SRNS-RP-2015-00008

SAVANNAH RIVER SITE

Environmental Report 2014

Savannah River Nuclear Solutions, LLC
Savannah River Site
Aiken, South Carolina

Front Cover - Steve Ashe, SRNS Corporate Communications, provided this year's cover photo of the Savannah River.

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Savannah River Site

Environmental Report for 2014

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TO OUR READERS

OVERVIEW

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.

The Savannah River Site Environmental Report for Calendar Year 2014 is an overview of environmental management activities conducted on and in the vicinity of the Savannah River Site (SRS) from January 1 through December 31, 2014. This report includes:

- A summary of environmental management systems in place to implement sound stewardship practices and environmental regulations and laws in place to protect air, water, land, and other natural and cultural resources impacted by SRS operations.
- Effluent monitoring and environmental surveillance of air, water, soil, vegetation, biota, and agricultural products for radioactivity. The results are compared with historical data, background measurements, and/or applicable standards and requirements in order to verify that the 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 and from special case exposure scenarios, and 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 “Overview” text box at the beginning of each chapter and the “highlights” in the left hand side margins. There are no tables, figures, or graphs in the overviews; however, the highlights may have some pictures. A lay person with little knowledge of science may comfortably read the overviews, key terms and focus on the highlights.
- 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. 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 links to these reports may be found in the chapters of discussion or in the CD provided with the hard copy of this report. There are also data tables on the CD, which provide original data used to perform the analyses and derive the conclusions.

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 CD found on the inside of the back cover of this report features 1) an electronic version of the report with hyperlinks to all supplemental information or reports; 2) an appendix of environmental sampling locations and dose maps that are identified as “Maps Figure” within the text of the report; 3) all sample results that are identified as “Data Tables” within the text of the report; and 4) annual reports from other SRS organizations. The data tables are presented in both Adobe and Excel formats.

The Savannah River Nuclear Solutions (SRNS), LLC develops this report as the Management & Operations contractor to the Department of Energy for the Savannah River Site. 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 Group, LLC, 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 page 1-3 and 1-4 or in the CD provided with the hard copy of this report.

The SRS Annual Environmental Report can be found 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

ALARA	As Low As Reasonably Achievable
ARP	Actinide Removal Process

B

BAT	Best Available Technology
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
CD	Compact Disk
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curie
CMP	Chemicals, Metals, and Pesticides
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	United States 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
ICRP	International Commission on Radiological Protection
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
MDA	Minimum Detectable Activity
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
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
RHA	Rivers and Harbors Act
RICE	Reciprocating Internal Combustion Engine
RM	River Mile

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
SEER	Seasonal Energy Efficiency Ratio
SNM	Special Nuclear Materials
SPF	Saltstone Production Facility
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
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

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
MHTW	Burke and Screven Counties Wells (Georgia)
MPTW	Burke and Screven Counties Wells (Georgia)
MSB	SRS Boundary Wells
NRC	Nuclear Regulatory Commission
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
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

OVERVIEW

This report was prepared following United States Department of Energy (DOE) Order 231.1B "Environment, Safety, and Health Reporting" to present summary environmental information and data for the Savannah River Site (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 report 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 SRS.

HISTORY

SRS is a government facility located in the western region of South Carolina along the Savannah River. The United States built SRS 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 including two chemical separation plants, a heavy water extraction plant, nuclear fuel and target fabrication facilities, a tritium extraction facility and waste management facilities were also built, and several of these facilities continue to operate. The main activities on Site today are waste processing and treatment, environmental cleanup and remediation and protection of nuclear material.

The Savannah River Site (SRS) has had an extensive environmental monitoring program in place since 1951 (before Site startup). In the 1950s, data generated by the onsite environmental monitoring program were reported in Site documents. Beginning in 1959, data from offsite environmental surveillance activities were presented in reports issued for public dissemination. SRS reported onsite and offsite environmental monitoring activities separately until 1985, when data from both programs were merged into one public document.

MISSIONS

The mission of SRS is to operate safely and efficiently to protect public health and the environment while supporting the nation's nuclear deterrent programs and the transformation of the Site for future use. 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, including surplus nuclear materials disposition, tritium supply management, and nuclear stockpile maintenance and evaluation.

Clean Energy – SRS is focused on research and development to accelerate technology development through public and private partnerships to provide sustainable regional energy while protecting environmental health.

You will find more information on SRS's website.

ORGANIZATION

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.

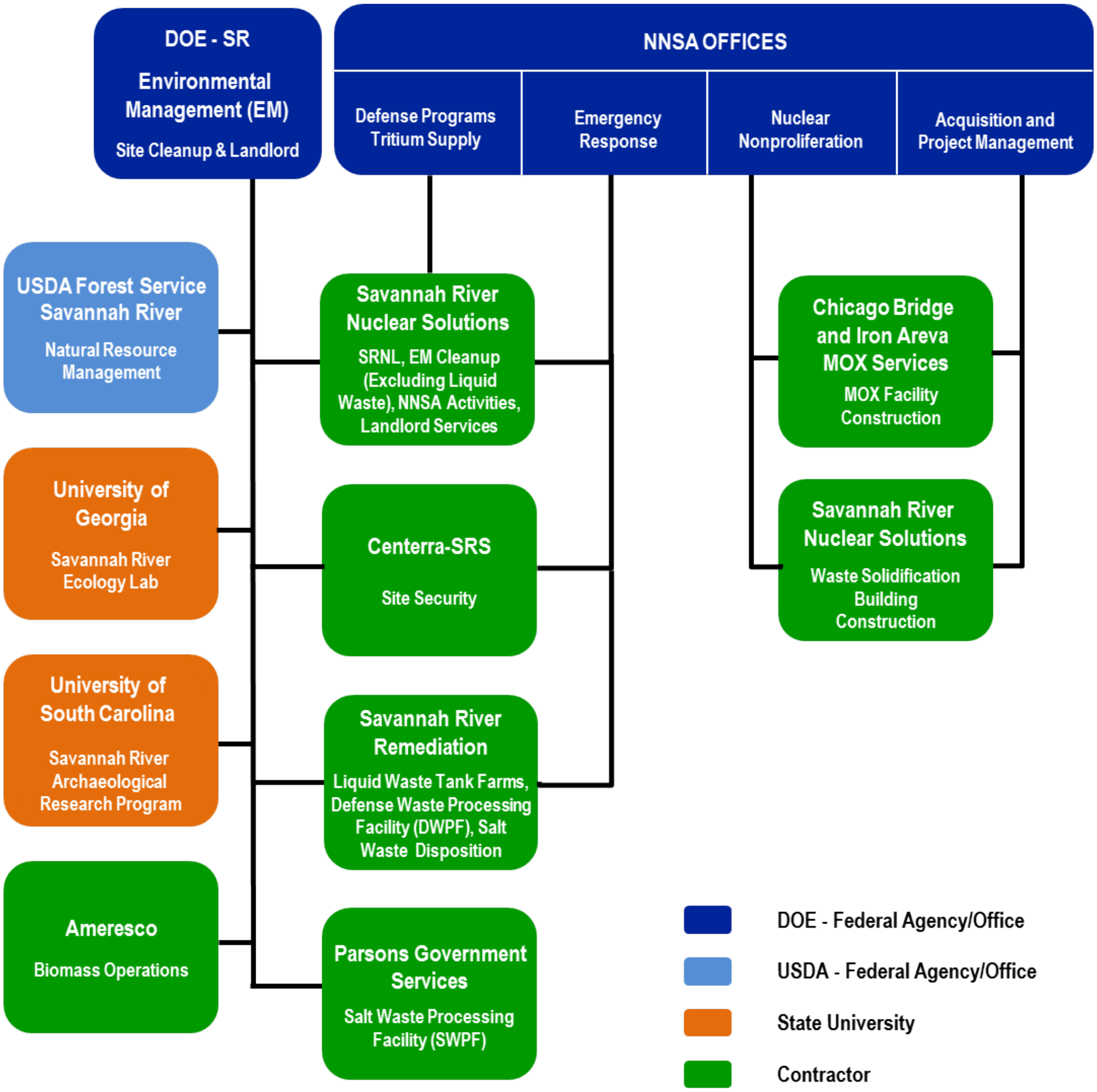


Figure 1-1 SRS Organization

The DOE Savannah River Operations Office (DOE-SR) is responsible for oversight of Environmental Management operations and landlord services supporting all mission areas at SRS. You will find more information on the DOE-SR website.

NNSA offices at SRS are 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 assets. 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 operates the Savannah River National Laboratory (SRNL), nuclear materials and spent nuclear fuel facilities, solid waste management facilities, tritium programs, Site infrastructure, and waste site remediation and closure projects in support of all three SRS mission areas. You will find more information on the SRNS website.

Operated by SRNS, SRNL is SRS's and DOE-EM's applied research and development laboratory. SRNL creates practical, high-value, cost-effective technological solutions in all three SRS mission areas. 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 the DOE-SR liquid waste contractor responsible for treating, storing, and disposing of radioactive liquid waste. SRR is composed of a team of companies led by AECOM (formerly AECOM Technology Corporation) with partners Bechtel National, CH2M Hill, and Babcock & Wilcox. 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 the DOE-SR contractor 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 the NNSA contractor 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 the DOE-SR contractor responsible for the protective force that fulfills security requirements and executes emergency contingency plans that protect special nuclear materials, government assets, and Site employees from security threats. You will find more information on the Centerra website. In 2014 Centerra Group, LLC acquired the parent company of Wackenhut-SRS. Wackenhut-SRS was renamed Centerra-SRS.

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. DOE-SR has contracted Ameresco to supply steam and electricity to SRS. Data from the plants are not included in the *SRS Environmental Report for 2014* because the facilities operate under environmental permits issued directly to Ameresco by the South Carolina Department of Health and Environmental Control (SCDHEC). 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 also includes, training future generations of scientists on how to evaluate such risks and to provide local communities with data on how DOE and Site contractors are addressing 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 United States 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.

SRS borders the Savannah River and covers about 310 square miles in the South Carolina counties of Aiken, Allendale, and Barnwell.

SITE LOCATION, DEMOGRAPHICS, AND ENVIRONMENT

The Site, which borders the Savannah River, 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. The capital letters within the SRS borders on Figure 1-2 identify operational areas referenced throughout this report.

Based on the U.S. Census Bureau's 2010 decennial 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.

Water Resources

The nearest downriver municipal facility that uses the river as a drinking water source is about 90 river miles from the Site.

The Savannah River bounds SRS on the southwest for 35 river miles. 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 fisherman, 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 generally migrates downward as well as laterally, eventually either discharging into the Savannah River and its tributaries or migrating into the deeper regional flow systems. SRS uses groundwater for both industrial processes and drinking water.

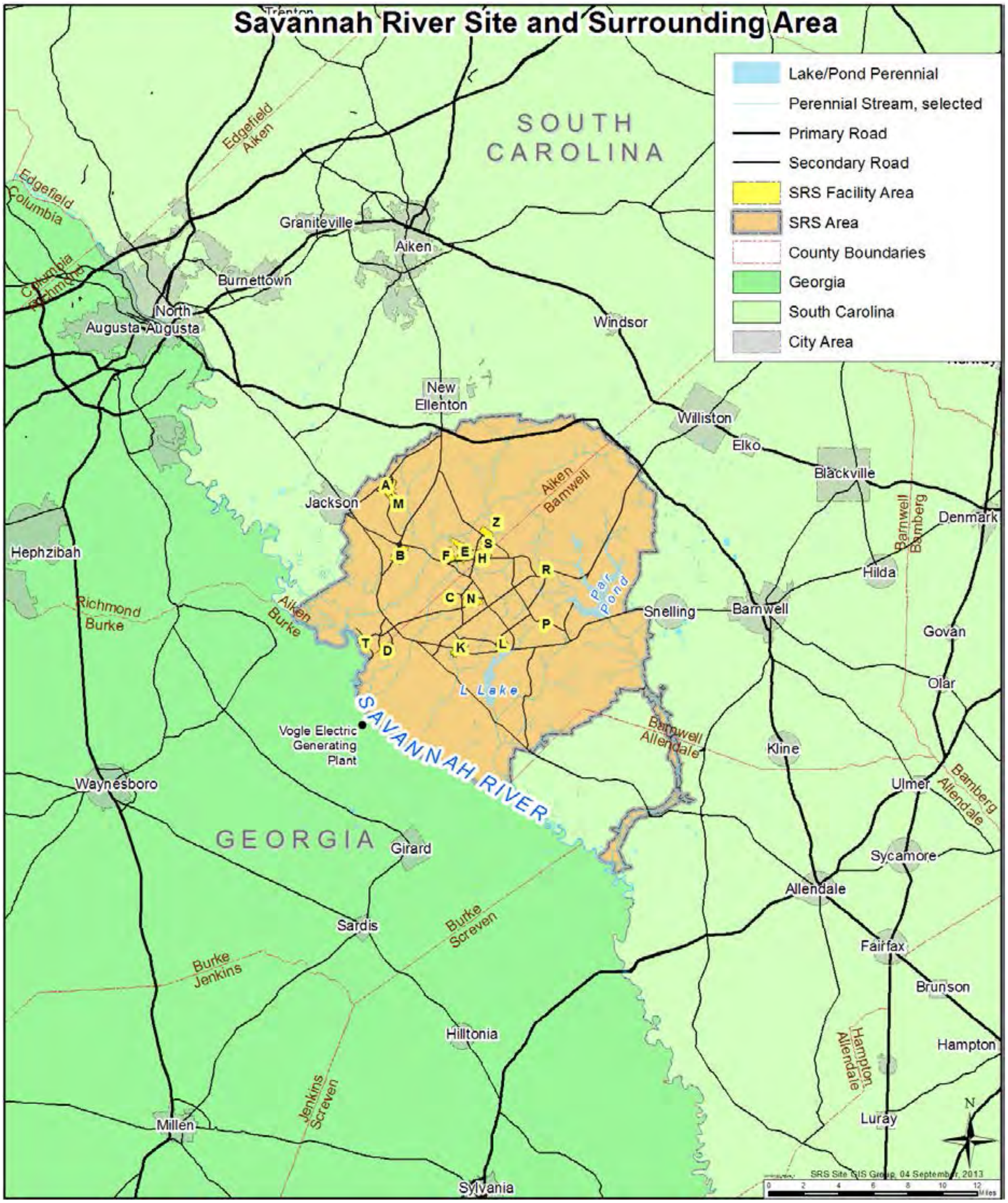


Figure 1-2 The Savannah River Site and Surrounding Area

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.

Land and Forest Resources

About 90 percent of SRS land area consists of natural and managed forests.

About 90 percent of SRS land area 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.

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.

SRS uses only about 10 percent of the total land area of the Site for industrial activities and the remaining 90 percent is natural and managed forest. 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, and the smooth purple coneflower (all federally listed as endangered) and at least 40 plant species of state or regional concern.

DOE EM PRIMARY SITE ACTIVITIES

Nuclear Materials Stabilization

In the past, separations facilities located in F and H Areas processed special nuclear materials (SNM) and spent fuel from Site reactors to produce materials for nuclear weapons and isotopes for 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

SRS's two primary separations facilities, called "canyons" because of their similarity to how a canyon looks, open space with high walls – like looking up and seeing the mountains on either side from the valley. These canyons are located in F and H Areas. F Canyon and H Canyon are where nuclear materials were chemically recovered and purified. DOE deactivated F Canyon in 2006 while H Canyon continues to operate. 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 primary missions of H Canyon since 2003 has been to recover and disposition high-enriched uranium from various spent and un-irradiated nuclear fuels as well as from uranium bearing materials from across the DOE complex. This is a key function of the nation's nuclear nonproliferation program. In H Canyon, the high-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.

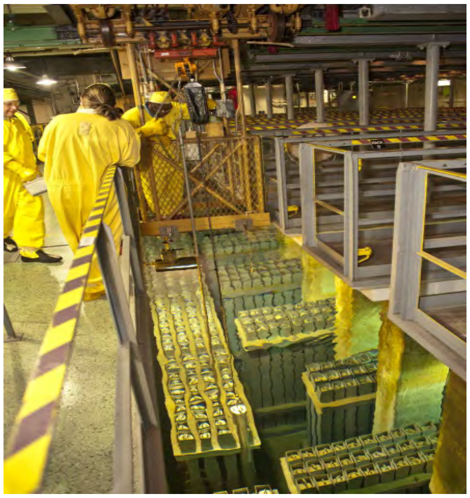
K-Area Complex

H Canyon also dissolves plutonium materials into a solution that is fed to the HB-Line facility (located on top of H Canyon) for conversion into a purified oxide product. DOE has forecasted the plutonium oxide product as feed for the MFFF. In 2014, H Canyon completed processing of sodium reactor experimental fuel. SRS previously used H Canyon and HB-Line to prepare surplus plutonium materials for disposition at the Waste Isolation Pilot Plant (WIPP) in New Mexico. DOE has transferred this mission to K Area. You will find more information on the H-Area Nuclear Materials Disposition page on SRS's website.

Nuclear Materials Consolidation and Storage

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

The K-Area Complex is DOE's only SNM 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 WIPP, the Defense Waste Processing Facility (DWPF), H Area facilities, and the MFFF.



Spent Fuel Storage in the L-Area Complex

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

Spent Nuclear Fuel Storage

SRS supports the DOE mission to reduce and protect vulnerable nuclear material at civilian sites around the world by safely and cost effectively 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.

Waste Management

SRS manages radiological and nonradiological waste created by previous operations at the nuclear reactors and their support facilities, as well as newly generated waste created by ongoing Site operations.

Radioactive Liquid Waste Management

SRS waste tanks have provided more than 50 years of safe storage for radioactive liquid waste.

The processing of nuclear materials for national defense, research, and medical programs generates radioactive liquid waste. Approximately 37 million gallons of radioactive liquid waste are safely stored in underground 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 tanks, a high priority for DOE. You will find more information in the Radioactive Liquid Waste: Operational Tank Closure and Liquid Waste Facilities fact sheets on SRS's website.

Solid Waste Management

Solid wastes managed at SRS include the following types:

- Low-level radioactive solid waste, which includes items such as protective clothing, tools, and equipment that have become contaminated with small amounts of radioactive material;

E-Area Waste Storage and Disposal Facilities

D-Area Coal Ash Landfill and Basins

- Transuranic (TRU) waste, which contains alpha-emitting isotopes with an atomic number greater than that of uranium;
- Hazardous waste, 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 wastes generated at SRS are treated, stored, and disposed 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. In 2014, pollution prevention (P2) projects avoided or diverted 165 cubic yards (yd^3) of hazardous and radioactive wastes. SRS also diverted 602 tons of routine sanitary waste to recycle markets.

During 2014, SRS completed remediating and characterizing all remaining legacy TRU waste. You will find more information on the Solid Waste Management page on SRS's website.

Area Completion

Past operations at SRS have resulted in the release of hazardous and radioactive substances to soil that have ended up in the groundwater. The purpose of the Area Completion program is to deactivate and decommission contaminated facilities and remediate soils, groundwater, surface water, and sediments to levels that are protective of human health and the environment. The program addresses contamination from hazardous constituents and substances (including radionuclides) and for the investigation and remediation of solid waste management units as appropriate.

During 2014, SRS began a five-year project to restore 90 acres located near the former coal-fired power plant in D Area. You will find more information on the Area Completion Projects page on SRS's website.

SRS collects thousands of samples of air, rainwater, surface water, drinking water, groundwater, food products, wildlife, soil, sediment, and vegetation.

Environmental Monitoring

SRS conducts an extensive environmental monitoring program to determine impacts, if any, from SRS operations to the surrounding communities and the environment. 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 2014, 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 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.

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.

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

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

OVERVIEW

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 of the EMS.

SRS EMS IMPLEMENTATION

Introduction

The framework DOE has chosen to employ environmental management systems (EMS) and sustainable practices is the International Organization for Standardization (ISO) Standard 14001 (Environmental Management Systems). The ISO 14001 model uses a system of policy development, planning, implementation and operation, checking, corrective action, and management review; ultimately, ISO14001 aims to improve performance as the cycle repeats. 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 put into practice environmental management systems.

The EMS integrates environmental protection into daily activities throughout operations at SRS with safety and health hazard identification and control processes, as well as quality management processes. It is an approach to planning, executing, evaluating, and modifying how SRS operates so that we have a minimal impact on the environment. EMS is incorporated into SRS's current management practices and procedures. Using EMS, SRS sets priorities for action and fosters continuous improvement. These priorities promote compliance with environmental regulations, thereby achieving environmental stewardship and sustainable practices.

DOE Order 436.1, "Departmental Sustainability," describes the requirements and responsibilities for implementing the EMS program. The Order requires SRS to develop and implement an annual Site Sustainability Plan (SSP) that identifies the Site's contributions toward meeting sustainability goals.

The SRS SSP reflects strategies in place or to be established for accomplishing the goals and requirements in DOE Order 436.1 and associated Executive Orders.

In addition, SRS must use an EMS as a platform for SSP implementation and to carry out programs with goals and measurable targets that contribute to SRS meeting its sustainability goals. Table 2-2 provides a list of the SRS EMS and SSP targets and goals along with the status of the Site's progress toward meeting these goals.

Integrated Safety Management System Continual Improvement Framework

Centerra-Savannah River and Chicago Bridge & Iron AREVA MOX Services, LLC (MOX Services) maintain similar EMS programs in compliance with applicable DOE Orders and contract-specific requirements. Ameresco provides information for use in the Site Sustainability Plan and Ameresco's 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 missions are accomplished while protecting the public, the worker, and the environment. Integrated Safety Management System execution is comprised of the five functions of Define Scope of Work, Analyze Hazards, Develop and Implement Controls, Perform work, and Feedback and Improvement.

SRS organizations follow this approach and account for environmental and regulatory requirements in their programs and procedures.

Additionally, SRS performs self-assessments to identify issues, areas of concern, and good practices and to determine the overall health of the environmental program. SRS conducted 14 program level self-assessments in 2014. The assessments identified some small concerns related to minor equipment repairs and records submissions. The SRS tracking system retains documentation of the corrective actions taken to address the identified issues. For information on assessments and inspections by outside agencies, see Chapter 3, "Compliance Summary."

