) – A passive device that measures the exposure from ionizing radiation.

total dissolved solids – Dissolved solids and total dissolved solids are terms generally associated with freshwater systems; they consist of inorganic salts, small amounts of organic matter, and dissolved materials.

total phosphorus – May occasionally stimulate excessive or nuisance growths of algae and other aquatic plants when concentrations exceed 25 mg/L at the time of the spring turnover on a volume- weighted basis in lakes or reservoirs.

total suspended particulates – Refers to the concentration of particulates in suspension in the air, regardless of the nature, source, or size of the particulates.

translocation – The deliberate movement of organisms from one site for release in another. It must be intended to yield a measurable conservation benefit at the levels of a population, species or ecosystem, and not only provide benefit to translocated individuals.

transport pathway – Pathway by which a released contaminant is transported physically from its point of discharge to a point of potential exposure to humans. Typical transport pathways include the atmosphere, surface water, and groundwater.

transuranic waste – Solid radioactive waste containing primarily alpha-emitting elements heavier than uranium.

trend – General drift, tendency, or pattern of a set of data plotted over time.

tritium - Elemental form of the radioactive isotope of hydrogen and occurs as a gas.

tritium oxide - Water in which the tritium isotope has replaced a hydrogen atom. Stack releases of tritium oxide typically occur as water vapor.

turbidity – Measure of the concentration of sediment or suspended particles in solution.

U

unidentified alpha and beta releases – The unspecified alpha and beta releases that are conservatively determined at each effluent location by subtracting the sum of the individually measured alpha-emitting (e.g., plutonium-239 and uranium-235) and beta- emitting (e.g., cesium-137 and strontium-90) radionuclides from the measured gross alpha and beta values, respectively. Unidentified alpha and beta releases also include naturally occurring radionuclides, such as uranium, thorium, radon progeny, and potassium-40.

utility water – Once-through non-contact cooling water, recirculated non-contact cooling water, boiler blowdown, steam condensate, air conditioning condensate, and other uncontaminated heating, ventilation and air conditioning or compressor condensates.

V

volatile organic compounds – Broad range of organic compounds, commonly halogenated, that vaporize at ambient, or relatively low, temperatures (e.g., acetone, benzene, chloroform, methyl alcohol).

W

waste management – The U.S. Department of Energy uses this term to refer to the safe, effective management of various kinds of nonhazardous, hazardous, and radioactive waste generated at DOE facilities.

waste unit – A particular area that is or may be posing a threat to human health or the environment. Waste units range in size from a few square feet to tens of acres and include basins, pits, piles, burial grounds, landfills, tank farms, disposal facilities, process facilities, and groundwater contamination.

water table – Planar, underground surface beneath which earth materials, such as soil or rock, are saturated with water.

weighting factor – Value used to calculate dose equivalents. It is tissue specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be attributed to that particular tissue. The weighting factors used in this report are recommended by the International Commission on Radiological Protection (Publication 26).

wetland – Lowland area, such as a marsh, swamp, bog, Carolina bay, floodplain bottom, where land is covered by shallow water at least part of the year and is characterized by somewhat mucky soil.

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Units of Measure

Symbol	Name	Symbol	Name
Temperature		***Concentration***	
°C	degrees Celsius	ppb	parts per billion
°F	degrees Fahrenheit	ppm	parts per million
Time		***Rate***	
d	day	cfs	cubic feet per second
h	hour	gpm	gallons per minute
y	year	***Conductivity***	
Length		µmho	micromho
cm	centimeter	***Radioactivity***	
ft	foot	Ci	curie
in	inch	cpm	counts per minute
km	kilometer	mCi	millicurie
m	meter	µCi	microcurie
mm	millimeter	pCi	picocurie
µm	micrometer	Bq	becquerel
Mass		***Radiation Dose***	
g	gram	mrad	millirad
kg	kilogram	mrem	millirem
mg	milligram	Sv	sievert
µg	microgram	mSv	millisievert
Area		µSv	microsievert
mi^2	square mile	R	roentgen
ft^2	square foot	mR	milliroentgen
Volume		µR	microroentgen
gal	gallon	Gy	gray
L	liter		
mL	milliliter		

Fractions and Multiples of Units				
Multiple	**Decimal Equivalent**	**Prefix**	**Symbol**	**Report Format**
10^{6}	1,000,000	mega-	M	E+06
10^{3}	1,000	kilo-	k	E+03
10^{2}	100	hecto-	h	E+02
10	10	deka-	da	E+01
10^{-1}	0.1	deci-	d	E-01
10^{-2}	0.01	centi-	c	E-02
10^{-3}	0.001	milli-	m	E-03
10^{-6}	0.000001	micro-	µ	E-06
10^{-9}	0.000000001	nano-	n	E-09
10^{-12}	0.000000000001	pico-	p	E-12
10^{-15}	0.000000000000001	femto-	f	E-15
10^{-18}	0.000000000000000001	atto-	a	E-18

Conversion Table (Units of Radiation Measure)		
Current System	***Systeme International***	**Conversion**
curie (Ci)	becquerel (Bq)	1 Ci = 3.7×10^{10} Bq
rad (radiation absorbed dose)	gray (Gy)	1 rad = 0.01 Gy
rem (roentgen equivalent man)	sievert (Sv)	1 rem = 0.01 Sv

Conversion Table					
Multiply	**By**	**To Obtain**	**Multiply**	**By**	**To Obtain**
in	2.54	cm	cm	0.394	in
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
liq qt-US	0.945	L	L	1.057	liq qt-US
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
d/m	0.450	pCi	pCi	2.22	d/m
pCi	10^{-6}	µCi	µCi	10^{6}	pCi
pCi/L (water)	10^{-9}	µCi/mL (water)	µCi/mL (water)	10^{9}	pCi/L (water)
pCi/m^3 (air)	10^{-12}	µCi/mL (air)	µCi/mL (air)	10^{12}	pCi/m^3 (air)

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