Environmental Policy

The SRS Environmental Policy documents SRS's intent to implement sound stewardship practices. These protect the air, water, land, and other natural and cultural resources potentially impacted by SRS construction, operations, maintenance, and decommissioning activities. Policy reviews and updates occur on an annual basis. Chapter 6 of the Savannah River Site Policy Manual contains the current policy.

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.*

Objectives, Targets, and Programs

Through the EMS, SRS identifies significant facility and operational activities (aspects) that interact with the environment and sets both qualitative and quantitative targets and goals for continuous improvement and reduction in SRS environmental impacts.

Some examples of environmental aspects and their impacts are shown in Table 2-1.

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

New targets and goals are set each year to meet these aspects and to support DOE's environmental objectives.

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

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

SRS established 10 specific target and goals for 2014. Table 2-2 shows these targets and goals and a summary of SRS's progress towards achieving them. Additional information is contained in this chapter on many of these items.

Table 2-2 2014 SRS EMS Targets and Goals (Summary)

EMS Objectives/Target	Status
Minimize energy use in SRS buildings	SRS conducted a study during 2013 on 25 buildings against the High Performance Sustainable Building (HPSB) guiding principles. Items to increase energy efficiency and reduce the environmental impacts identified in these buildings are implemented as funds become available.
Reduce greenhouse gases	The SRS biomass plants continue to provide SRS with steam and electricity; reductions in greenhouse gas (GHG) emissions are significant, compared with those from coal plants used until 2012. Since 2008, SRS has reduced GHG emissions by 70.2% using biofuels instead of fossil fuels. SRS also continued to encourage the use of webinars and video conferences to reduce some travel-related emissions.
Maximize renewable energy	Biomass energy facilities provided all of steam and 22% of the electricity needs for Site operations.
Maximize alternative fuel vehicle usage	SRS has a goal to maximize the use of E85 vehicles where possible. Approximately 84% of SRS's light duty fleet currently uses E85 fuel. SRS is participating in the General Services Administration Electric Vehicle Pilot Program with one electric vehicle and charging station.
Maximize the purchase of green products	SRS includes the use of cost-effective Environmentally Preferable Purchasing (EPP) products in all new applicable procurement solicitations. The site met the goal of 95% of applicable solicitations including the EPP clause.
Minimize the use of toxic chemicals	Through effective monitoring of chemical purchases and use of less toxic replacements, SRS reduced the purchase of high hazard chemicals during the year.
Minimize solid waste generation	SRS continued to minimize sanitary waste disposal by achieving a 40% recycle rate during the year, exceeding the goal of 35%.
Maximize the use of low-energy electronics	SRS met the goal of 95% of electronic products purchased during the year meeting the Electronic Product Environmental Assessment Tool (EPEAT).
Ensure all releases to the environment remain within established regulatory limits	SRS environmental programs use an aggressive mixture of proactive in-field observations and education of SRS personnel. These programs ensure that SRS facilities maintain their requirements and commitments. Chapter 3, "Compliance Summary," discusses the specific compliance status for SRS operations.
Ensure facility activities meet regulatory expectations	SRS assigns employees to perform inspections of major facilities on a regular basis. The results of these inspections are formalized in lessons learned shared electronically Site wide.

SRS Recycled Over 17,000 lbs. of Light Bulbs Last Year

SUSTAINABILITY ACCOMPLISHMENTS

Pollution Prevention/Waste Minimization

SRS strives to prevent or reduce pollution and waste generation whenever feasible. In 2014, pollution prevention (P2) projects avoided or diverted 165 cubic yards (yd^3) of hazardous and radioactive wastes. The annual cost avoidance from these projects is about $4.6 million. Table 2-2 shows a 2014 summary of the P2 and waste minimization projects and their contributions.

Annually, SRS establishes a performance target for recycling routine office-type sanitary waste. For 2014, the sanitary waste recycle target was 35% and SRS achieved a recycle rate of 40%. The effort diverted 602 tons of routine sanitary waste to recycle markets. In addition, SRS redirected many useful materials to recycle or reuse during the year. Table 2-3 provides highlights of those activities.

Table 2-3 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	5 yd^3
Low level radioactive waste generation avoided due to pollution prevention projects	158 yd^3
Mixed hazardous and low level mixed waste generation avoided due to pollution prevention projects	1.3 yd^3
Light bulbs recycled	17,900 lbs
Used oil recycled	15,700 gals
Lead-acid batteries recycled	35,900 lbs
Used tires recycled	35,000 lbs
Metals recycled	840,000 lbs
Furniture recycled/reused	133,000 lbs
Scrap electronic devices recycled (Does not include computers returned to vendor for reissuance)	115,000 lbs

Water Management

SRS reduced potable water intensity 22% in 2014.

DOE Order 436.1 requires that sites reduce potable (water that is suitable for drinking) water intensity by 26% by Fiscal Year (FY) 2020 relative to the FY 2007 baseline. Compared to the baseline, SRS has now reduced potable water intensity by 22.15%. In FY 2014, installation of low-flow toilet flush valves, low-flow urinal flush valves, and low-flow faucets continued as a part of routine maintenance practices. SRS replaced several hundred faucets and flush valves with reducers or low-flow units in recent years.

Energy Intensity

Through FY 2014, SRS has reduced energy intensity by 71%.

Energy intensity is the amount of energy per square foot needed to satisfy the energy needs of a facility. By FY 2015 DOE as an agency is required to reduce its energy intensity by 30% from a FY 2003 baseline. SRS has surpassed the goal by achieving a 71.1% decrease through FY 2014. The major contributor to the reduction was the shutdown of the coal fired energy facilities at SRS and the full operation of the biomass facilities, providing steam and electricity. Energy intensity calculations do not include energy derived from renewable sources such as biomass.

SRS found additional energy intensity reductions, beyond the reductions required by DOE. SRS conducted many activities in FY 2014 that reduced energy intensity including:

- Continuing to operate the Ameresco Biomass Co-generation Facility,
- Replacing several heating, ventilation, and air conditioning (HVAC) units with new, higher Seasonal Energy Efficiency Ratio (SEER) units. SEER refers to the relative energy usage of HVAC units. The higher the SEER, the more energy efficient the unit,
- Advising SRS personnel to reduce energy usage during summer months by implementing the Peak Alert checklist in their buildings,
- Using “cool roof” technology (material designed to reflect more sunlight and absorb less heat than standard roofs) on five new roof replacements, and
- Reducing motor fuel usage in MOX Services by 30% due to changes in the construction project during the year.

Sustainability Practices

SRS incorporates sustainability practices into many aspects of maintenance associated with infrastructure and Site processes. The following are some of the programs employed by the Site in 2014:

- New heating, ventilation, and air conditioning (HVAC) units have higher SEER ratings and employ environmentally friendly refrigerants.
- Site stores stock low-flow water use devices (flush valves, aerators, etc.) for use in maintenance replacements.
- Predictive maintenance programs use thermography to determine hot spots in electrical equipment to help maintain motor efficiency.
- Predictive maintenance programs across the Site use vibration analysis and lube oil analysis to reduce unnecessary maintenance and oil usage.
- HVAC cleaning, filter replacements, etc., have been optimized for increased efficiency.

Renewable Energy

Many laws, regulations, and DOE orders encourage the use of renewable energy sources, such as biomass fuels. DOE operates new steam and electrical generation facilities that use biomass as the primary fuel, eliminating coal as a source of energy at the Site. SRS has four biomass steam plants in permanent operation in A Area, L Area, K Area, and G Area.

Greenhouse Gas Reduction

DOE defines greenhouse gases as carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

SRS is committed to reducing GHG Scope 1 and 2 emissions by 28% by FY 2020 from the FY 2008 baseline. Scope 1 consists of direct emissions such as onsite combustion of fossil fuels or fugitive GHG emissions; Scope 2 consists of indirect emissions associated with the consumption of electricity, heat, or steam. Actual targets by DOE take into account new mission growth and other factors.

Ongoing organization of GHG data associated with the various impact sources, such as Site energy use and vehicle/equipment use, will allow for development of a comprehensive inventory and subsequent management.

SRS has reduced greenhouse gas emissions over 70%.

SRS generates and inventories Scope 1 and 2 GHG emissions from the following sources:

- Purchased electricity,
- Fuel oil,
- Fugitive emissions,
- Diesel fuel,
- Aviation fuel,
- Wood (biomass),
- Propane,
- Gasoline, and
- E85 (ethanol) fuel.

SRS has greatly reduced GHG emissions by transitioning to a biomass-based energy supply versus the previous coal-based supply. The operation of the existing biomass plants caused the FY 2014 GHG reduction of 70.2%.

Transportation and Fleet Management

84% of SRS vehicles use E85 or are gasoline hybrids.

The two primary DOE transportation and fleet management goals are 1) to decrease fleet petroleum consumption by 2% annually by FY 2020 from the FY 2005 baseline and 2) to increase alternative fuel (E85) consumption by 10% annually by FY 2015 relative to the FY 2005 baseline. SRS has exceeded these goals that demonstrate compliance with Executive Order 13423 and support SRS's ongoing effort to reduce GHG emissions.

The use of E85 (fuel that contains 85% ethanol alcohol and 15% petroleum gasoline) fuel at SRS has increased dramatically in recent years while gasoline usage has decreased. Approximately 84% of vehicles in the light duty fleet currently utilize E85 fuel or are gasoline hybrids. The Site works to ensure the use of E85 fuel remains high by prioritizing the use of flex fuel vehicles. In the first year of E85 fuel use (FY 2000), SRS consumed about 80,000 gallons of E85 fuel. In FY 2014, this consumption total was greater than 334,000 gallons. Conversion of the F area unleaded fuel station to an E85 station will occur in January 2015. The F Area station is a 10,000-gallon in-ground tank with two dispensers. The other E85 stations (A & H area) are 10,000-gallon above ground tanks each having two dispensers.

Hybrid Electric Vehicle and Charging Station at SRS

SRS is also participating in the General Services Administration pilot program for hybrid electric vehicles. SRS has installed an electric vehicle charging station in the main administration area for use with the new vehicle.

Sustainable Acquisition

In 2014, 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).

Electronic Assets Management

SRS continued to purchase EPEAT and other energy efficient electronic products. Leasing of many of the computers allows for easy return and redeployment of devices no longer needed at SRS.

EMS BEST PRACTICES/LESSONS LEARNED

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.

During 2014, recommendations to SRS employees included:

- Using reusable shopping bags,
- Recycling,
- Turning computers off when not in use,
- Saving money at the gasoline pump through changes in driving habits,
- Involvement in Earth Day activities,
- Personal commitments to "going green," and
- Celebrating an environmentally friendly Christmas.

Chemical Management Center

SRS has distributed 18,000 lb of chemicals for reuse in the community.

SRS provides centralized control of chemical materials procurement and management of excess chemical materials to reduce the volume and toxicity of the chemicals procured, reduce chemical inventories and waste, and improve tracking and communication of chemicals currently in onsite inventory. Hazardous and non-hazardous chemicals are reused onsite, returned to vendors when possible, sold through sealed bid sales to approved vendors, and donated to local government institutions when appropriate. SRS distributed more than 18,000 pounds of chemicals for reuse in 2014.

AWARDS AND RECOGNITION

DOE recognizes significant contributions to SRS missions that positively affect the local and surrounding environment. SRS continues to examine its activities and projects for noteworthy practices, successful implementation of new and emerging technologies, and insightful approaches to resolving environmental stewardship issues.

For the second time, the South Carolina Department of Health and Environmental Control selected MOX Services for membership in the South Carolina Environmental Excellence Program. Membership requires commitment to reducing waste streams through pollution prevention activities, and/or through reducing energy or other resource consumption with the goal of improving South Carolina's environment.

In 2014, SRS received a DOE Sustainability Award in the category of waste minimization and pollution prevention. This award recognized the waste avoidance and cost savings from the development of a testing technique that substantially improved measurements for determining waste package content and configuration. These are top-level awards presented for sustainable environmental performance in DOE.

3 COMPLIANCE SUMMARY

OVERVIEW

To ensure the protection of human health and the environment through safe operations, the Savannah River Site (SRS) implements programs designed to fulfill requirements of applicable federal and state environmental laws and regulations, and with U.S. Department of Energy (DOE) orders, notices, directives, policies, and guidance.

This chapter reports the status of Savannah River Site (SRS) compliance with applicable statutes, orders, directives, and programmatic documents.

COMPLIANCE STATUS

This section addresses SRS compliance in the areas of environmental restoration, waste management, radiation protection, air and water quality and protection, as well as other environmental requirements.

SRS's exceptional compliance record demonstrates our commitment to protect the environment. During 2014, SRS successfully managed more than 500 environmental permits, each containing numerous compliance requirements and conditions. SRS did not receive any Notices of Violation (NOV) or Notices of Alleged Violation (NOAVs) in 2014 and continued to meet all regulatory requirements of its permits. NOVs/NOAVs are the formal regulatory notices that allege violations of an organization's permits or of environmental laws or regulations.

For the SRS National Pollutant Discharge Elimination System (NPDES) industrial wastewater program only one of approximately 3,221 sample analyses performed during 2014 exceeded the NPDES permit limits, a 99.9% compliance rate. SRS continues to evaluate and improve its compliance program to minimize potential environmental impacts.

ENVIRONMENTAL RESTORATION

Environmental Restoration/Cleanup

The Federal Facility Agreement (FFA), entered into in 1993, integrates the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and hazardous waste regulations (Resource Conservation and Recovery Act, or RCRA) requirements to achieve a comprehensive remediation of 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) 2014, 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 Appendices C ("RCRA/CERCLA Units List"), G ("Site Evaluation List") and H ("Solid Waste Management Units Evaluation") of the FFA. You can learn more about the status of FFA activities for FY 2014 in the Federal Facility Agreement Annual Progress Report for Fiscal Year 2014.

WASTE MANAGEMENT

Atomic Energy Act/DOE Order 435.1, Radioactive Waste Management

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. 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.

SRS performs a comprehensive PA annual review for disposal facilities to ensure operations and any developing information does not alter the original conclusions of the PAs and there is a reasonable expectation the facility will continue to meet the performance objectives of the Order.

Under the NDAA, the Secretary of Energy signed the Section 3116 Determination for Closure of the H-Tank Farm in December 2014. This Determination allows closure under SCDHEC approved closure plans.

In addition, as required by the Order, SRS has prepared a Composite Analysis (CA), which assesses the combined impact of multiple low-level waste disposal facilities after closure. An annual CA review evaluates the adequacy of the 2010 SRS CA and verifies that SRS activities were conducted within the bounds of the analysis.

Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005, Section 3116

Tank Closure and Salt Disposition

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 reprocessing is not high-level radioactive waste if it meets the criteria set forth in Section 3116(a) and does not require deep geologic disposal.

The determination acknowledges that the stabilized tanks and ancillary structures in the H-Tank Farm meet the criteria set forth in Section 3116(a) and therefore will not require permanent isolation in a deep geologic repository. SRS will manage closure of the H-Tank Farm pursuant to closure plans approved by South Carolina Department of Health and Environmental Control (SCDHEC). During 2014, DOE supported the NRC consultative role for the H-Tank Farm by submitting responses to NRC questions and participating in a public meeting with the NRC. Based on issuance of the *Section 3116 Determination for Closure of the H-Tank Farm at the Savannah River Site,* the NRC consultative process is complete and the NRC will assume their monitoring role, in coordination with the State of South Carolina, of H-Tank Farm under Section 3116(b) of the NDAA.

SRS disposes of treated salt waste in the Saltstone Disposal Facility based on authorization provided in the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*. The NRC, in coordination with the State of South Carolina, monitors the Saltstone Disposal Facility as required by NDAA Section 3116(b). During 2014, DOE supported the NRC by hosting an on-site observation visit, participating in teleconferences with the NRC, and by providing various documents to the NRC, as requested. The NRC performs their monitoring role of F-Tank Farm in coordination with the State of South Carolina. In addition to SCDHEC representatives, EPA also participates in NRC tank farm monitoring activities.

You will find more information on Tank Closure and Salt Disposition 3116 activities on the Tank Farms at the Savannah River Site and Salt Waste Disposal at the Savannah River Site web pages.

Radioactive Liquid Waste Processing and Disposition Facilities

SRS immobilized 2.5 million curies of radioactivity in glass at the Defense Waste Processing Facility in 2014.

SRS continued to meet all regulatory requirements and deadlines pertaining to radioactive liquid waste processing, disposition and tank closure. You will find more information in the Liquid Waste Disposition and the Waste Solidification fact sheets on the SRS web page.

The Actinide Removal Process (ARP), Modular Caustic Side Solvent Extraction Unit (MCU) is an interim salt waste processing system. SCDHEC permitted ARP/MCU and the Saltstone Production Facility (SPF) under the South Carolina industrial wastewater regulations. The ARP/MCU process will eventually be replaced by the Salt Waste Processing Facility, which is under construction.

The Defense Waste Processing Facility (DWPF) is where the sludge-like high activity waste from the tank farms is immobilized in glass. SCDHEC permitted DWPF under the South Carolina industrial wastewater regulations.

In FY 2014, DWPF produced 126 canisters with approximately 500,000 pounds of glass, immobilizing approximately 2.5 million curies of radioactivity. Since operations began in March 1996, approximately 15 million pounds of glass have been produced and 55.5 million curies have been immobilized. These canisters are stored at SRS in preparation for final disposal in a federal repository.

The Effluent Treatment Project (ETP) is where low-level radioactive wastewater from processes in the tank farms is treated. SCDHEC permitted ETP under the South Carolina industrial wastewater regulations. ETP processes up to approximately 20 million gallons of wastewater per year that is monitored and discharged to a state permitted outfall.

In 2014, Construction Continued on SRS's First Mega-Volume Saltstone Disposal Unit (SDU), Capable of Holding 10 times the Volume of Waste in Current SDUs

SCDHEC permitted the Saltstone Disposal Facility (SDF) under the South Carolina solid waste landfill regulations. In 2014, SRS continued to use cylindrical Saltstone Disposal Units (SDUs) for disposal operations. SRS initiated 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 but will be much larger and will hold ten times the volume of waste. In FY 2014, over 1 million gallons of waste was processed and disposed through the Saltstone facilities.

Radioactive Liquid Waste Tank Closure

SCDHEC permits the F- 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. 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), Section 3116, discussed later in this chapter.

The tanks undergo an extensive waste removal process that includes bulk waste removal, specialized mechanical cleaning, and isolation of the tanks from all external systems. This bulk waste is either processed in ARP/MCU, DWPF or disposed of in SDF facilities. These activities culminate in regulatory confirmation that the tanks are ready for stabilization followed by grouting of the tanks.

In 2014, there were no tanks operationally closed, however, SRS continued preparation activities for the closure of Tanks 16H and 12H, which are two of four tanks to close in fulfillment of the FFA milestones by FY2015.

In 2014, SRS made 60 shipments of transuranic waste to the Waste Isolation Pilot Plant in New Mexico.

Solid and Transuranic (TRU) Waste Management

SRS packages TRU waste and ships the containers to the Waste Isolation Pilot Plant (WIPP) in New Mexico for disposal. SRS made 60 shipments to WIPP in 2014.

The 2014 annual reviews for the E-Area Low-Level Waste Facility PA and the Saltstone Disposal Facility PA, showed that operations in FY 2014 were within the performance envelope and that SRS continued to operate the facilities such that the public and the environment were protected.

Resource Conservation and Recovery Act (RCRA)

SCDHEC's inspection and audit conducted in October 2014 found all 19 underground storage tanks to be compliant with RCRA standards. This marks the 12th consecutive year without a violation.

SCDHEC issued a RCRA hazardous waste permit to SRS. RCRA establishes regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste, such as a flammable or corrosive liquid. EPA authorizes SCDHEC to regulate hazardous waste and the hazardous components of mixed waste at SRS.

In 2014, 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 21, 2014 found all 19 tanks to be in compliance, marking 12 consecutive years without a violation.

Federal Facility Compliance Act (FFCA)

The FFCA's main purpose is identification of mixed waste, and the requirement to treat that waste. The FFCA requires site owners to develop a Site Treatment Plan (STP) which fulfills the requirements contained in the FFCA. DOE is required to implement the STP with enforceable timetables for the development of treatment capacities and technologies. SRS and SCDHEC held the annual STP status meeting in June 2014 to examine current milestones against projected STP goals. No concerns regarding these milestones warranted submittal of a 2014 STP update. SRS will schedule the next annual STP status meeting in 2015.

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 EPA-approved disposal facility within the regulatory period of one year from the date of generation.

SRS completed the 2014 PCB document log on March 11, 2015 and submitted the 2014 annual report of onsite PCB disposal activities to EPA on June 1, 2015, meeting applicable requirements.

SRS also generates radioactive waste contaminated with PCBs. PCB waste that is contaminated with TRU requires disposal at the WIPP. SRS completed four shipments of PCB/TRU to WIPP in 2014.

South Carolina Infectious Waste Management Regulation

SCDHEC has 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 and destruction of infectious waste generated in the N-Area Medical Building. In 2014, SRS managed all infectious wastes in compliance with the requirements for treatment, storage, transportation, and disposal or destruction. SCDHEC Infectious Waste Program staff inspected the N-Area facility on September 23, 2014 and identified no issues or violations during the inspection.

RADIATION PROTECTION

DOE Order 458.1, 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. DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard to the public is 100 millirem (mrem) (1 millisievert [mSv]) per year to a person from routine DOE operations.

In 2014, SRS radioactive discharges to air and water were well below regulatory standards for the public and the environment. The potential radiation dose to the public was well below the DOE public dose limit. Chapter 6, “Radiological Dose Assessments,” provides additional information on the radiological dose to the public.

AIR QUALITY AND PROTECTION

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.

SCDHEC classifies SRS as a "major source" of nonradiological air emissions, and SRS 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, 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.

A review by SCDHEC found that SRS sources operated in compliance with permitted emission rates and the ambient air quality standards.

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 submittal of an annual emissions inventory of air pollutant emissions. Table 3-1 shows the total air emission estimates for all SRS permitted sources as determined by the air emissions inventory conducted for the last five years. SCDHEC review of the emissions has 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 another draft permit will be transmitted for review again in 2015 prior to public comment.

Table 3-1 SRS Estimated SCDHEC Nonradiological Pollutant Air Emissions, 2010 - 2014 (TV-0080-0041)

Pollutant Name	Emissions (Tons/Year)				
	2010	2011	2012[b]	2013[c]	2014
Sulfur dioxide (SO_2)	4110	4560	953	6.8	6.7
Total particulate matter (PM)	803	329	26	12.4	12.5
Particulate matter < 10 micrometers (PM10)	637	142	18	9.1	8.7
Particulate matter < 2.5 micrometers (PM2.5)	136	427	16	7.2	6.6
Carbon monoxide (CO)	44.6	125	52	21.7	58.0
Volatile organic compounds (VOCs) (Ozone Precursors)[a]	45	46	40	41.5	39.6
Gaseous fluorides (as hydrogen fluoride)	12.2	12.3	3	0.0025	0.0021
Nitrogen dioxide (NO_2)	2060	2,060	621	268.4	223.6
Lead (lead and lead compounds)	0.0391	0.0166	0.00064	0.0047	0.0045

[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.

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 2014.

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. In August 2014, SRS notified EPA Region 4 that a comfort –cooling unit containing R-22 refrigerant had leaked refrigerant and was not repaired within the 30 days allowed by the regulations. SRS repaired the unit and implemented corrective actions. No other excursions occurred during 2014.

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 2014 emissions inventories on March 26, 2015. 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.

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.

NESHAP Radionuclide Program

During 2014, the maximally exposed individual (MEI) effective dose equivalent was estimated to be less than 1 % of the EPA standard.

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 2014, the maximally exposed individual (MEI) effective dose equivalent, calculated using the NESHAP required CAP88 computer code, was estimated to be less than 1 percent of the EPA standard. SRS transmitted the *SRS Radionuclide Air Emissions Annual Report for 2013* on June 26, 2014 to EPA, SCDHEC, and DOE headquarters. Chapter 6, "Radiological Dose Assessments," contains details on this dose calculation.

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. SRS successfully submitted initial, semiannual, and annual RICE compliance certifications in 2013. No additional compliance reporting was required in 2014.

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 107 permitted renovations and demolitions involving asbestos in 2014.

SRS issued 99 notifications in 2014. Certified personnel removed and disposed of 302 linear feet, 918 square feet, and 7 cubic feet of friable (easily crumbled or pulverized) asbestos, and 512 linear feet, 3,520 square feet and 150 cubic feet of non-friable asbestos during 2014. Nonradiological 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 173 linear feet and 757 square feet of radiologically contaminated asbestos waste in 2014 at the SRS E-Area Low-Level Waste Facility.

WATER QUALITY AND PROTECTION

Clean Water Act (CWA)

National Pollutant Discharge Elimination System (NPDES)

SRS received a satisfactory rating during the 2014 SCDHEC audit of NPDES permitted outfalls.

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 2014:

- 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.

In August of 2014, SCDHEC conducted an audit of the NPDES permitted outfalls and SRS received a "satisfactory" rating.

Throughout the year, SRS monitors 28 NPDES-permitted industrial wastewater outfalls across SRS on a frequency specified by the permits. Although typically once a month, monitoring requirements vary from as much as once a day at some locations to once a quarter at others.

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. In 2014, the SRS NPDES program maintained a greater than 99% compliance rate. SRS had one permit limit exceedance and one permit exception during 2014 and received no NOVs. Table 3-2 summarizes the NPDES exceedance and exception.

Table 3-2 Summary of NPDES Limit Exceedances/Exceptions

Outfall	Parameter	Number of Exceptions	Description/Solution
		Exceedance	
K-12	Flow	1	High rainfall resulted in an exceedance of the daily maximum flow limit.
		Exception	
H-16	Biochemical Oxygen Demand (BOD)	1	A contract laboratory quality control issue resulted in an invalidated BOD value. Since H-16 is a batch discharge, the outfall could not be resampled.

Chapter 4, "Effluent Monitoring," provides additional information about SRS's NPDES permits.

Stormwater pollution prevention plans (SWPPPs) are required for two types of activities on Site: construction and industrial activities 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 40 outfalls that are covered under this SWPP.

In 2014, no construction stormwater monitoring was required at SRS and there were no non-compliances issued by SCDHEC.

You will find the results from sampling of stormwater outfalls in Data Table 4-9.

The data tables identified in this chapter are located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2014*.

Dredge and Fill; Rivers and Harbors

In 2014, SRS had five open permits under the Nationwide Permits (NWPs) program (general permits under Section 404) as follows:

- SRS completed dam construction on an unnamed tributary to Fourmile Branch for the Mixed Waste Management Facility Groundwater Interim Measures project in 2000 under NWP 38, "Hazardous Waste Cleanup." However, mitigation for the impact to wetlands was pending in 2014 and must be addressed before the permit can be closed. DOE is evaluating a request to use wetland mitigation bank credits to satisfy the mitigation issue and close the permit.
- The Savannah River Ecology Laboratory installed plastic tubs in wetlands as part of a carrion consumption research project. The study will help determine how scavengers such as invertebrates, vertebrates and microbes are affected by contamination. SRS permitted this activity by rule under NWP 5, "Scientific Measuring Devices" in June 2014.
- Workers installed a piezometer in a wetland to collect shallow groundwater samples. SRS permitted this activity by rule under NWP 5 in July 2014.
- Workers installed metal poles in wetlands for deployment of long-term, solar-powered monitoring well sensors. SRS permitted this activity by rule under NWP 5 in November 2014.
- Workers installed a deck, ladder, and tread boards in McQueen Branch and adjacent wetlands to mitigate safety hazards associated with environmental sample collection. SRS permitted this activity by rule under NWP 5 in December 2014.

Safe Drinking Water Act (SDWA)

All samples collected in 2014 from onsite drinking waste facilities met SDWA standards.

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 utilize 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 2014 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.

ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT

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 project.

SRS conducted 362 NEPA reviews in 2014 (Table 3-3). Categorical exclusion (CX) determinations accounted for 82 % of completed reviews. You will find additional information on SRS NEPA activities on the SRS NEPA web page.

Table 3-3 Summary of NEPA Reviews

Type of NEPA Review	Number
CX Determinations	296
"All No" EEC Determinations[a]	42
Actions Tiered to Previous NEPA Reviews	18
Environmental Impact Statements (EIS)[b]	3
Supplement Analysis (SA)[c]	1
Interim Action[d]	0
Revised Finding of No Significant Impact (FONSI)	0
EA	2
Total	**362**

[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 for High-Level Waste Tank Closure (DOE/EIS-0303-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 2014:

- Supplement Analysis, High-Level Waste Tank Closure
- Environmental Assessment, Acceptance and Disposition of Used Nuclear Fuel Containing U.S.-Origin Highly Enriched Uranium from the Federal Republic of Germany [DOE/EA-1977]

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] is in progress.

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 2014 on February 26, 2015.

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 2014, SRS submitted the Toxic Release Inventory Report on June 25, 2015 for each of the following regulated chemicals: ammonia, chromium, copper, formic acid, lead/lead compounds, manganese, mercury/mercury compounds, nickel/nickel compounds, nitrate/nitrate compounds, nitric acid, sodium nitrite, and sulfuric acid. You will find details on the EPA Toxic Release Inventory Program website.

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. The SRS must comply with both FIFRA and the South Carolina Pesticide Control Act.

The SRS has procedures in place that define 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.

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 endangered 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 purple coneflower. In addition, SRS is home to the gopher tortoise, which was recently listed as a candidate for protection by the ESA. South Carolina has enacted legislation that lists additional plants and animals not on the federal list to encourage management of sensitive populations. Those found on SRS include the Carolina gopher frog and the swallow tailed kite. While the bald eagle is no longer on the endangered species list, nesting bald eagles and wintering golden eagles remain protected by the Bald and Golden Eagle Protection Act. These birds nest on the SRS. The U.S. Forest Service-Savannah River (USFS-SR) manages programs onsite to enhance the habitat and survival of these species. SRS found evidence of this success in botanical surveys conducted in 2014, which located a new smooth purple coneflower population giving SRS four wild populations.

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

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.

During FY 2014, while implementing the *United States Department of Energy Natural Resources Management Plan for SRS*, USFS-SR amended seven SRS watershed management plans resulting in seven reviews of biological evaluations for timber, research, and wildlife-related management activities associated with ice storm damage within SRS watersheds.

These biological evaluations determined that forest implementation plans are not likely to affect threatened and endangered species adversely due to beneficial, insignificant, or discountable effects.

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 2014, 461 acres of land on the SRS were investigated for cultural resource management; including 25 field surveys and testing. Eighteen 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 2014 report is located on the *Savannah River Site Environmental Report for 2014* web page.

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.

In 2014, SRS found two Northern Mockingbird (*Mimus polyglottos)* nests located at two locations. Site workers relocated a mobile piece of equipment from one area of the site to another prior to the discovery of the nest of a migratory bird, specifically the Northern Mockingbird. This nest was abandoned with two eggs in it.

Later, another Northern Mockingbird nest was discovered in a hose reel in a construction zone. Because these nests require protection under the MBTA, SRS maintained barricades around the hose reel until the hatchlings fledged.

Also 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 once the young fledged. A pole with a nest platform was erected; nesting material was moved from the power pole to the platform; and exclusion devices were placed on the power pole to discourage the ospreys from rebuilding their nest in the previous location. USFS-SR staff will monitor the nest platform for nesting activity during the coming season.

DOE ORDERS/EXECUTIVE ORDERS FOR ENVIRONMENTAL SYSTEMS

Summary of Environmental Management Systems (EMS)

SRS organizations comply with the requirements set forth in DOE Order 436.1 “Departmental Sustainability” or DOE Order 450.1A “Environmental Protection Program”; implementing the EMS framework for SRS operations in order to achieve sustainable environmental practices.

Environmental Occurrences

The Occurrence Reporting and Processing System (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 2014 there were 3 ORPs reportable events of note, as described below.

- On March 25, 2014, diesel fuel spilled on the dam area of the New Fire Pond. The workers, while mounting the fuel pump, lost control of the pump, it rolled into the pond and overturned. Diesel fuel leaked from the pump to the pond creating a sheen. Workers minimized the environmental impact by quickly applying oil booms and absorbent pads in the area of the spill.

There was no evidence of any diesel fuel reaching the discharge of the pond. The amount of diesel fuel spilled was estimated at two gallons.

- On June 23, 2014, a 100-ton mobile crane was found leaking diesel fuel. Investigation determined that the tank had a small hole and began leaking sometime between June 19, 2014 and June 22, 2014. It is estimated approximately 75 gallons of diesel fuel leaked to the ground in the remote laydown yard. The leak appeared to have soaked into the surrounding ground with no movement into any storm drains or waters. Workers excavated the spill area and disposed of the contaminated soil in a state permitted landfill.
- On December 2, 2014, during installation of a thermocouple cable to support facility startup testing at the Waste Solidification Building, portions of the insulation was removed (stripped back) to allow thermocouple connection. It was later discovered that the thermocouple cable installed contained asbestos material. After identification, SRS removed the asbestos. SRS has performed an investigation and identified corrective actions to prevent reoccurrence of the events.

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 3-4 provides a summary of the results of the 2014 audits and inspections.

Regulatory Self-Disclosures

SRS made two self-disclosures, summarized below, during 2014.

Incident Report to SCDHEC on Hazardous Waste Management - On March 28, 2014, SRS notified SCDHEC that it had shipped four compressed gas cylinders off-site for processing. Regulations require generators to manage pressurized cylinders as hazardous waste. SRS followed this verbal notification with written notification on April 9, 2014. In a June 3, 2014, follow-up letter, SRS informed SCDHEC that the four cylinders were empty; therefore, the cylinders were transported properly. However, this letter noted that the investigation of gas cylinder management discovered that gases had been improperly vented over several years. The final letter on this subject to SCDHEC, dated July 30, 2014, identified potential air compliance issues as well as hazardous waste management issues. This letter stated that SRS could not accurately quantify the vented gases, but a conservative estimate showed that the total amount was within limits imposed by the Site air permit. This final letter also identified corrective measures.

- *Interim Voluntary Disclosure Notification of Savannah River Site (SRS) Asbestos Release* - On December 19, 2014, SRS notified SCDHEC of a release of friable asbestos at the Waste Solidification Building, as described in the "Environmental Occurrences" section of this chapter.

Table 3-4 Summary of Audits/Inspections 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.
Clean Air Act, Title V Inspection	SCDHEC Bureau of Air Quality performed a Title V permit inspection.	No issues were identified.
Comprehensive Groundwater Monitoring Evaluation	SCDHEC inspected SRS groundwater facilities associated with the F-Area and H-Area Seepage Basins, M-Area Settling Basin, Metallurgical Laboratory Basin, Mixed Waste Management Facility, and Sanitary Landfill. A records review of groundwater related files was also completed.	Inspectors identified seven damaged groundwater monitoring well signs. SRS replaced signs, as required, 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 industrial wastewater permitted facilities in D Area, the Waste Solidification Building, the waste disposal modification at the SPF, and Tanks 18F and 19F in the F-Area Tank Farm.	No issues were identified.
Infectious Waste Inspection	SCDHEC Department of Health inspected the medical waste storage area in 719-5N.	No issues were identified.
Interim Sanitary Landfill Post-Closure Inspection	SCDHEC conducted an annual review of the landfill.	The inspector identified bushes/trees growing in the sediment basin and one well was missing a lock. SRS replaced the lock before the inspection was completed. Additionally, SRS cut the bushes/trees in the sediment basin. No other issues were identified.

Table 3-4 Summary of Audits/Inspections and Results (Continued)

Audit/Inspection	Purpose	Results
RCRA Compliance Evaluation Inspection (CEI)	SCDHEC inspected 26 Site facilities and reviewed hazardous waste program requirements (i.e., notifications and reports to SCDHEC, plans, training records, internal inspections, and waste documentation).	SCDHEC noted that SRS had failed to make an accurate hazardous waste determination. SRS corrected the deficiency.
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.

RELEASE REPORTING

EPCRA (40 CFR 355.40) requires that reportable releases of extremely hazardous substances or CERCLA hazardous substances be reported to any local emergency planning committees and state emergency response commissions likely to be affected by the release. SRS had no EPCRA-reportable releases in 2014.

Unplanned Releases

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 of a hazardous substance (including radionuclides) occurs, CERCLA requires notification to the National Response Center. Reportable quantities are those quantities of a hazardous substance greater than or equal to values specified in Table 302.4 (“Designation of Hazardous Substances”) of 40 CFR 302 (“Designation, Reportable Quantities, and Notification”). SRS had no reportable releases exceeding a reportable quantity in 2014.

The CWA requires SRS to notify the National Response Center if an oil spill causes a sheen on navigable waters, such as rivers, lakes, or streams. On March 25, 2014, a diesel fuel release resulted in a sheen on the water, as described in the “Environmental Occurrences” section of this chapter. SRS called the National Response Center and SCDHEC. SRS also notified SCDHEC upon completion of spill cleanup per their request.

PERMITS

SRS had 514 construction and operating permits in 2014 that specified operating levels to each permitted source. Table 3-5 identifies these permits. These numbers reflect permits for all organizations at SRS, with the exception of Ameresco.

Table 3-5 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	181
Industrial Wastewater	77
NPDES Permits	8
Construction Stormwater Grading Permit	10
RCRA Hazardous Waste	1
RCRA Solid Waste	4
RCRA Underground Storage Tank	4
Sanitary Wastewater	103
SC Department of Natural Resources Scientific Collecting Permit	0
SCDHEC 401	0
SCDHEC Navigable Waters	1
Underground Injection Control	8
Total	**514**

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 3-6 Status of Key Federal Environmental Laws Applicable to SRS

Regulatory Program Description	2014 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 2014 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.	The SRS continues to operate under a CAA Permit that expired on March 31, 2008. SRS anticipates receiving a renewal draft permit in 2015. 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 FY2014, 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 greater than 99% compliance rate. SRS had one permit limit exceedance and one permit exception. SRS did not receive any NOVs.
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. SRS submitted the Chemical Inventory Report (Tier II) in February 2015 and the Toxic Release Inventory Report for 2014 on June 25, 2015.
Endangered Species Act (ESA) prevents the extinction of threatened and endangered species and conserves critical habitats.	SRS continued to protect these species and their habitats as outlined the Natural Resource Management Plan for SRS.
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 initiated preparations for closure of Tanks 16H and 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 2014 STP update.

Table 3-6 Key Federal Environmental Laws Applicable to SRS (Continued)

Regulatory Program Description	2014 Status
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. SRS maintained a protective barricade around a Northern Mockingbird nest until the hatchlings fledged. A new osprey (*Pandion haliaetus*) nest platform at the L-Lake Dam was built at the suggestion of the USFWS.
National Defense Authorization Act, Section 3116(a) (NDAA) 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.	The Secretary of Energy signed the 3116 Determination for Closure of the H-Tank Farm at the SRS in December 2014.
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 completing the following: • 362 NEPA reviews, • 296 categorical exclusions, • One supplement analysis, and • Two environmental assessments.
National Historic Preservation Act (NHPA) protects historical and archaeological sites.	In FY2014, after analysis of artifacts recovered through daily compliance activities, 1,555 artifacts were entered into curation. Artifacts included tools, building materials, pottery shards, and points.
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. Also regulates universal waste and recyclable used oil.	SRS received the annual compliance certificate for 19 underground storage tanks after SCDHEC conducted an annual inspection.
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.

Table 3-6 Key Federal Environmental Laws Applicable to SRS (Continued)

Regulatory Program Description	2014 Status
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 2014 annual report of onsite disposal activities to EPA on June 1, 2015.

ENVIRONMENTAL COMPLIANCE SUMMARY

SRS did not receive any Notices of Violation or Notices of Alleged Violation in 2014.

SRS was not involved in any environmental lawsuits during 2014.

SRS did not receive any NOVs or NOAVs in 2014.

Table 3-7 summarizes the NOVs/NOAVs received from 2010 through 2014.

Table 3-7 NOV/NOAV Summary, 2010 - 2014

Program Area	NOV/NOAV				
	2010	2011	2012	2013	2014
CAA	2	0	0	0	0
CWA	0	0	1	2	0
RCRA	0	0	0	0	0
CERCLA	0	0	0	0	0
Others	0	0	0	0	0
Total	**2**	**0**	**1**	**2**	**0**

4

EFFLUENT MONITORING

OVERVIEW

Effluent monitoring is a major activity on the Savannah River Site (SRS). Effluent monitoring is the collection and analysis of samples or measurements of liquid and airborne discharges. The purpose of the monitoring is to determine and quantify contaminants, assess any chemical or radiological exposures to members of the public, and demonstrate compliance with applicable United States Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and United States Department of Energy (DOE) standards.

SRS conducts monitoring activities for the following effluent categories:

- Radiological airborne emissions,
- Radiological liquid discharges,
- Nonradiological airborne emissions, and
- Nonradiological liquid discharges.

This chapter presents a summary of the effluent monitoring programs and data results. The data tables identified in this chapter are located in the "SRS Environmental Data/Maps" on the SRS Environmental Report for 2014 webpage.

In 2014, effluent releases for all categories except nonradiological liquid effluent were below permit limits and applicable standards. One nonradiological liquid effluent sample exceeded National Pollutant Discharge Elimination System (NPDES) permit limits, and one nonradiological liquid effluent sample measurement resulted in an NPDES permit exception. You will find additional details in Chapter 3 (Table 3-2), "Compliance Summary."

RADIOLOGICAL MONITORING

SRS works to ensure that radiation exposures to employees and the public remain below regulatory limits. SRS takes actions to maintain exposures and releases to levels that are as low as reasonably achievable. In order to demonstrate compliance with radiation dose standards established by EPA and DOE for public protection, SRS performs radiological effluent monitoring.

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.

> ### *Chapter 4 Key Terms*
>
> ***Derived concentration standard (DCS)*** *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).*
>
> ***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.*
>
> ***Gross alpha and beta releases*** *are the total alpha-emitting and beta-emitting activity determined at each effluent location.*
>
> ***Outfall*** *is a 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.*
>
> ***Radiological*** *pertains to materials that emit energy from unstable atoms.*
>
> ***Tritium*** *is the elemental form of the radioactive isotope of hydrogen and occurs as a gas.*
>
> ***Tritium oxide*** is *water in which the tritium isotope has replaced a hydrogen atom. Tritium oxide is chemically identical to normal water; thus, it cannot be filtered from the normal water.*

SCDHEC regulates both radioactive and nonradioactive airborne pollutant emissions from SRS sources. SCDHEC permits each major source of airborne emissions on the SRS Clean Air Act (CAA) Part 70 Air Quality Permits, identified hereafter as the CAA program Permits, with specific limitations and monitoring requirements.

SRS quantifies the total amount of radioactive material released to the environment by using (1) data obtained from monitored airborne effluent release points, (2) calculated releases of unmonitored isotopes from the dissolution of spent fuel, and (3) 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 uses laboratory analyses of samples to determine concentrations of radionuclides in airborne emissions. Airborne effluent samples are collected on filter papers for particulates and in charcoal canisters for gaseous iodine.

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. Data Table 4-1 provides a summary of analytical results and individual sample results for radioactive airborne effluent measurements taken at SRS in 2014.

Calculated Sources

Each year, SRS calculates radionuclide release estimates (in curies [Ci]) from unmonitored diffuse and point sources. Point sources are 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. These estimates are included in the SRS radioactive release totals in Data Table 4-2.

SRS calculates emissions from unmonitored releases using the methods contained in Appendix D of EPA's NESHAP regulations (EPA 1989). Because these methods employ conservative assumptions, they generally lead to overestimation of actual emissions. Although SRS does not monitor these releases at their source, onsite and offsite environmental surveillance monitoring stations are in place to quantify unexpected airborne releases. You will find additional information regarding the atmospheric surveillance program in Chapter 5, "Environmental Surveillance."

Releases Summary

Data Table 4-2 presents year-end estimates of the radiological airborne emissions from SRS including tritium. These estimates include monitored, unidentified alpha and beta, calculated diffuse and point source releases, and annual totals based on actual operation time. Unidentified alpha and beta releases are alpha-emitting and beta-emitting activity remaining when the sum of individually measured alpha-emitting (e.g., plutonium-239) and beta-emitting (e.g., cesium-137) radionuclides are subtracted from the gross alpha and beta releases. As a result of the dissolution of spent fuel at H- Canyon, SRS also calculates emissions of the following radionuclides: krypton-85, carbon-14 and tritium oxide. These values are also reported in Data Table 4-2.

Tritium

Tritium releases in elemental and oxide forms make up the majority of the radionuclide releases from SRS to the air which is summarized below. Stack releases of tritium oxide typically occur as water vapor.

In 2014, tritium accounted for more than 80% of the total radioactivity released to the atmosphere from SRS operations. SRS released 27,300 Ci of tritium in 2014, compared with 24,300 Ci in 2013, an increase of 12%. Over 95% of the tritium releases came from the five tritium processing facilities in H Area. Shutdown activities in one building in the tritium processing facilities began in 2013 and continued in 2014. These activities were the primary reason for an increase in tritium releases. These shutdown activities, such as opening previously closed systems (e.g., piping, process beds), are necessary to prepare for future deactivation activities. Reactor areas releases and the estimated releases from ongoing remediation and restoration activities makeup less than 5% of the tritium releases. The dissolution of spent nuclear fuel in H Canyon resulted in the release of less than 1% of tritium.

SRS Laboratory Technicians Prepare Air Effluent Samples (filters and charcoal) for Analysis

The amount of tritium released from SRS is based on mission activities and on the annual production schedules of the tritium processing facilities and is depicted in Figure 4-1. The average value during the past 10 years is 31,460 Ci per year with a range between about 17,000 to 41,000 Ci per year. The 2014 tritium release (27,300 Ci) from SRS to the atmosphere is below this ten-year average value.

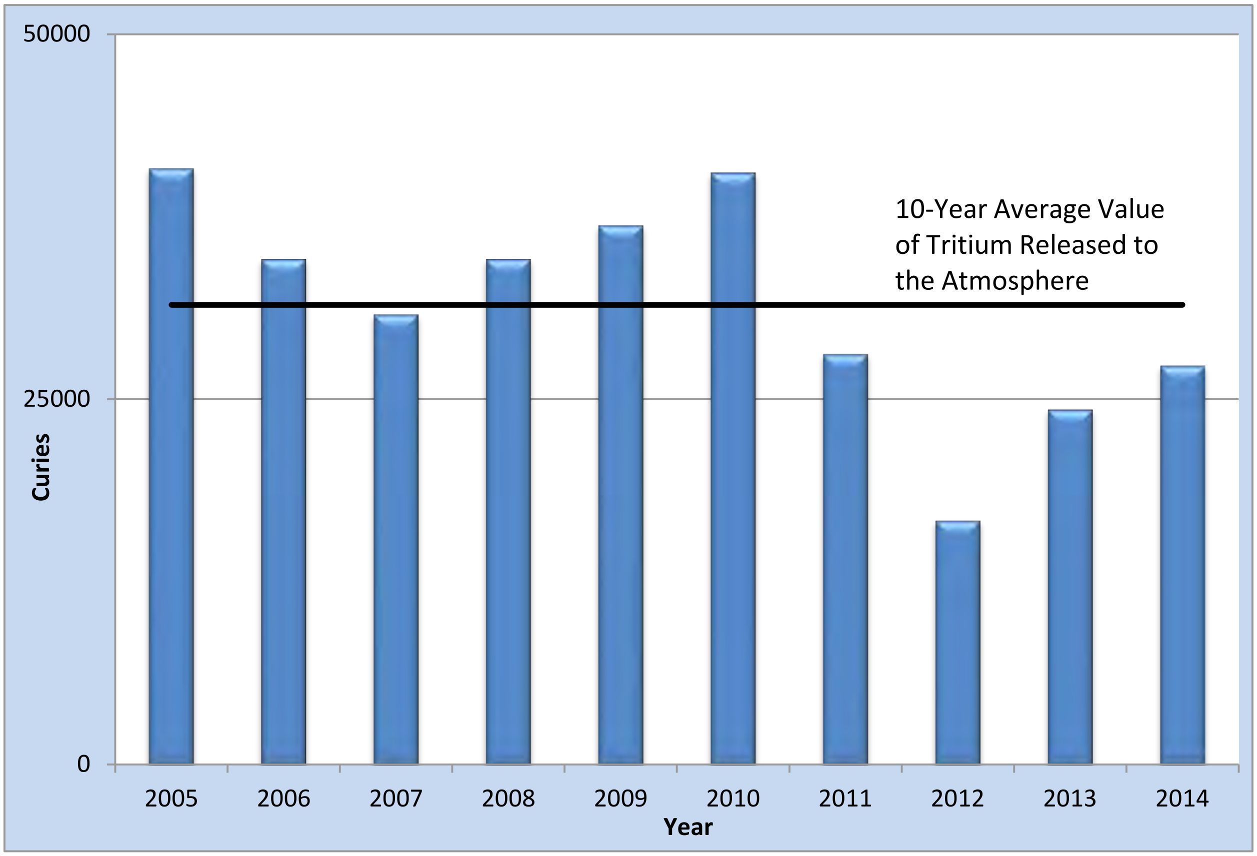


Figure 4-1 Ten-Year History of SRS Annual Tritium Releases to the Atmosphere

Compliance with DOE Derived Concentration Standards

The annual average concentrations are compared to the DOE derived concentration standards (DCSs) as documented in DOE Derived Concentration Technical Standard (DOE 2011a) 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 are used 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 that are used at all DOE sites. DOE compliance with DCS is demonstrated when the sum of the fractional (isotopic) DCS values for all radionuclides detectable in the effluent is less than 1.00, based on consecutive 12-month average concentrations.

Data Table 4-3 provides the 2014 airborne effluent annual average concentrations and comparisons against the DOE DCSs by monitored discharge point. Calculated concentrations, which are also contained in Data Table 4-3, include the tritium concentrations from the reactor areas and the tritium processing facilities.

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).

Concentrations are also calculated for krypton-85, carbon-14, and tritium released during dissolving operations in the H Canyon facility. The concentrations are calculated based on the annual releases in curies and the annual stack volume.

SRS bases this DCS comparison on isotopic concentrations; the average concentration is determined only if there is at least one statistically significant result for the isotope. With the exception of tritium oxide releases (from several facilities) and calculated gaseous radionuclides (only from the H Canyon facility), the concentrations reported in Data Table 4-3 correspond only to the emissions that occur during sampling events. Concentrations for other periods, including any time between stack samples, gross alpha and gross beta results, and other emissions estimated using calculations, though not included in Data Table 4-3, are included in the radionuclide dose assessment.

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. Additionally, krypton-85 in H Area exceeds its DCS due to the dissolution of spent nuclear fuel in H Canyon facility. 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), as discussed in Chapter 6, "Radiological Dose Assessments."

A Field Technician Replaces Tubing for an Automated Water Sampler at a Liquid Effluent Outfall

Liquid Effluents

Monitoring Program

SRS routinely samples and analyzes for radioactivity at each liquid effluent discharge point that releases or has potential to release radioactive materials. As shown in Figure 4-2, effluent sampling points are near SRS facilities. Data Table 4-4 presents the analytical results for radioactive liquid effluent measurements taken at SRS in 2014.

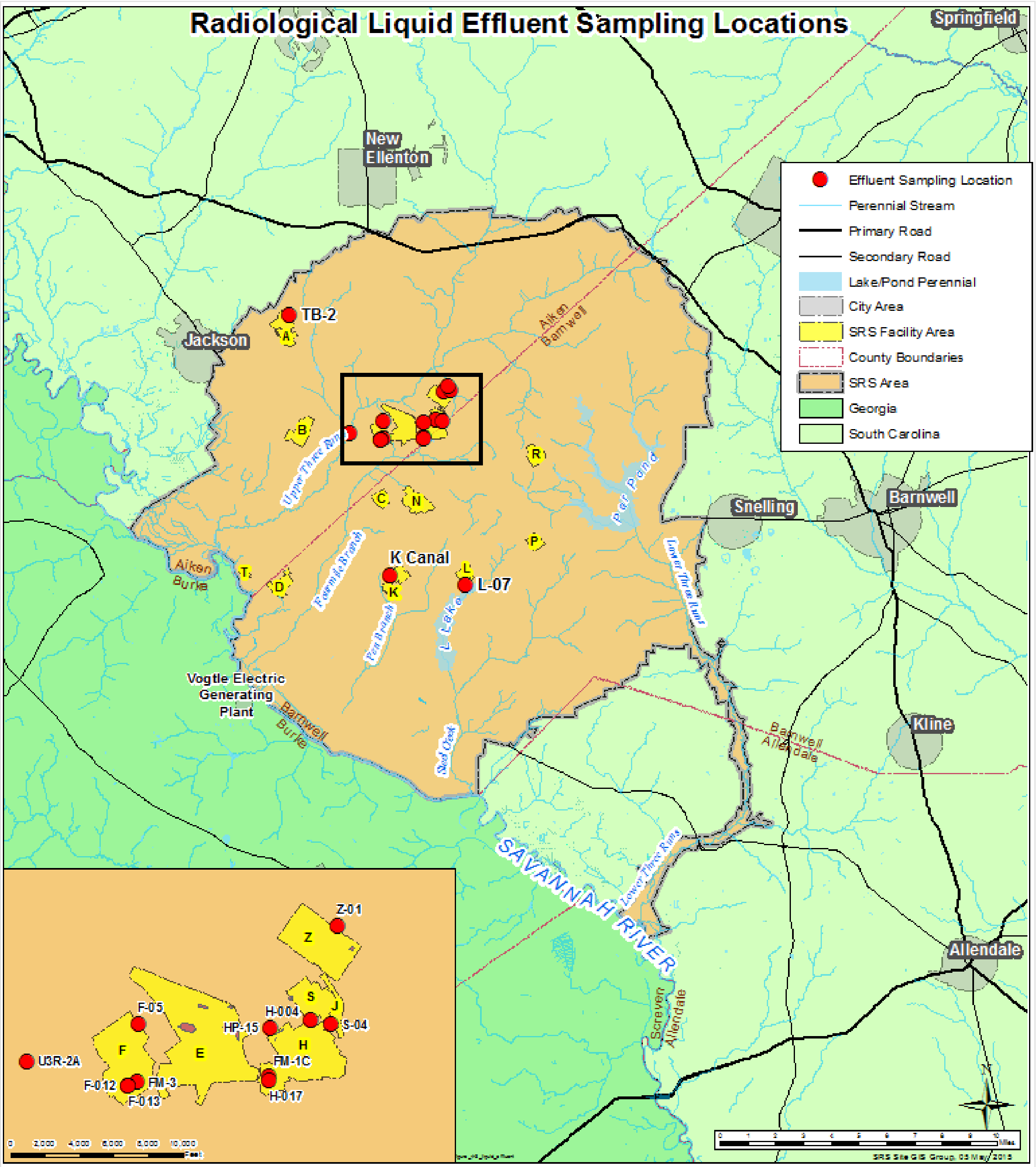


Figure 4-2 Radiological Liquid Effluent Sampling Locations

SRS uses data from monitored liquid effluent discharge points to determine current releases to the Savannah River. These data are evaluated in conjunction with SRS seepage basin and Solid Waste Disposal Facility migration release estimates to quantify the radionuclides released to the Savannah River from SRS operations.

Chapter 5, "Environmental Surveillance," describes groundwater migration and transport of radionuclides from SRS seepage basins and the Solid Waste Disposal Facility and includes a summary table (Table 5-9) of releases to the Savannah River.

Releases Summary

SRS released 42 Ci of tritium in 2014. For the past 10 years, the general trend has been a reduction in tritium releases from liquid effluents.

SRS quantifies discharges of liquid effluents at or close to the point of release. SRS bases the release totals on measured concentrations and measured flow rates.

In 2014, tritium accounted for 99.95% of the total radioactivity discharged in SRS liquid effluents. Current and past operations at SRS result in releases of tritium to the Savannah River.

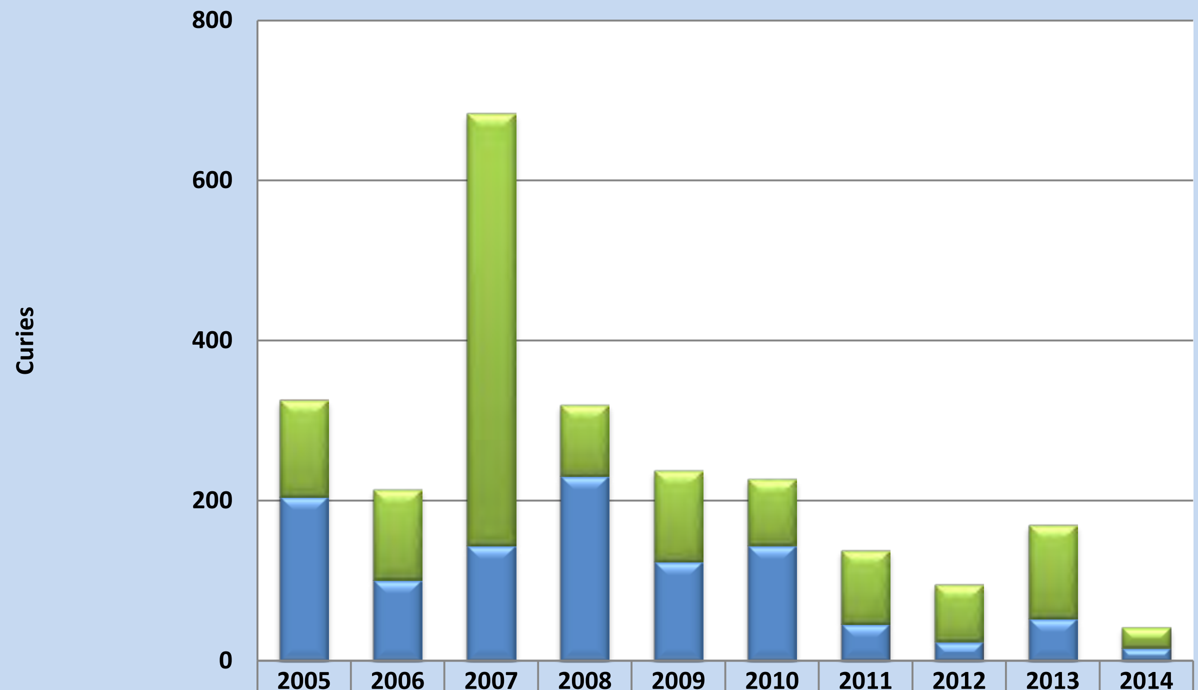
Data Table 4-5 provides SRS liquid radioactive releases for 2014. The total amount of tritium released directly from process areas to SRS streams during 2014 was 42 Ci. This is a decrease from the 170 Ci released in 2013. The increase that occurred in 2013 was due to higher than average rainfall. The rain picked up atmospheric tritium, which was deposited in outfalls. It also caused higher effluent flow volumes to be released. The decrease that occurred from 2013 to 2014 was due to a return to average rainfall. As seen in Figure 4-3, the total direct release of tritium has a general decreasing trend.

Higher than average rainfall in early 2014 caused the Z-Area stormwater basin to discharge to the Z-01 Outfall location in January. This basin does not normally discharge. A calibrated flow could not be determined due to equipment limitations; however, a sample was collected. Later in 2014, the equipment was upgraded during expansion of the Z-Area stormwater basin.

You will find additional information about the data results in Chapter 5, "Environmental Surveillance."

Compliance with DOE Derived Concentration Standards

DOE Order 458.1 requires comparison to DCS values for most radionuclides. According to DOE Order 458.1, exceedance of the DCSs at any discharge point may require an investigation of "best available technology" (BAT) waste treatment for the liquid effluents. DOE Order 458.1 specifically excludes tritium in liquid effluents from BAT requirements; however, DOE Order 458.1 does not exclude it from the requirement to keep radioactive emissions and external exposures as low as reasonably achievable.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
SRNL	0.495	0	0.33	0	0	0	0.28	0.21	0.12	0
Reactor Areas	121	113	540	89	114	83	91.5	71.6	116.8	26.1
Separations Areas	205	101	144	231	124	144	46.5	24.1	53.3	16.2

Figure 4-3 Ten-Year History of Direct Releases of Tritium to SRS Streams

In 2014, liquid releases remained well below DOE standards.

Compliance with DCSs is demonstrated when the sum of the fractions for all radionuclides detected in the effluent is less than 1.00, based on consecutive 12-month-average concentrations. DCSs are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion). Data Table 4-6 provides the quantities of radionuclides released and the 2014 liquid effluent annual-average concentrations compared to the DOE DCSs by discharge point. All discharges in 2014 were well below the standards and the sum of the fractions for all locations was less than 1.00.

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.

NONRADIOLOGICAL MONITORING

Airborne Emissions

SCDHEC regulates nonradioactive air pollutant emissions from SRS sources. SCDHEC permits, regulates, or exempts each source of airborne emissions under the Clean Air Act (CAA) program described in Chapter 3. Various SCDHEC and EPA pollution control regulations and standards outline the bases for the limitations and monitoring requirements. Many of the applicable standards are source-dependent (i.e., applicable to certain types of industries, processes, or equipment). Visit the SCDHEC Your Air webpage for additional information.

Monitoring Program

Major nonradiological emissions of concern from SRS facility stacks include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter, volatile organic compounds (VOCs), and toxic and hazardous air pollutants. Under the CAA Program, SRS is required to perform numerous continuous and periodic monitoring; the largest emission sources are discussed below.

The primary method of documenting source emissions at SRS is the annual air emissions inventory. 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.

SRS operates a 40 million BTU biomass boiler under a CAA program Permit issued by SCDHEC. The permit requires SRS to perform compliance tests every two years at the facility to confirm particulate matter emissions are within the limits of the permit. In addition to the source test, SRS monitors and records particulate matter emissions during times of operation and performs weekly visual inspections. The next test is required prior to March 31, 2015.

All fuel oil-fired equipment operated on SRS must comply with sulfur dioxide standards listed in the permit under the CAA program, and SRS reports compliance to SCDHEC semi-annually. The sulfur content of the fuel oil used at SRS must be below 0.05%; SRS verifies compliance by analysis and requires the vendor to supply fuel certification for each delivery. The monitoring of SRS diesel-powered equipment includes tracking fuel oil consumption monthly and calculating a 12-month rolling total for determining permit compliance with a SRS consumption limit.

SRS has several soil vapor extraction units and two air strippers that are sources of toxic air pollutants and VOCs. SRS must sample monthly for VOC concentrations and calculate the total VOC emissions for comparison against a 12-month rolling limit. SRS currently reports the VOC emissions to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices, such as electrostatic precipitators, baghouse dust collectors, or condensers. SRS must monitor these devices continuously during operation, and record and compare the data against specific operating ranges.

SCDHEC assesses compliance of all SRS permitted sources during annual compliance inspections.

The inspections include a review of each permit condition (e.g., daily monitoring readings, equipment calibrations, control device inspections, etc.); SCDHEC last performed an air compliance inspection in June 2014 and found no instances of noncompliance.

Releases Summary

SRS nonradiological air emission sources operated in compliance with permitted emissions rates.

SRS is required to report its air emissions inventory for all Site emission sources annually to SCDHEC. SRS compiles operating data and calculates emission data for each calendar year. Data Table 4-7 provides a list of the 2010-2014 estimated emissions.

Chapter 3, "Compliance Summary", Table 3-1, "SRS Estimated SCDHEC Nonradiological Pollutant Air Emissions, 2010 – 2014", provides a summary of the emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in each of the past five years. A review of the calculated emissions for each source for each calendar year demonstrated that SRS sources operated in compliance with permitted emission rates.

SCDHEC limits use of diesel fuel in the Site's Title V operating permit as VOC emissions are directly related to fuel consumption. The total diesel fuel consumption for portable air compressors, generators, emergency cooling water pumps, and firewater pumps was found to be well below the SRS limit for the entire reporting period. As reported to SCDHEC during 2014, the calculated annual VOC emissions were well below the permit limit for each unit.

Liquid Effluents

Monitoring Program

SRS continues to evaluate and implement new technologies that will enhance monitoring efforts, as appropriate. In 2014, SRS implemented wireless notification technology in support of the liquid effluent monitoring program. Stormwater monitoring enhancements include immediate text notifications of rain events and wireless startup of automated samplers where the SCDHEC permit requires sampling be performed within 30 minutes of rain flow.

Industrial Stormwater Outfall with Wireless Technology Setup

SRS monitors nonradioactive 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 in South Carolina and is responsible for the permitting, compliance, monitoring, and enforcement activities of the program. The permits issued by SCDHEC to SRS provide specific requirements for sampling locations, parameters to be tested, and monitoring frequency as well as collection, analytical, and reporting methods.

In 2014, SRS operations resulted in discharges of water into SRS streams under six NPDES permits:

- Two for industrial wastewater, SC0047431 (covers D Area) and SC0000175 (covers remainder of SRS);
- One for stormwater runoff from industrial activities, SCR000000;
- One for stormwater runoff from construction activities, SCR100000;
- One for general utility water, SCG250000; and
- One for vehicle wash water, SCG750000.

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

Figure 4-4 shows NPDES industrial wastewater outfall sampling locations. Twenty-eight industrial wastewater outfalls were regulated at SRS in 2014 under NPDES Permits SC0000175 and SC0047431.

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 to be analyzed.

Figure 4-5 shows NPDES industrial stormwater outfall sampling locations. Forty industrial stormwater outfalls were regulated at SRS in 2014 under the NPDES General Permit for Stormwater Discharges associated with Industrial Activity (except construction activity).

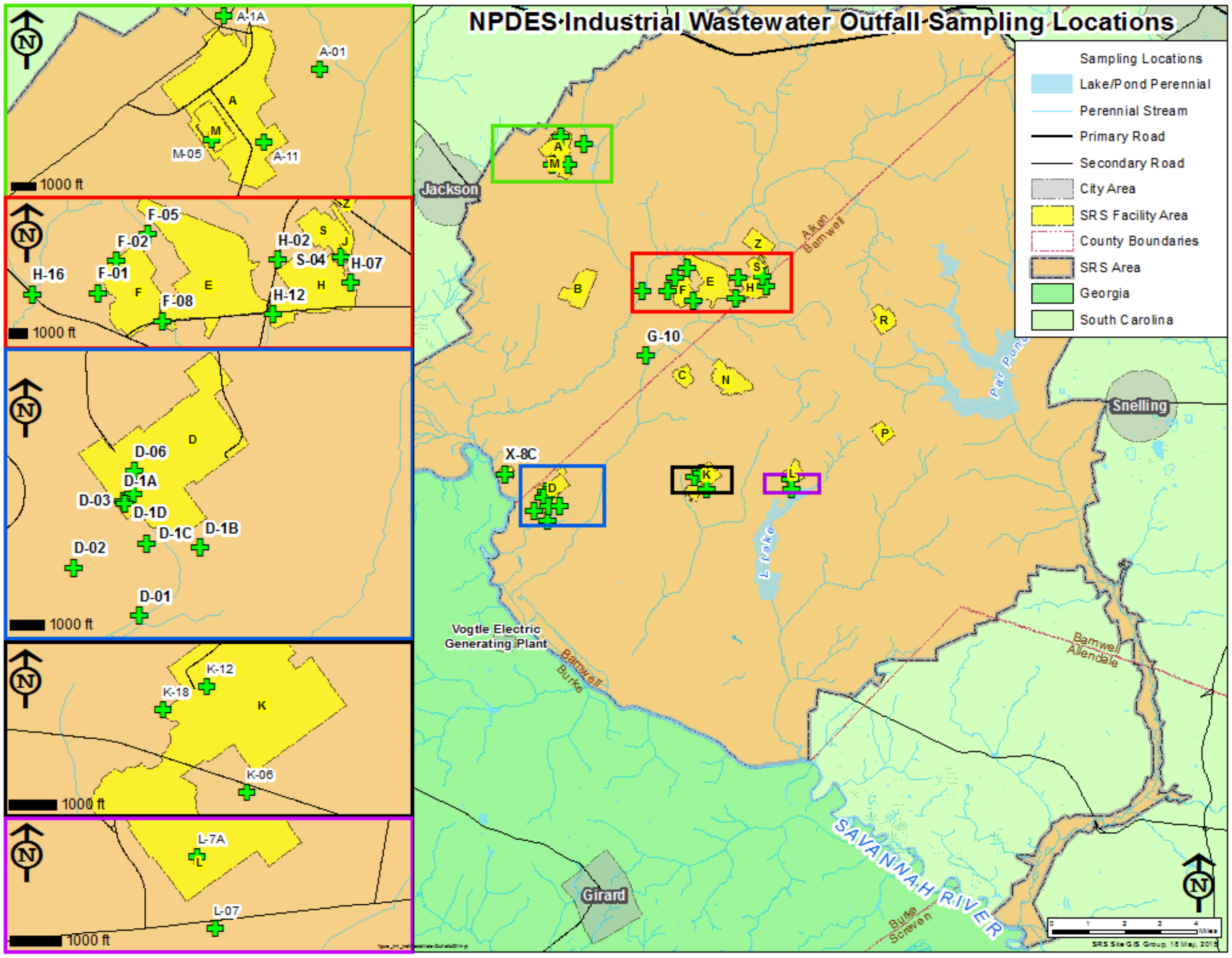


Figure 4-4 NPDES Industrial Wastewater Outfall Sampling Locations

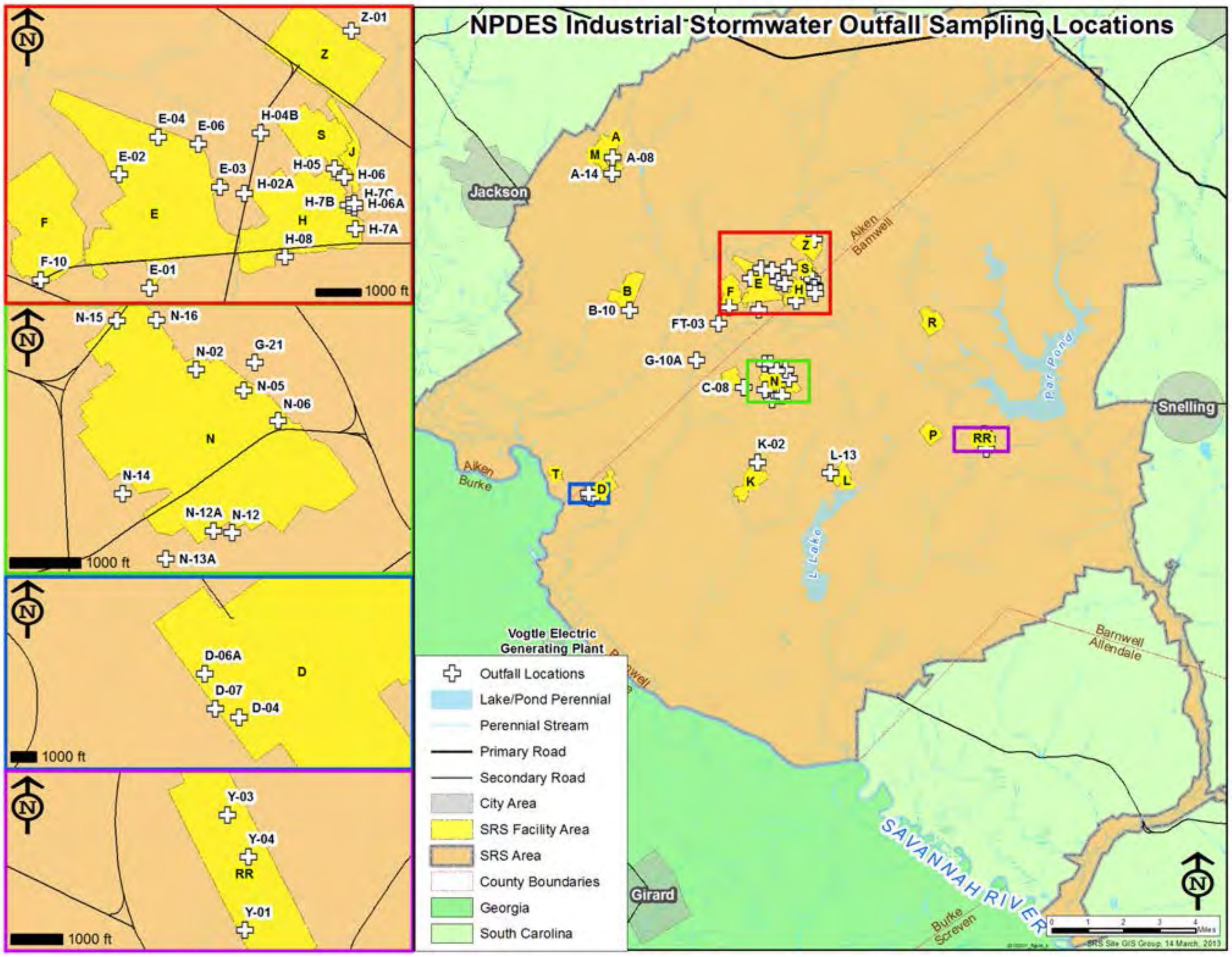


Figure 4-5 NPDES Industrial Stormwater Outfall Sampling Locations

SRS achieved a 99.9% compliance rate with NPDES permit limits.

Sludge from the sanitary wastewater treatment facilities is managed under the requirements contained in Permit ND0072125, a no-discharge, 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. No sludge land applications were performed in 2014.

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 last performed a compliance evaluation inspection in August 2014 and issued a satisfactory rating, the highest grade possible.

A Field Technician Measures Flow at an Industrial Wastewater Outfall

Releases Summary

SRS reports NPDES industrial wastewater analytical results to SCDHEC through monthly discharge monitoring reports. One out of approximately 3,221 sample analyses performed during 2014 exceeded NPDES permit limits, a 99.9% compliance rate. SRS had one permit limit exceedance for daily maximum flow limit at K-12 Outfall and one permit exception for an invalidated biochemical oxygen demand sample at H-16 Outfall during 2014. SRS received no notices of violation in 2014. Chapter 3, "Compliance Summary," Table 3-2, Summary of SRS NPDES Limit Exceedances/Exceptions describes the NPDES exceedance and exception. Data Table 4-8 provides a compilation of industrial wastewater analytical data for 2014.

SRS monitored all industrial stormwater outfalls per the requirements of the permit. Sample results demonstrated compliance with permit requirements. Data Table 4-9 provides a compilation of stormwater analytical data for 2014.

Stormwater runoff from construction activities does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site; SCDHEC did not request such sampling in 2014.

Sampling for general utility water (e.g., non-contact cooling water, steam condensate, boiler blowdown, etc.) and vehicle wash water was not required in 2014.

5

ENVIRONMENTAL SURVEILLANCE

OVERVIEW

Savannah River Site (SRS) conducts environmental surveillance in accordance with United States Department of Energy (DOE) Orders, federal and state air and water quality standards. SRS characterizes routine and non-routine releases from the Site.

Radiological surveillance provides data used in calculating the potential doses to individuals and populations near the Site, as required by DOE Order 458.1. Regarding nonradiological surveillance, SRS complies with South Carolina regulations and United States Environmental Protection Agency (EPA) standards for water quality.

SRS performs environmental surveillance within and beyond the SRS perimeter at designated sampling points. The sampling points are representative of the major contaminant pathways (liquid and airborne) and extend from the source of Site releases to 100 miles from the Site. The number of sampling locations depends on wind patterns, liquid flows, and distance from the release point. Sample locations become fewer in number the farther they are from the source because contamination becomes increasingly less concentrated the farther it is from the release point. In 2014, results from SRS onsite and offsite surveillance activities confirm that SRS operations have a minimal impact on the public and the environment with results indicating levels below applicable standards. In 2014, nonradiological surveillance results were below regulatory limits.

SRS OFFSITE SURVEILLANCE

Surveillance involves collecting and analyzing samples of air, river water, soil, sediment, vegetation, milk, food products, fish, and other media from many locations. These samples are analyzed for radioactive or nonradioactive contaminants to assess trends in the different environmental media. SRS collects samples beyond the SRS perimeter in Georgia (GA) and South Carolina (SC) at 25 and 100 miles from the Site, as well as 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), river locations downriver of each SRS stream entry point, and above the Site at River Mile 160 as a control location. The map in Figure 5-1 displays the SRS offsite environmental sampling locations. Chapter 7, "Groundwater Management Program" provides information on the SRS groundwater monitoring activities.

Chapter 5 – Key Terms

Contaminant pathway *is the way contaminants move and settle in the environment after release from SRS facilities to the air and water.*

Derived concentration standard *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).*

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

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

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

Fallout *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.*

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

Table 5-1 summarizes the SRS offsite surveillance 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 (19)	5 (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 (37)**	**255 (24)**

RADIOLOGICAL SURVEILLANCE

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. Appendix A provides a summary of the radiological surveillance sampling media and frequencies.

Atmospheric Surveillance

SRS conducts atmospheric monitoring to determine whether airborne radionuclides from SRS releases have reached the environment in measurable quantities. 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 atmospheric surveillance program monitors both air and rainwater. SRS maintains a network of 14 atmospheric surveillance sampling stations (Figure 5-2 and Maps Figure 1) in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air and rainwater.

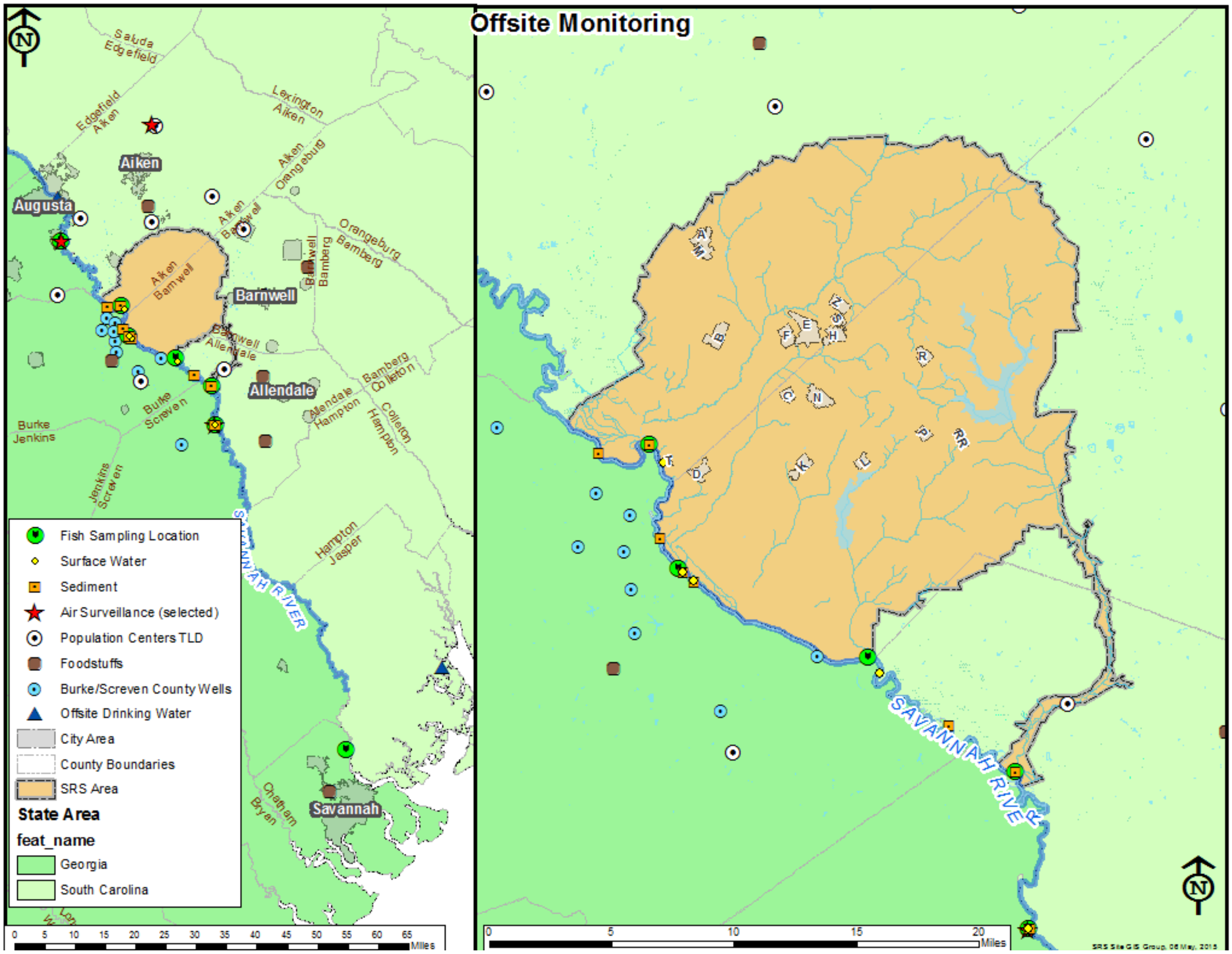


Figure 5-1 SRS Offsite Sampling Media Locations for Georgia and South Carolina

The surveillance 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 unimpacted by SRS operations). SRS has 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 surveillance sampling station consists of the components listed in Table 5-2.

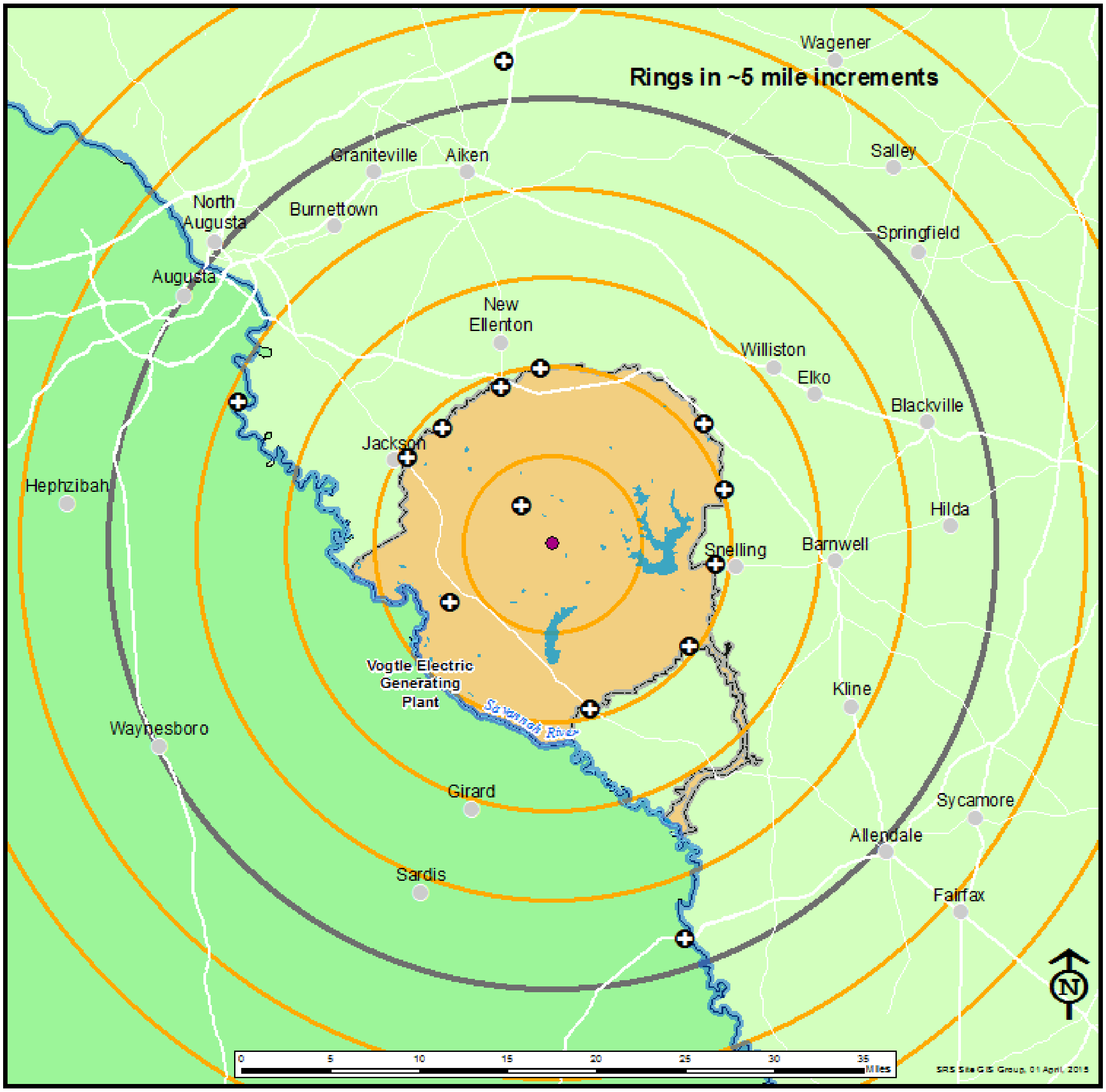


Figure 5-2 Air Sampling Locations Surrounding SRS up to 25 Miles

Table 5-2 Atmospheric Surveillance Stations

Media	Purpose	Radionuclides	Data Table
Glass-Fiber Filter	Airborne Particulate Matter	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides	**5-1**
Charcoal Canister	Gaseous States of Radioiodine	Iodine-129, Iodine-131, gamma-emitting radionuclides	**5-2**
Silica Gel	Tritiated Water Vapor	Tritium	**5-3**
Rain Ion Column	Wet and Dry Deposition	Gamma-emitting radionuclides, gross alpha/beta-emitting radionuclides, total strontium, actinides (plutonium, americium, uranium, curium, and neptunium)	**5-4**
Rainwater	Tritium in Rainwater	Tritium	**5-5**

Table 5-2 lists the airborne radionuclides that are measured. These radionuclides were selected based on known SRS airborne releases. 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.

Results Summary

Atmospheric surveillance results for radionuclides in air are within the historical five-year trend and below 1% of the dose standard.

Table 5-3 provides a summary of the atmospheric surveillance results for 2014. Discussions on comparisons to the standard and trends are included below.

Gross Alpha and Beta-emitting Radionuclides

Gross alpha and beta results provide useful information for trending of the total activity in screening samples; however, these results cannot provide concentrations of specific radionuclides. If the gross analytical results are greater than the EPA drinking water screening standards, SRS may perform analyses for specific radionuclides to investigate a potential problem, such as an unplanned release. There were no elevated screening levels of gross alpha and beta in air surveillance filters during 2014. Average gross alpha and beta results for 2014 were similar to 2013 and the previous five years.

Gamma-emitting Radionuclides

SRS releases small amounts of cesium-137 and other gamma-emitting radionuclides into the air in quantities well below the Derived Concentration Standard (DCS). Air filter and charcoal canister analytical results for 2014 indicated no detectable amounts of man-made gamma-emitting radionuclides in the environmental surveillance samples, which is consistent with 2013 and the previous historical results.

Alpha-emitting Radionuclides (Actinides)

During 2014, alpha-emitting radionuclides were comparable to 2013 and the previous five years showing low detectable levels (less than 1% of the DCS) of uranium-234, uranium-238, americium-241, and plutonium-238.

Iodine-129

Analytical results indicated one charcoal sample with detectable levels of iodine-129 in 2014, which was <1% of the DCS of 278 pCi/L, consistent with 2013 and the previous historical trend.

Tritium-in-Air

Tritium-in-air results for 2014 were comparable or slightly lower than those observed in 2013 and the previous five years. Results showed detectable levels in 84 of 373 (23%) samples for 2014. Figure 5-3 provides a summary of the maximum results for 2014. As shown in Figure 5-3, the maximum tritium levels decrease to background levels once reaching offsite.

At one location at the Barnwell Gate, tritium in rainwater was detected over 2.5 times the maximum value in the previous five years due to H-Area tritium releases and greater than five inches of rainfall.

Rainwater Monitoring

Rainwater is collected with pans located on top of the monitoring stations. Seven stations are equipped to sample for radionuclide deposition (except tritium), where the rainwater passes through an ion exchange resin column also known as a rain ion column. Rainfall washes the dry deposition material (particles) that was on the pan prior to the rainfall through the system and onto the rain ion column. The ion column is analyzed for gamma-emitting radionuclides, gross alpha, and gross beta while the rainwater is analyzed for tritium.

Table 5-3 Summary of Maximum Radionuclide Concentrations in Air

Radionuclide	Number of Samples	Number of Detections	Maximum Concentration (pCi/m^3)	Equivalent to 1 mrem Dose (pCi/m^3) [a]	Location of Maximum Concentration	Comments
Tritium	373	84	405	2,190	Approximate Center of SRS	Maximum concentration is expected at this location because this is the closest location to SRS tritium releases.
Gross Alpha[a]	375	372	0.00254	Specific radionuclide values are applicable[b]	D-Area, Onsite Perimeter Southwest	Maximum concentration is expected because this location is onsite and within the sector of less air mixing.
Gross Beta[a]	375	375	0.0414	Specific radionuclide values are applicable[b]; EPA screening limit = 1 pCi/m^3	D-Area, Onsite Perimeter Southwest	Maximum concentration is expected because this location is onsite and within the sector of less air mixing.
Iodine-129	15	1	0.00233	0.391	Jackson, Onsite Perimeter Northeast	Maximum value is small because SRS operations release very low quantities in air.
Cesium-137	375	0	Less than MDC	9.18	Not Applicable	None
Uranium-234	14	11	0.0000220	0.0111	D-Area, Onsite Perimeter Southwest	Maximum concentration is onsite and within the sector of less air mixing. Dust particles contain natural uranium.
Uranium-235	14	0	Less than MDC	0.0125	Not Applicable	None
Uranium-238	14	11	0.0000138	0.00134	Greenpond Road, Northwest SRS Perimeter	Dust particles contain natural uranium.
Americium-241	14	5	0.0000135	0.001	Aiken Airport, 25 miles North of SRS	Maximum value is small because SRS operations release very low quantities in air.
Curium-244	14	0	Less than MDC	0.00155	Not Applicable	None
Plutonium-238	14	3	0.0000057	0.000908	Patterson Mill Road, Onsite Perimeter Southeast	Maximum value is small because SRS operations release very low quantities in air.
Plutonium-239	14	0	Less than MDC	0.000838	All Less than MDC	None

[a] The concentration needed to receive a dose of 1 mrem. This value is provided for a relative comparison to the maximum concentration.
[b] See information on page 5-6 regarding gross alpha and beta screening
Note: DOE Dose Standard for all exposure pathways = 100 mrem

Tritium-in-Rainwater

Tritium-in-rainwater results showed detectable levels in 20 of the 181 rainwater samples (11%) for 2014 with levels similar to the previous five years with the exception of the Barnwell Gate location. One tritium result from the Barnwell Gate showed tritium in rainwater over 2.5 times the maximum observed over the previous five years. This result was observed during tritium releases from H-Area following shutdown activities and greater than five inches of rainfall. Concentrations from all locations are below the EPA 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 (Table 5-4).

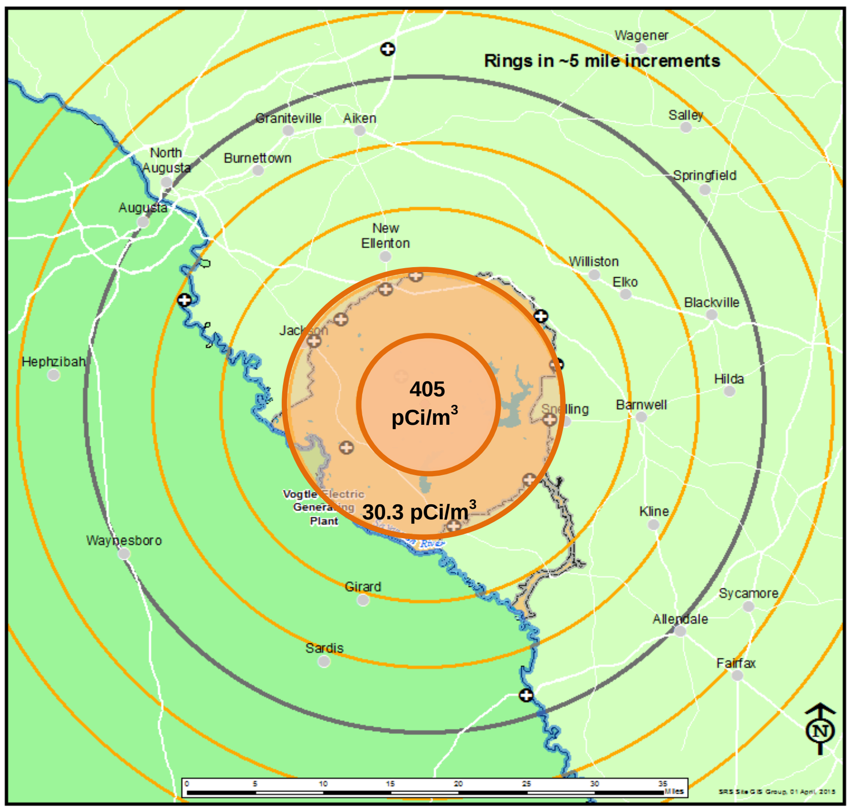


Figure 5-3 2014 Tritium in Air Maximum Concentrations (pCi/m^3)

Table 5-4. 2014 Tritium-in-Rainwater Concentrations (pCi/L)

Location	Location Description	Number of Samples	Number of Samples Greater than MDC	Maximum	Comments
Onsite (Center)	Approximate Center of SRS	13	12	8,760	Maximum concentration is expected at this location because this is the closest location to SRS tritium releases along with rainfall causing fallout from the air.
Site Perimeter (Northwest)	Green Pond, SC	13	1	751	Maximum value is small because SRS operations release very low quantities in air along with rainfall causing fallout from the air.
Site Perimeter (North)	Talatha Gate, SC	13	0	Less than MDC	None
Site Perimeter (North)	East Talatha, SC	13	0	Less than MDC	None
Site Perimeter (Northeast)	Darkhorse, SC	13	0	Less than MDC	None
Site Perimeter (East)	Highway 21/167, SC	13	1	473	Maximum value is small because SRS operations release very low quantities in air along with rainfall causing fallout from the air.
Site Perimeter (South)	Barnwell Gate, SC	13	1	1,510	Higher than maximum concentration is expected at this location due to H-Area releases and primary wind direction towards Barnwell gate during this timeframe, along with greater than 5 inches of rain.
Site Perimeter (Southwest)	Patterson Mill Road, SC	13	1	422	Maximum value is small because SRS operations release very low quantities in air along with rainfall causing fallout from the air.
Site Perimeter (South)	Allendale Gate, SC	12	0	Less than MDC	None
Site Perimeter (Southwest)	D-Area, SC	13	4	754	Maximum concentration is onsite and within the sector of less air mixing.
Site Perimeter (West)	Jackson, SC	13	0	Less than MDC	None
25 miles from SRS (Northwest)	Augusta, GA	13	0	Less than MDC	None
25 miles from SRS (North)	Aiken Airport, SC	13	0	Less than MDC	None
25 miles from SRS (South)	Highway 301, GA (CONTROL)	13	0	Less than MDC	None

EPA Drinking Water Standard for Tritium in Water = 20,000 pCi/L

Gross Alpha and Beta-Emitting Radionuclides

Gross alpha and gross beta results from 2014 wet and dry deposition were lower than those of 2013 and previous five years historical trend levels. Results in wet and dry deposition from rainfall ranged from below the minimum detectable concentration (MDC) to a maximum concentration of 6.22 pCi per square meter gross alpha and a maximum of 117 pCi per square meter gross beta.

Gamma-Emitting Radionuclides

No detectable levels of man-made gamma-emitting radionuclides, such as cobalt-60 and cesium-137, were observed in deposition samples during 2014, consistent with 2013 and the previous five years.

Alpha-Emitting Radionuclides-Actinides

Uranium-234 concentrations ranged from below the MDC to 0.161 pCi per square meter at the Greenpond location, on the northeast perimeter of SRS.

Uranium-238 concentrations ranged from below the MDC to 0.175 pCi per square meter at the Highway 301 location, 25 miles south of SRS. Uranium is naturally occurring in soil and is expected to be present at low concentrations in deposition samples. Americium-241 concentrations ranged from below the MDC to 0.139 pCi per square meter at the Darkhorse Site perimeter location.

Strontium

In 2014, none of the strontium-89, 90 results from wet and dry deposition were above the MDC, consistent with 2013 and the previous five years.

Ambient Gamma Surveillance

A Field Technician Collects TLDs at the Burial Ground North Air Surveillance Station

SRS has been monitoring ambient (surrounding) environmental gamma exposure rates with thermoluminescent dosimeter (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.

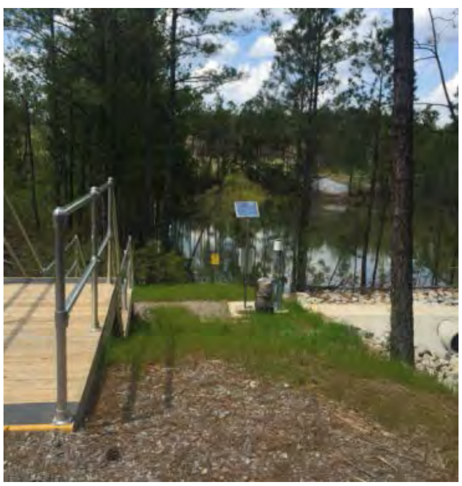
An extensive network of TLDs in and around SRS monitors external ambient gamma exposure rates. The SRS ambient gamma radiation monitoring program has four subprograms: Site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor exposures from Georgia Power's 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.

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 2014, ambient gamma exposure rates varied between 52 mR/yr (location GAL_1L near D Area) and 124 mR/yr (location Burial Ground North near the center of SRS) (Data Table 5-6, Maps Figure 2).

Ambient gamma results are consistent with the previous five-year trends and 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.



The New Z-01 Outfall and Expanded Stormwater Basin

Stormwater Basin Surveillance

SRS performs surveillance of stormwater accumulating in the Site's stormwater basins (Maps Figure 3) for gross alpha, gross beta, tritium, strontium, gamma-emitting radionuclides, and actinides. There are no active processes discharging to stormwater basins onsite, hence 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).

In 2014, SRS conducted surveillance at six E-Area basins as well as at the Z-Area Stormwater Basin and F-Area Pond 400.

Results Summary

Table 5-5 provides a summary of analytical results from Z-Area Stormwater Basin water samples. The concentrations of radionuclides are much lower than 2013, with maximum cesium-137 levels 94% lower and well below the DCS. Data Table 5-7 provides a summary of analytical results from sediment samples from the basin.

Table 5-5. Radionuclide Concentrations in Z-Area Stormwater Basin Water

Radionuclide	Average (pCi/L)	Maximum (pCi/L)
Cesium-137	721	2,430
Technetium-99	24.7	129
Strontium-89, 90	1.17	2.26
Uranium-238	0.044	0.089
Uranium -234	0.040	0.094
Plutonium-238	0.016	0.034
Tritium	2,090	4,350
Iodine-129	0.247	1.01

Table 5-6 provides a summary of gross alpha, beta, and tritium results for the other SRS stormwater basins. Gross alpha concentrations ranged from below the MDC to a maximum of 79.5 pCi/L at Pond 400. Gross beta results ranged from below the MDC to a maximum of 55.7 pCi/L at Pond 400. The highest maximum tritium concentration was observed at the E-002 Basin, at 28,100 pCi/L, consistent with the previous five years of historical results. This basin does not actively discharge to the environment. The stormwater basin radiological results are in Data Table 5-7.

Table 5-6 Radionuclide Concentrations Summary for Stormwater Basins (pCi/L)

Basin Location	Average Gross Alpha	Average Gross Beta	Average Tritium	Maximum Tritium
E-001	0.35	3.37	3,710	7,570
E-002	0.48	5.15	12,800	21,700
E-003	1.32	3.12	9,120	21,900
E-004	0.70	2.35	7,250	11,700
E-005	1.53	4.42	6,510	13,500
Pond 400	1.06	4.56	398	1,870

SRS Stream Surveillance

SRS conducts continuous surveillance 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.

Figure 5-4 displays the radiological surface water sampling locations. The frequency and types of analyses reflect the upstream discharges and groundwater migration history of radionuclides.

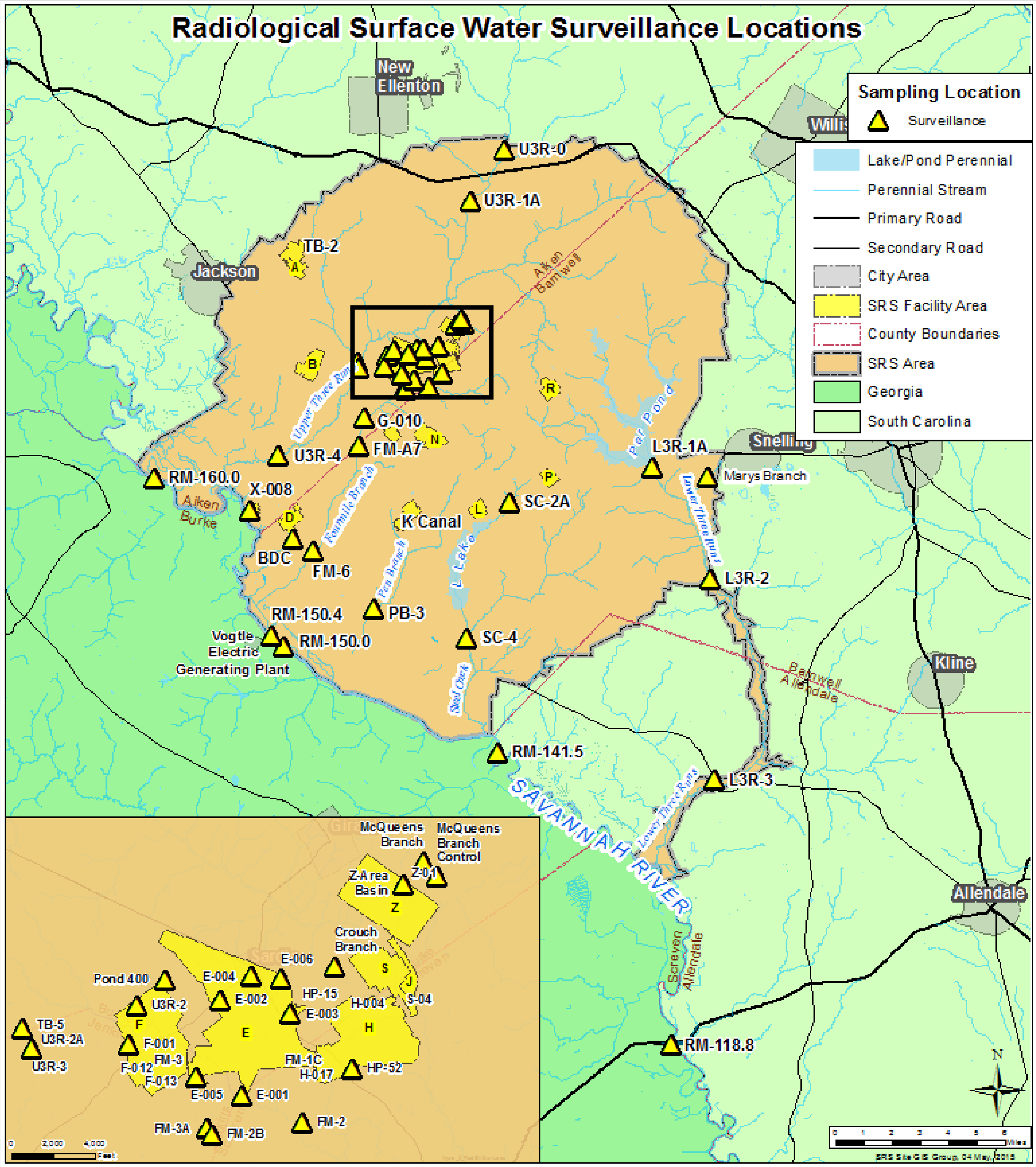


Figure 5-4 Radiological Surface Water Sampling Locations

A Technician Takes Readings on an Electronic Tablet

Table 5-7 presents the average 2014 concentrations of gross alpha, gross beta, and tritium in SRS streams. All of the results are included in Data Table 5-8. SRS found detectable concentrations of tritium, the predominant radionuclide detected above background levels in SRS streams, at least once at all stream locations in 2014. The ten-year trend charts (Figure 5-5 and Figure 5-6) 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 5-6 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, the EPA drinking water standard is the standard on which cleanup is based. 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 migration from the historical seepage basins and Solid Waste Disposal Facility (SWDF).

In 2000, in order to reduce the tritium flux to Fourmile Branch, SRS started a phytoremediation project to manage the tritium-containing water. 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. A sheet-pile dam captures the water from springs prior to release to Fourmile Branch. Irrigation of the captured water onto the forest results in transfer of the water to the atmosphere where it rapidly disperses and represents no significant dose to the facility workers or offsite residents. This project has been very effective, reducing the tritium flux to Fourmile Branch by about 65%.
Average tritium levels in Pen Branch are just below the standard and Upper Three Runs, Steel Creek, and Lower Three Runs are well below the EPA standard.

The radiological results are included in Data Table 5-8.

Table 5-7 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)	20.0	9.55	245	524
Lower Three Runs (L3R-3)	6.89	5.47	987	1,780
Steel Creek (SC-4)	0.82	1.42	1,590	2,170
Pen Branch (PB-3)	0.83	1.38	14,500	22,300
Fourmile Branch (FM-6)	1.61	5.83	30,800	35,700
Upper Three Runs (U3R-4)	12.9	7.74	468	630
Onsite Control Locations (for comparison purposes)				
Upper Three Runs (U3R-1A)	3.89	2.45	81.9	248

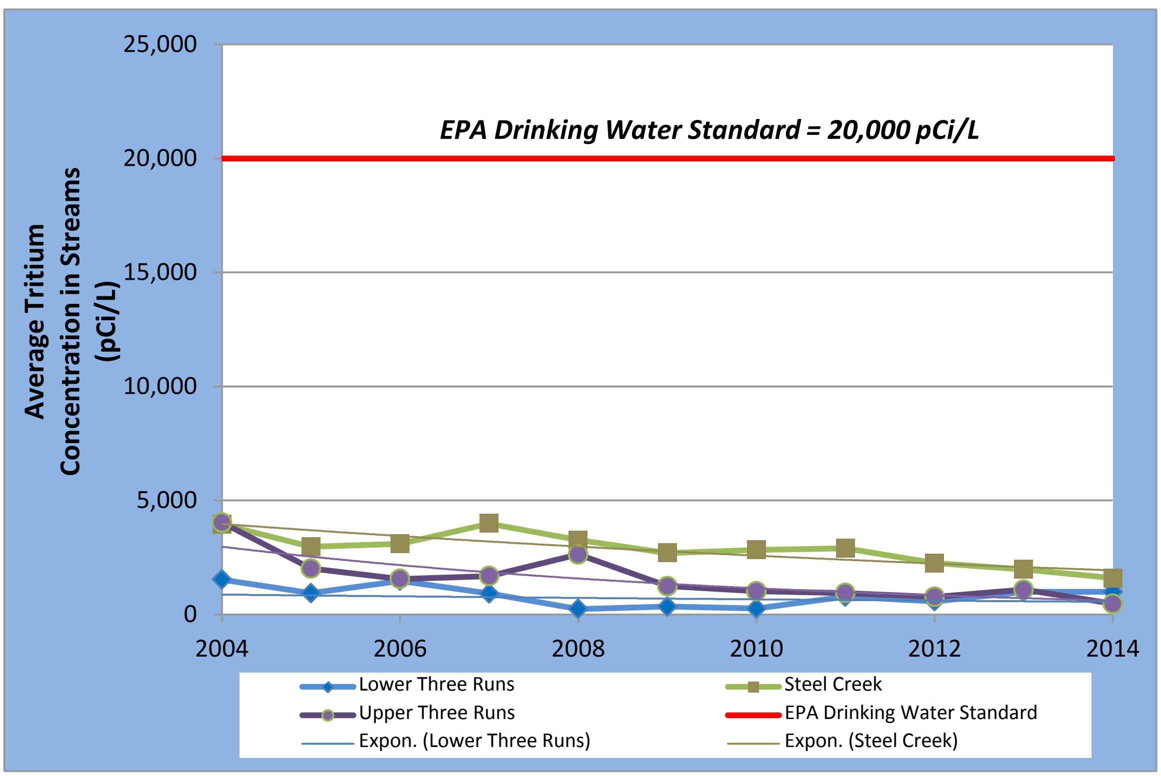


Figure 5-5 Ten-Year Trend of Tritium in Lower Three Runs, Steel Creek, and Upper Three Runs (pCi/L)

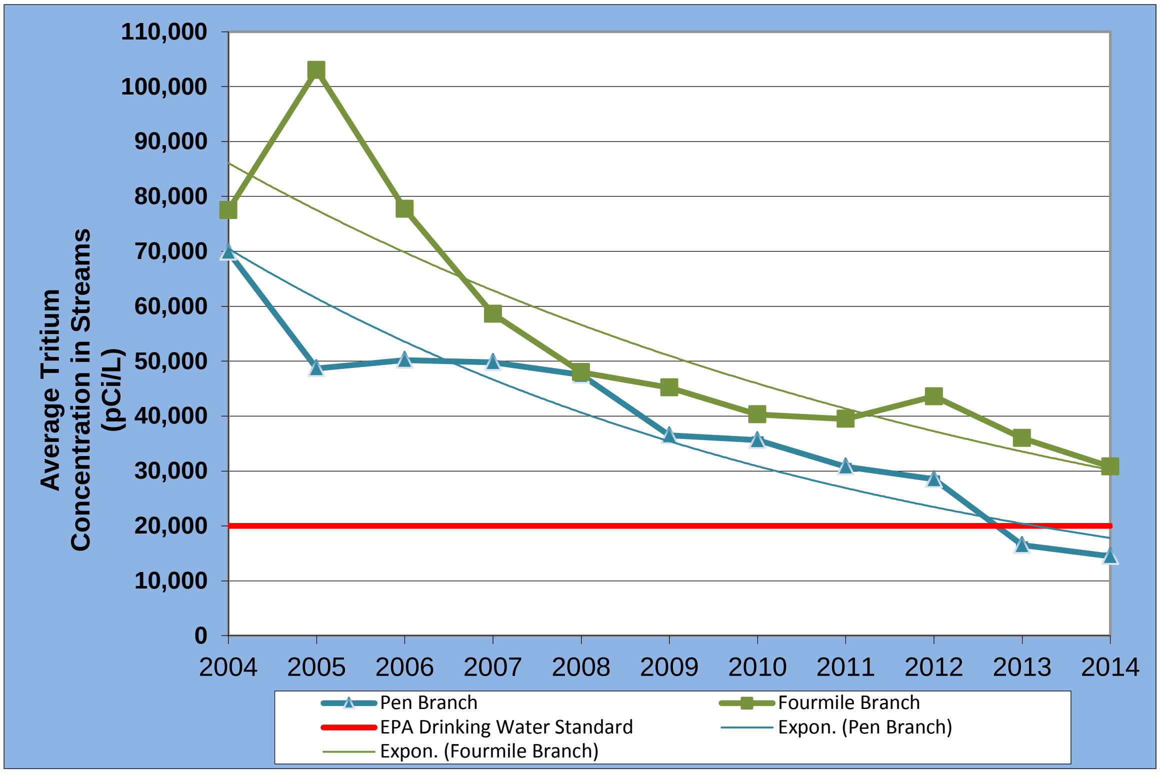
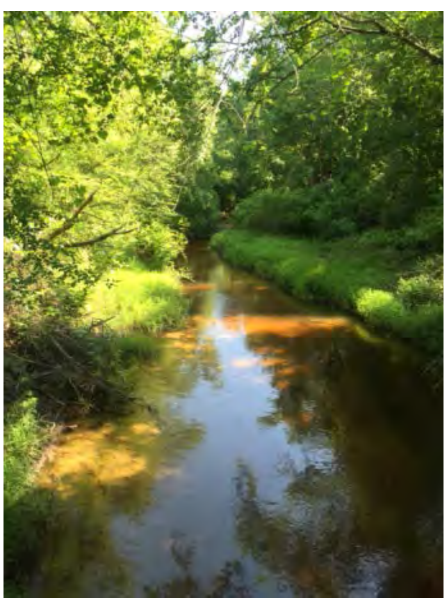


Figure 5-6 Ten-Year Trend of Tritium in Pen Branch and Fourmile Branch (pCi/L)

Seepage Basin and Solid Waste Disposal Facility (SWDF) Radionuclide Migration Monitoring



Fourmile Branch is Monitored at Several Locations to Determine Radionuclide Migration

SRS monitors and quantifies the migration of radioactivity from SRS seepage basins and the SWDF as part of its stream surveillance program. Seepage basins include the General Separations Area (F and H Area) Seepage Basins and 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. Migration from the SWDF is not distinguishable from the H-Area Seepage Basins because of their close proximity. Groundwater contamination from K-Area Seepage Basin migrates into Pen Branch.

Results Summary

Figure 5-7 is a graphical representation of releases of tritium via migration to Site streams from 2004 through 2014. 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 2014, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 657 Ci compared to 912 Ci in 2013, a 28% decrease. The ten-year trend displays a decrease in tritium migration. (Figure 5-7 and Table 5-8). Sample results used to determine the migration into Fourmile Branch, Upper Three Runs, and Pen Branch are in Data Table 5-9.

Of the 657 Ci of tritium migrating into SRS streams, 423 Ci were measured in Fourmile Branch (Table 5-9). Migration releases of other radionuclides vary from year-to-year but have remained below 0.1 Ci the past ten years. The summary of radionuclide migration into Fourmile Branch is included in Table 5-9.

SRS estimated tritium migration from the north side of SWDF and the General Separations Area into Upper Three Runs in 2014 was 47.6 Ci, compared with 158 Ci in 2013.

Sampling in Pen Branch measures the tritium migration from the seepage basin and the percolation field below the K-Area Retention Basin. The 2014 estimated migration of 186 Ci is comparable to the 202 Ci recorded in 2013.

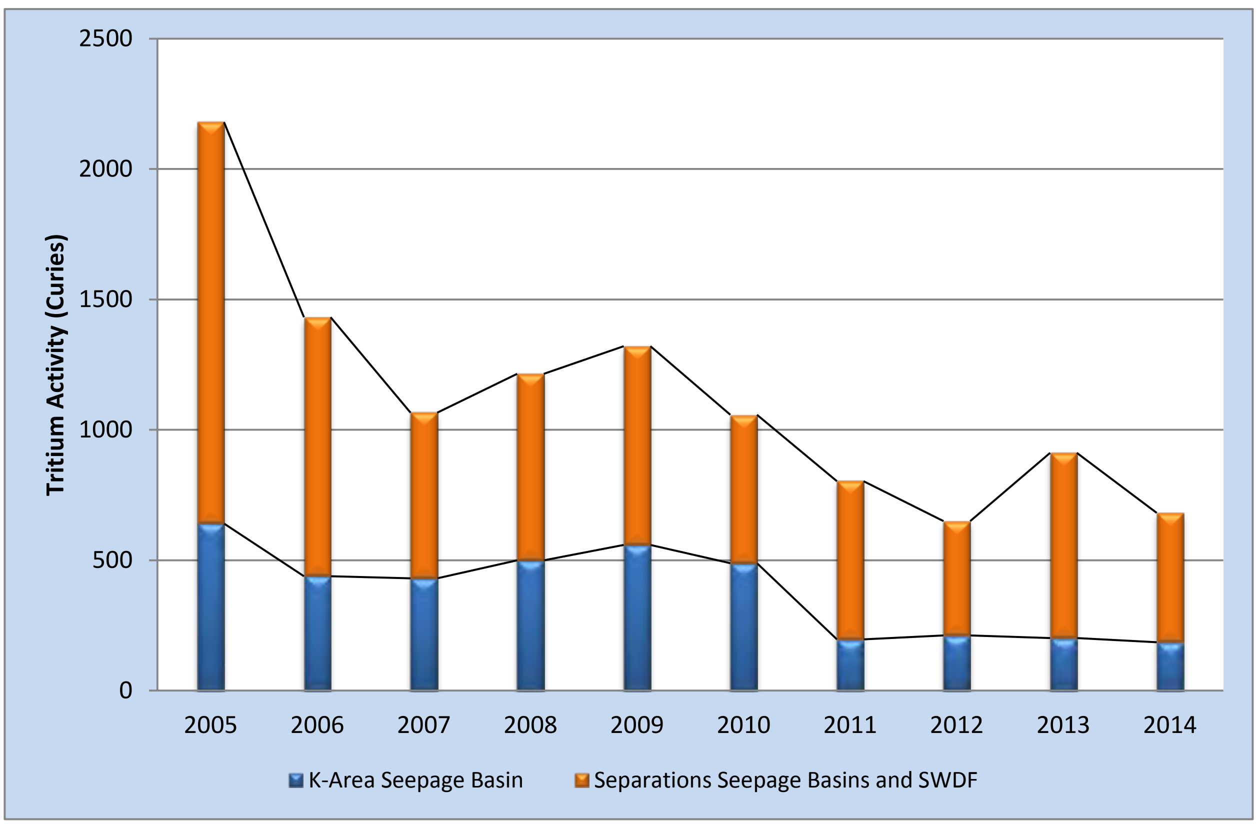


Figure 5-7 Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

Table 5-8 Tritium Migration Total (Curies) From SRS Seepage Basins and SWDF

Year	K-Area Seepage Basin	Separations Seepage Basins and SWDF	Total
2005	641	1,539	2,180
2006	439	993	1,432
2007	431	635	1,066
2008	500	715	1,215
2009	559	762	1,321
2010	489	569	1,058
2011	197	606	803
2012	212	438	650
2013	202	710	912
2014	186	472	657

Table 5-9 Migration into Fourmile Branch - Total (Curies)

Radionuclide	Year				
	2010	2011	2012	2013	2014
Tritium	500	538	368	552	423
Strontium-89, 90	0.026	0.015	0.015	0.021	0.052
Technetium-99	0.013	0.011	0.011	0.018	0.026
Iodine-129	0.023	0.015	0.013	0.027	0.025
Cesium-137	0.037	0.0195	0.046	0.0025	0.044

Technicians Take River Flow Measurements at River Mile 118.8

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

SRS streams are measured for alpha specific isotopes such as the actinides (uranium, plutonium, americium, and curium) when gross alpha results for the five major streams that deposit into the Savannah River are greater than the EPA screening level of 15 pCi/L gross alpha. Alpha specific isotope analysis is performed to evaluate potential radionuclide migration. Some samples from Upper Three Runs, Fourmile Branch, and Lower Three Runs showed alpha levels above the EPA screening level. Samples were collected from these streams for the alpha specific isotopic analysis. Overall, the alpha specific (Pu238, Pu-239, Am-241, Cm-244, U-234, U-235, and U-238) isotope values for 2014 showed no elevated levels and were consistent with historical measurements.

Savannah River Surveillance

SRS conducts continuous surveillance along the Savannah River at locations above and below SRS streams, including at a location where liquid discharges from VEGP enter the river to understand SRS contributions.

Five locations (Figure 5-4 and Maps Figure 3) along the river continued to serve as environmental surveillance points in 2014. Samples are collected at these river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides (Data Table 5-10).

Results Summary

The average 2014 concentrations of gross alpha, gross beta, and tritium at river locations are listed in Table 5-10. The tritium concentration levels are well below the EPA drinking water standard of 20,000 pCi/L.

Table 5-10 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)	0.277	1.93	58.4
RM-150.4 (VEGP)	0.286	1.98	1,100
RM-150	0.232	1.94	224
RM-141.5	0.228	1.93	400
RM-118.8	0.292	1.85	385

The combined SRS and VEGP tritium estimates in the Savannah River at River Mile 118.8 are 2,513 Ci in 2014 compared to 2,482 Ci in 2013.

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 2,513 Ci in 2014 compared to 2,482 Ci in 2013. 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 2014. Gross alpha and beta averages are slightly lower than the average gross alpha and beta for the previous five years. Tritium averages for 2014 are consistent with the averages for the previous five years. Overall river results are within the historical trends of the previous five years.

Tritium Transport in Streams and Savannah River Surveillance

SRS production areas introduce tritium into SRS streams and the Savannah River. 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).

General agreement between the three calculational 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.

Results Summary

In 2014, tritium levels showed a general decrease, specifically:

- The direct releases of tritium decreased by approximately 35% (from 1,082 Ci in 2013 to 701 Ci in 2014)
- The stream transport of tritium decreased by approximately 36% (from 1,057 Ci in 2013 to 677 Ci in 2014)
- The river transport of tritium in 2014 increased slightly by approximately 1% (from 2,482 Ci in 2013 to 2,513 Ci in 2014) [Both VEGP and SRS contributed to these values]

SRS tritium transport data from 1960-2014 (Figure 5-8), shows the history of direct releases, stream transport, and river transport. The history of tritium transport at SRS is included in Data Table 5-11 and in Data Table 5-12. Due the significant decrease in tritium transport from the early operational years until now, a ten-year trend analysis is provided in Figure 5-9 that shows a decreasing trend.

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.

In the past few years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the Barnwell Low-Level Disposal Facility (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. During 2014, SRS implemented monitoring at Mary's Branch and quantified the amount of tritium from BLLDF to be 90 Ci. For 2014, this amount 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 701 Ci in 2014) is used (see Chapter 6, "Radiological Dose Assessments").

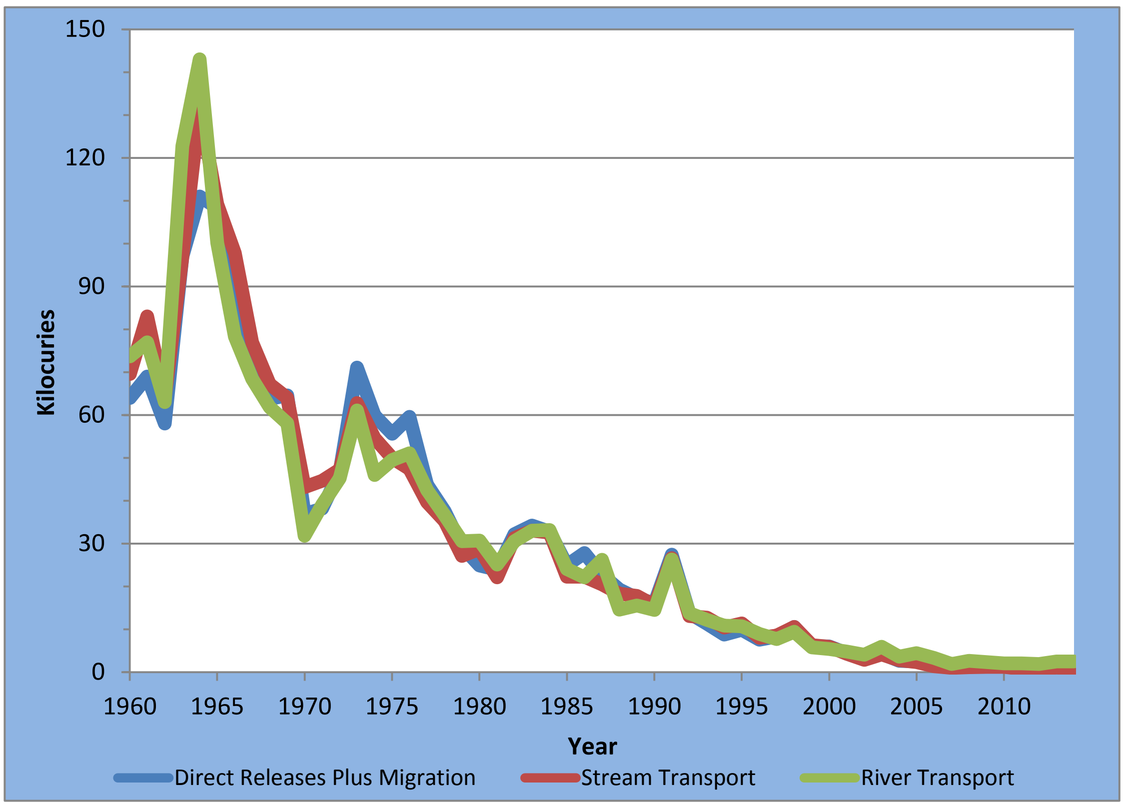


Figure 5-8 SRS Tritium Transport Summary

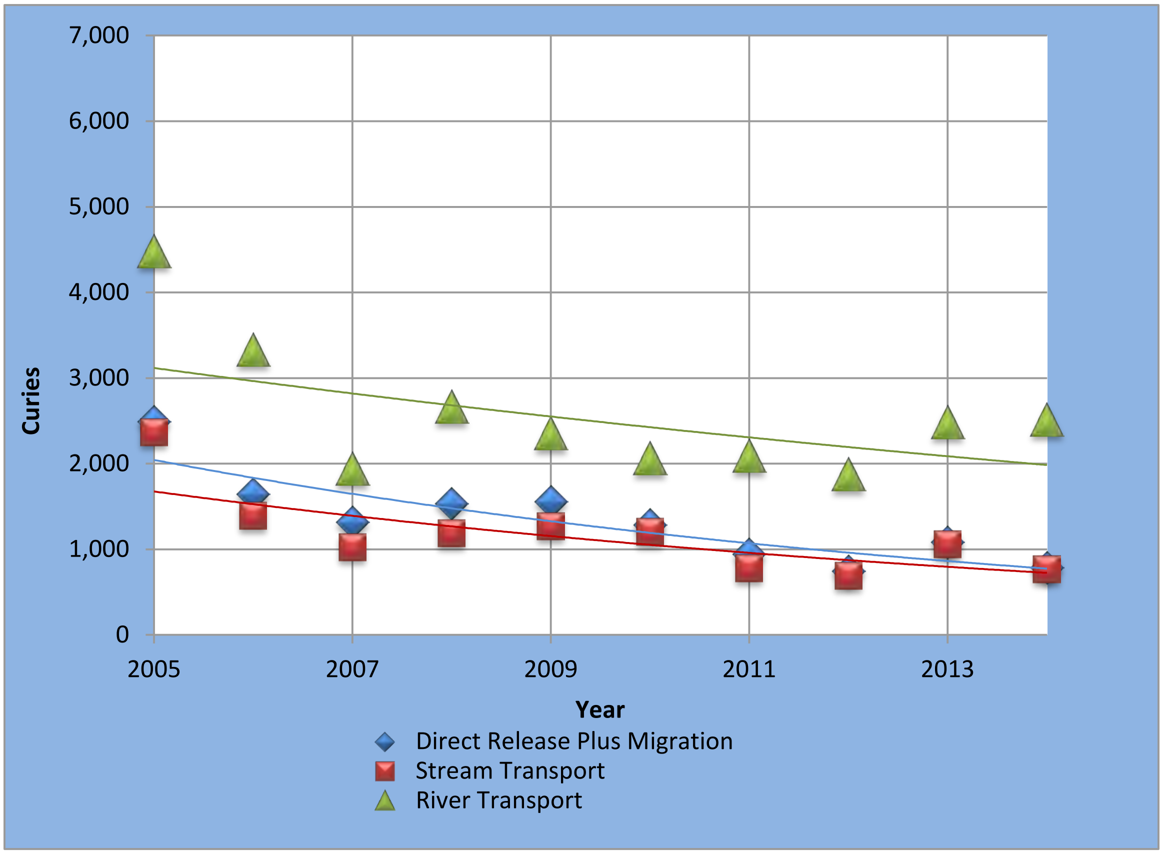


Figure 5-9 Ten-Year Trend of SRS Tritium Transport

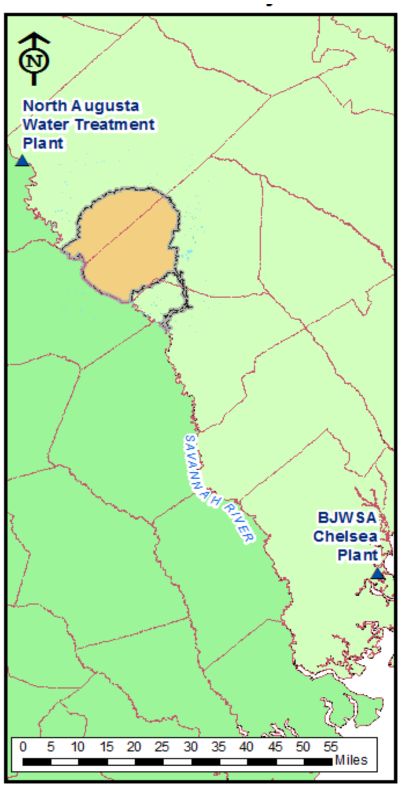


Figure 5-10 Offsite Drinking Water Locations

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 (Maps Figure 4). 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.

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 collects samples offsite from two locations (Figure 5-10):

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

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 Chelsea WTP intake is the furthest downriver sampling location. These locations are compared to evaluate potential impacts from upstream sources which includes SRS.

Results Summary

All radionuclide analyses of 2014 drinking water samples were below EPA standards.

In 2014, 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 5-11 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 2% of the EPA standard for tritium and decreases further at the downstream sampling location.

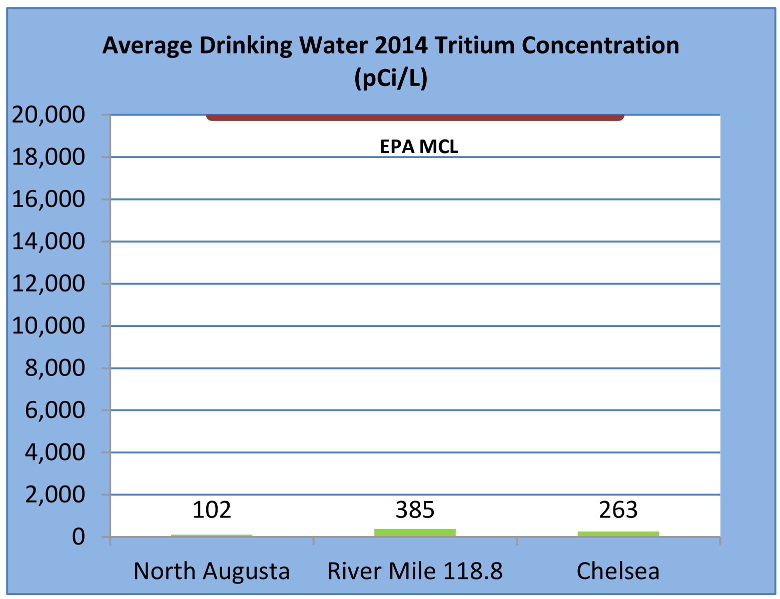


Figure 5-11 Tritium in Offsite Drinking Water and River Mile 118.8 (pCi/L)

Cobalt-60, cesium-137, strontium-89, 90, uranium-235, plutonium 239, and curium-244 were not detectable in any drinking water samples. Sample results indicated detectable levels of americium-241 in five onsite samples, plutonium-238 in one onsite sample, and uranium-234 and uranium-238 in four and five onsite samples, respectively (Data Table 5-13). Concentrations are near the levels of detection for these four analytes. All analytical results are well below the EPA standard.

Food Product Surveillance

Terrestrial Food Products

Samples of Soybeans Collected for the Food Product Surveillance

The terrestrial food products surveillance program consists of radiological analyses of food product samples typically grown in the Central Savannah River Area and consumed by the local public. The results of the analyses provides information on whether radionuclides are present in the environment and if present, where the radionuclides are located. The analytical results are used in the determination of whether SRS operations are affecting the public through the food chain.

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 we consume the meat of these exposed animals, we are thus exposed to radiation. In the case of dairy cows, they produce milk which 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.

Strontium-89, 90 in collards greens was detected at levels higher than usually found. The value is below US FDA and IAEA guidelines for foodstuff consumption.

The area around the Site is split into four equal size quadrants for sampling (i.e. NE, NW, SW, and SE). Samples are collected from locations in each quadrant. In addition, southeast quadrant samples collected outside of the 10-mile radius to the 25-mile radius are control samples. SRS collects milk on a quarterly basis from eight dairies within a 25-mile radius of the SRS. In general, as part of the food product surveillance, SRS conducts a three-year rotating schedule for sampling of meat, fruit, and green vegetables. Beef, collards, peanuts, soybeans, and watermelon were sampled in 2014 as part of this program. Thirty-two milk samples and five samples of each food type were collected, with the exception of beef, as described below. Tritium releases from SRS and non-SRS sources are the primary contributors to tritium in food products. Beef samples from livestock butchered in 2014 were obtained in four of the five quadrants. No beef samples were identified in the southeast-10 miles quadrant. 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.

Results Summary

Results for terrestrial food products and dairy are included in Data Tables 5-14 and 5-15, respectively. Tables 5-11 and 5-12 present a summary of the detected radionuclides in dairy and terrestrial food products, respectively. Included in these two tables is the concentration for the individual radionuclides by food type that would be equivalent to a one mrem dose. In 2014, collards and soybeans had detectable levels of tritium as shown in Table 5-12. All tritium results for milk were nondetects.

In 2014, cesium-137 was the only gamma-emitting radionuclide detected in food products, as shown in Table 5-12. Analysis detected strontium-90 in milk samples and strontium-89, 90 in food products, as shown in Table 5-11 and Table 5-12, respectively. Three of the 16 milk samples from the South Carolina dairies in the SRS surveillance program were above the MDC. All sixteen milk samples from the four GA dairies in the SRS surveillance program were nondetects. The strontium-90 results in dairy samples are within the five-year trend for the locations. Technetium-99, uranium-234, uranium-235, and uranium-238 in food products were detected above the MDC.

The radioisotopes of uranium are naturally occurring in local soils. Gross beta activity was detected in all food products. No detectable levels of gross alpha were observed in any of the food products. The 2014 results appeared randomly distributed among the surveillance locations with no underlying spatial pattern.

Table 5-11 Radionuclides Detected in Milk Products

Analyte	Number of Samples	Number of Detections	Maximum Concentration (pCi/L)	Equivalent to 1 mrem Dose
Strontium-90	32	3	1.40	28.8
Note: DOE Dose Standard for all exposure pathways = 100 mrem				

Of the 2014 food products sample results; there is one new maximum value. The value of 1.16 pCi/g for strontium-89,90 in collards is below the US. Food and Drug Administration's Derived Intervention Level of 4.3 pCi/g for strontium-90 (FDA 2005) and the International Atomic Energy Agency's guideline level of 2.7 pCi/g for strontium-89,90 in foods consumed by members of the public (IAEA 2011). Expected values based on collards data from 2005 through 2013 range from not detected to 0.508 pCi/g. The reanalysis of the 2014 sample confirmed the reported value.

Table 5-12 Radionuclides Detected in Food Products

Analyte	Food Product	Locations by Quadrant in which Analyte was Detected	Maximum Concentration (pCi/g)	Equivalent to 1 mrem Dose[1]
Tritium	Collards	NE,**SW**	0.0757	1,610
Tritium	Soybeans	NE**,SE**	0.0468	1,610
Cesium-137	Collards	**NW,**SE,SE-25,SW	0.0908	2.54
Cesium-137	Soybeans	**SE**	0.0110	2.54
Strontium-89/90	Beef	**NW,**SE-25	0.00241	0.0927
Strontium-89/90	Collards	NE, **NW**, SE-25**,** SW	1.16	0.938
Uranium-234	Beef	NE,SE-25,**SW**	0.0000773	0.0574
Uranium-234	Collards	NE,NW,SE,**SE-25**,SW	0.0248	0.581
Uranium-234	Peanuts	**SW**	0.00111	0.581
Uranium-234	Soybeans	**NE,**NW,SE	0.00551	0.581
Uranium-235	Collards	**SE-25**	0.00189	0.615
Uranium-235	Soybeans	**NE**	0.00201	0.615
Neptunium-237	Soybeans	**SE-25**	0.00176	0.217
Uranium-238	Beef	**NW,**SW	0.0000692	0.0637
Uranium-238	Collards	NE,NW,SE,**SE-25,**SW	0.0324	0.645
Uranium-238	Peanuts	**SE-25**	0.000905	0.645
Uranium-238	Soybeans	**NW**, SE-25	0.00154	0.645
Plutonium-238	Soybeans	**SE-25**	0.00292	0.128
Plutonium-239	Melons	**SW**	0.0000892	0.117
Americium-241	Soybeans	**SE-25**	0.00276	0.142
Curium-244	Soybeans	**SE-25**	0.00184	0.224
Technetium-99	Collards	**NE**,NW,SE,SW	0.484	37.5
Technetium-99	Peanuts	**SW**	0.150	37.5
Technetium-99	Soybeans	NE,NW,**SE**,SE-25,SW	0.305	37.5

All quadrants, except as noted, are within 10 miles of the SRS boundary. Locations annotated in bold are the quadrants in which the maximum concentration was detected. No beef sample was collected in the SE quadrant (See text for additional information).
Note: DOE Dose Standard for all exposure pathways = 100 mrem
1. Reference for values is Stone and Jannik 2013

Aquatic Food Products

The aquatic food product surveillance program includes freshwater and saltwater fish and saltwater shellfish. SRS maintains a program for collecting and analyzing fish from the Savannah River and surrounding freshwater bodies (Maps Figure 5). Various species of fish collected offsite from streams and tributaries are included in the determination of the potential dose and risk to the public from consumption. Six surveillance points for the collection of freshwater fish are on the Savannah River from above SRS at Augusta, Georgia to the coast at Savannah, Georgia. One surveillance point for the collection of saltwater fish is at the mouth of the Savannah River, near Savannah, Georgia. Composite samples composed of three to five fish of a given species are prepared for each species from each location. SRS uses three categories of freshwater fish: bass, panfish (bream), and catfish. Saltwater fish include composites of sea trout, red drum (spot tail bass), and mullet. Saltwater shellfish include oysters and crabs. The shellfish are purchased from vendors in the Savannah area that harvest from local saltwater that is potentially influenced by waters of the Savannah River. Fish categories sampled represent the most common fish caught in the Savannah River. SRS analyzes two types of composites. They are edible (meat and skin only) and non-edible (bone) composites. Analyses conducted on edible composites include tritium, gross alpha, gross beta, gamma-emitting radionuclides (that is Cs-137 and Co-60), strontium-89, 90, technetium-99, and iodine-129. Strontium-89, 90 is the only analyses conducted on the non-edible composites.

Oysters are One of the Types of Saltwater Shellfish Collected as part of the Routine Aquatic Food Products Program

During the first quarter of 2014, SRS performed upgrades to the fish collection equipment. These activities resulted in missing the collection window for sea trout, found in the estuaries when the water temperatures are coldest (January and February). Thus, no sea trout were collected in 2014.

Results Summary

Data Table 5-16 provides the results for saltwater. For freshwater fish, Data Table 5-17 provides detailed results. The results for shellfish are reported in Data Table 5-18. In 2012, SRS revised the method for computing the mean value. The mean is set to zero when the three composites for the species are below the MDC. The aquatic food product results in 2014 were similar to levels recorded during the previous five years.

Radionuclide results for all fish, including shellfish, are consistent with the results of the previous five years.

In 2013, SRS modified the preparation method for the non-edible samples. Previously, scraps of flesh attached to the bone were included in the analyses. Beginning with the 2013 samples, the non-edible sample was “cooked” to remove any flesh prior to processing the bone for analysis. This preparation method change resulted in an order of magnitude (roughly 10 times) increase in the concentration of strontium-89, 90 in the non-edible samples at all locations and for all fish types. By analyzing bone only, as is done as a result of the new preparation method, the concentrations are based on the amount of strontium-90 found in bone, which is greater than what is found in the flesh. Additional samples were collected in 2014 for two species to conduct a comparison of the two preparation methods.

The results confirmed the order of magnitude increase noted during 2013. Data Table 5-17 includes the results of this comparison.

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 composites at maximum concentrations of 3.46 pCi/g and 3.38 pCi/g, respectively. This is most likely attributed to the naturally occurring radionuclide potassium-40.

Cesium-137 was detected above the MDC in 21 of 54 freshwater fish composites at a maximum of 0.159 pCi/g in panfish. Average and maximum concentrations of cesium-137 for freshwater fish sampled are within historical trends. Analysis of saltwater fish found no man-made gamma-emitting radionuclides.

Strontium-89, 90 was greater than the MDC in all of the 60 nonedible freshwater fish composites at a maximum of 2.66 pCi/g and in three of six of the nonedible saltwater fish composites at a maximum of 0.241 pCi/g. For the saltwater fish composites, technetium-99 was below the MDC. For the freshwater fish, four of 54 of the composites contained technetium-99 above the MDC, with a maximum value of 0.088 pCi/g. Average and maximum concentrations of technetium-99 for freshwater fish sampled are within historical trends.

Iodine-129 was detected at levels greater than the MDC in two of 54 of the freshwater composites with a maximum concentration of 0.053 pCi/g in panfish. Iodine-129 has been detected above the MDC in one to two fish at different locations and in different species each year for the period 2010 through 2013 with comparable activities. The data do not indicate any apparent trends. Iodine-129 was not detected in levels above the MDC in saltwater fish.

Gross beta was detected in shellfish at a concentration of 1.26 pCi/g. Gross alpha was detected in both species of shellfish with a maximum concentration of 0.503 pCi/g. These levels were within the historical statistical trends. No detectable levels of strontium-89, 90, iodine-129, technetium-99, cesium-137, and cobalt-60 were reported above the MDC in shellfish.

Calculations of risk from the consumption of fish from the Savannah River are included in Chapter 6 "Radiological Dose Assessments."

Wildlife Surveillance

Deer, Hog, and Coyote

Annual game animal hunts, open to members of the public, are conducted to reduce animal-vehicle collisions and control SRS's deer, coyote, and feral hog populations.

All animals monitored during wildlife surveillance activities were cleared for release to the hunters.

Prior to releasing any animal to a hunter, SRS uses portable sodium iodide detectors to perform field analyses for cesium-137. SRS collects samples for laboratory analysis of cesium-137 concentrations in deer (muscle and bone) samples based on (1) a set frequency, (2) the cesium-137 levels, or (3) exposure limit considerations. Cesium-137 is chemically similar to and behaves like potassium in the environment. It 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.

SRS has an administrative dose limit for the consumption of game animals set at 22 mrem per year. Chapter 6, "Radiological Dose Assessments," reports the doses from deer and hog consumption.

Results Summary

Hunters harvested a total of 587 deer, 135 feral hogs, and 26 coyotes during the 2014 SRS hunts. With the exception of 25 coyotes not wanted by the hunters, all animals were released to the hunters. As observed during previous hunts, cesium-137 was the only man-made gamma-emitting radionuclide 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 8.37 pCi/g while laboratory measurements ranged from 0.17 pCi/g to 7.76 pCi/g. Laboratory measurement results are included in Data Tables 5-19 and 5-20 for deer tissue and bone and in Data Tables 5-21 and 5-22 for hog tissue and bone, respectively. Results of field and laboratory measurements are summarized in Table 5-13. 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 5-12.

In 2014, all 97 deer bone and 7 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 3.81 pCi/g and a maximum of 18.8 pCi/g. Strontium-89, 90 was detected in hog bone with an average of 1.51 pCi/g and a maximum of 2.86 pCi/g.

For the deer muscle tissue samples, 14 out of the 97 muscle tissue samples had detectable levels greater than the MDC for strontium-89, 90 with a maximum of 0.045 pCi/g. These average results are similar to those of previous years.

Table 5-13 Cesium-137 Results for Laboratory and Field Measurements in Wildlife

2014	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	587	1.29	8.37	1.52	7.76
Hog	135	1.29	3.84	1.12	3.59
Coyote	26	1.10	1.96	-----	-----

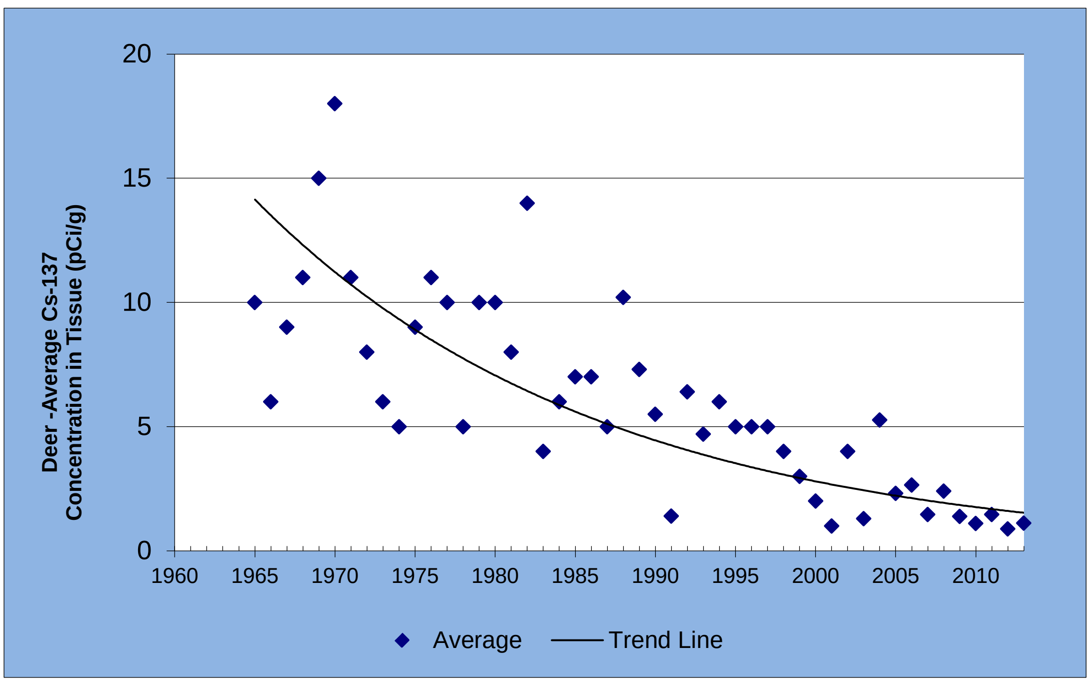


Figure 5-12 Historical Trend of Cesium-137 Concentration in Deer (pCi/g)

Equipment Used to Monitor Turkeys During the Annual Turkey Hunt for the Mobility Impaired

<u>Turkey</u>

SRS hosted a special turkey hunt during April 2014 for hunters with mobility impairments. Twenty-two turkeys were harvested, monitored, and released to hunters.

Results Summary

All field measurement results for the 22 turkeys harvested had cesium-137 levels below 1.00 pCi/g. All animals were assigned a default concentration of 1.00 pCi/g.

Soil Surveillance

SRS conducts soil surveillance to provide:

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

SRS collected soil samples in 2014 from five onsite locations, 10 Site perimeter locations, and three offsite locations (Maps Figure 6). 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, the data is evaluated for long-term trend analysis.

A Laboratory Technician Weighs a Soil Sample During Preparation for Radiological Analyses

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

<u>Results Summary</u>

In 2014, radionuclides were detected in soil samples from all 18 sampling locations (five onsite, 10 at the perimeter, and three offsite). Table 5-14 provides a summary of the results compared to the SRS control location.

The concentrations at these locations are consistent with historical results, with the maximum cesium-137 concentration found at onsite perimeter air station Darkhorse at Williston Gate (Data Table 5-23). No soil concentrations at the SRS perimeter or offsite exceeded the limit used at SRS for posting Soil Contamination Areas (SCA) (150 pCi/g for beta and gamma radionuclides). At SRS, an SCA is an area that has soil contamination levels with the potential for being a radiological hazard if the soil is disturbed. An SRS SCA requires special signage be posted and access is strictly controlled. Uranium is naturally occurring in soil and therefore expected to be present in soil samples.

The remaining radionuclides are slightly higher than the upstream SRS control location in Upper Three Runs, but lower than any SCA limits and comparable to natural background levels.

Table 5-14 Summary of Radiological Results of Soil

Radionuclide	Number of Detections	Maximum Concentration (pCi/g)	SRS Soil Control Location Maximum Concentration (pCi/g)
Cesium-137	15 of 18	0.43	0.0735
Uranium-234	18 of 18	2.70	1.37
Uranium-235	16 of 18	0.127	0.056
Uranium-238	18 of 18	2.76	1.30
Plutonium-238	9 of 18	0.082	Less than MDC
Plutonium-239	17 of 18	0.072	0.00268
Neptunium-237	1 of 18	0.00751	Less than MDC
Strontium-89, 90	1 of 18	0.338	Less than MDC
Americium-241	15 of 18	0.042	Less than MDC
Curium-244	7 of 18	0.012	Less than MDC

Sediment Surveillance

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 2014 (Maps Figure 7).

Sediment sample results indicate no buildup of radioactive materials from effluent release points.

Results Summary

Results for 2014 sediment sampling are summarized in Table 5-15 below and in more detail in Data Table 5-24. The maximum of each radionuclide is included in Table 5-15 below compared to the SRS control location.

The maximum cesium-137 concentration was observed in the Z-Area Stormwater Basin, a posted SCA. More information on the Z-Area Stormwater Basin is discussed in the stormwater basin section of this chapter. For the river and stream sediments, cesium-137 ranged from below the MDC to 108 pCi/g at R-Canal (100-R Location) which also is a posted SCA. All other locations were below the SCA levels. The highest level from the river, 0.243 pCi/g, was from RM 134 (Below Little Hell Landing); the lowest levels were below detection.

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.

Table 5-15 Summary of Radiological Results of Sediment

Radionuclide	Number of Detections	Maximum Concentration (pCi/g)	Location	SRS Sediment Control Location Maximum Concentration (pCi/g)
Cesium-137	25 of 35	1,500	Z-Area Stormwater Basin	0.098
Uranium-234	35 of 35	8.51	Steel Creek – 2A	1.44
Uranium-235	32 of 35	0.389	Steel Creek – 2A	0.099
Uranium-238	35 of 35	8.62	Steel Creek – 2A	1.62
Plutonium-238	24 of 35	0.649	Fourmile Creek –2	Less than MDC
Plutonium-239	26 of 35	0.851	Pond 400	0.0060
Neptunium-237	6 of 30	0.0254	Fourmile Creek –2	Less than MDC
Strontium-89,90	8 of 34	0.253	R-Area	Less than MDC
Americium-241	26 of 35	0.156	100-R	0.00557
Curium-244	17 of 35	0.0438	Fourmile Creek A-7	Less than MDC

Settleable Solids Surveillance

A measure of settleable solids in water is required to determine, in conjunction with routine sediment monitoring, whether a long-term buildup of radioactive materials occurs in stream systems. Settleable solids are solids in water that are heavy enough to sink to the bottom of the collection container. DOE limits 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 of settleable solids with low Total Suspended Solids (TSS).

TSS levels below 40 parts per million comply with DOE limits. To determine compliance with these limits, SRS uses TSS results gathered as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program from outfalls co-located at or near radiological effluent points.

Results Summary

In 2014, all NPDES TSS sample results were below 40 parts per million. The 2014 NPDES TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

Grassy Vegetation Surveillance

SRS conducts the radiological program for grassy vegetation from onsite and offsite 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 the deposition of airborne radioactive contaminants and internally 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.

A Laboratory Technician Prepares Grassy Vegetation Samples for Gamma Analysis

Results Summary

SRS detected radionuclides in the grassy vegetation samples collected during 2014 at all locations (one onsite, 10 at the perimeter, and three offsite; Maps Figure 8). Table 5-16 provides a summary of the results. Results for all radionuclides are within the trends of the previous ten years. (Data Table 5-25).

Table 5-16 Summary of Radiological Results of Grassy Vegetation

Radionuclide	Number of Detections	Maximum Concentration (pCi/g)	Maximum Location	SRS Control Location Maximum Concentration (pCi/g)
Tritium	1 out of 14	0.22	Approximate Center of SRS, Burial Ground North	Less than MDC
Gross Alpha	1 out of 14	1.51	Greenpond, Northwest Perimeter	Less than MDC
Gross Beta	14 out of 14	16.6	Approximate Center of SRS, Burial Ground North	13.3
Cesium-137	7 out of 14	0.273	Jackson, Northwest Perimeter	Less than MDC
Uranium-234	14 out of 14	0.0470	Augusta Lock and Dam Northwest 25 Miles	0.0.00311
Uranium-235	3 out of 14	0.00194	Augusta Lock and Dam, Northwest 25 Miles	Less than MDC
Uranium-238	14 out of 14	0.0484	Augusta Lock and Dam, 25 miles northwest	0.00216
Plutonium-238	4 out of 14	0.00305	Highway 301 Southeast 25 miles	0.00305
Plutonium-239	1 out of 14	0.000857	East Talatha, North Perimeter	0.000324
Technetium-99	14 out of 14	0.624	Approximate Center of SRS, Burial Ground North	0.359
Strontium-89/90	14 out of 14	0.432	East Talatha, north	0.080
Americium-241	0 out of 14	Less than MDC	Augusta Lock and Dam, Northwest 25 Miles	Less than MDC
Curium-244	0 out of 14	Less than MDC	East Talatha, North Perimeter	Less than MDC

NONRADIOLOGICAL SURVEILLANCE

SRS conducts nonradioactive surveillance sampling and analysis of surface water, drinking water, rainwater/wet disposition, air, sediment, groundwater (Chapter 7, "Groundwater Management Program"), and fish, according to water and air quality standards and potential contaminants pathways into the environment. Appendix A provides a summary of the nonradiological surveillance sampling media and frequencies.

Surface Water Surveillance

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

- 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.

Surface water samples are collected from five Savannah River and 11 SRS stream locations and are analyzed for various chemical and physical properties that include but are not limited to dissolved oxygen, pH, temperature, hardness, metals, mercury, pesticides/herbicides, and total organic carbon. (Figure 5-13 and Maps Figure 9).

Results Summary

SRS measured water quality parameters at all 16 sampling locations in SRS streams and along the Savannah River during 2014. Metals were detected in at least one sample at each location. With the exception of the pesticide, Endosulfan sulfate detected in April 2014 at Four Mile 6 (FM-6), no other sample results showed detectable levels of pesticides, herbicides, or polychlorinated biphenyls (PCBs). These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the river (Data Table 5-26).

The majority of the creeks in the water quality surveillance program routinely receive industrial inputs. Beaver Dam Creek is the exception. Due to dewatering of the D-Area Ash Settling Basin in August 2014 Beaver Dam Creek flowed. Otherwise, there was no industrial contribution to the creek in 2014.

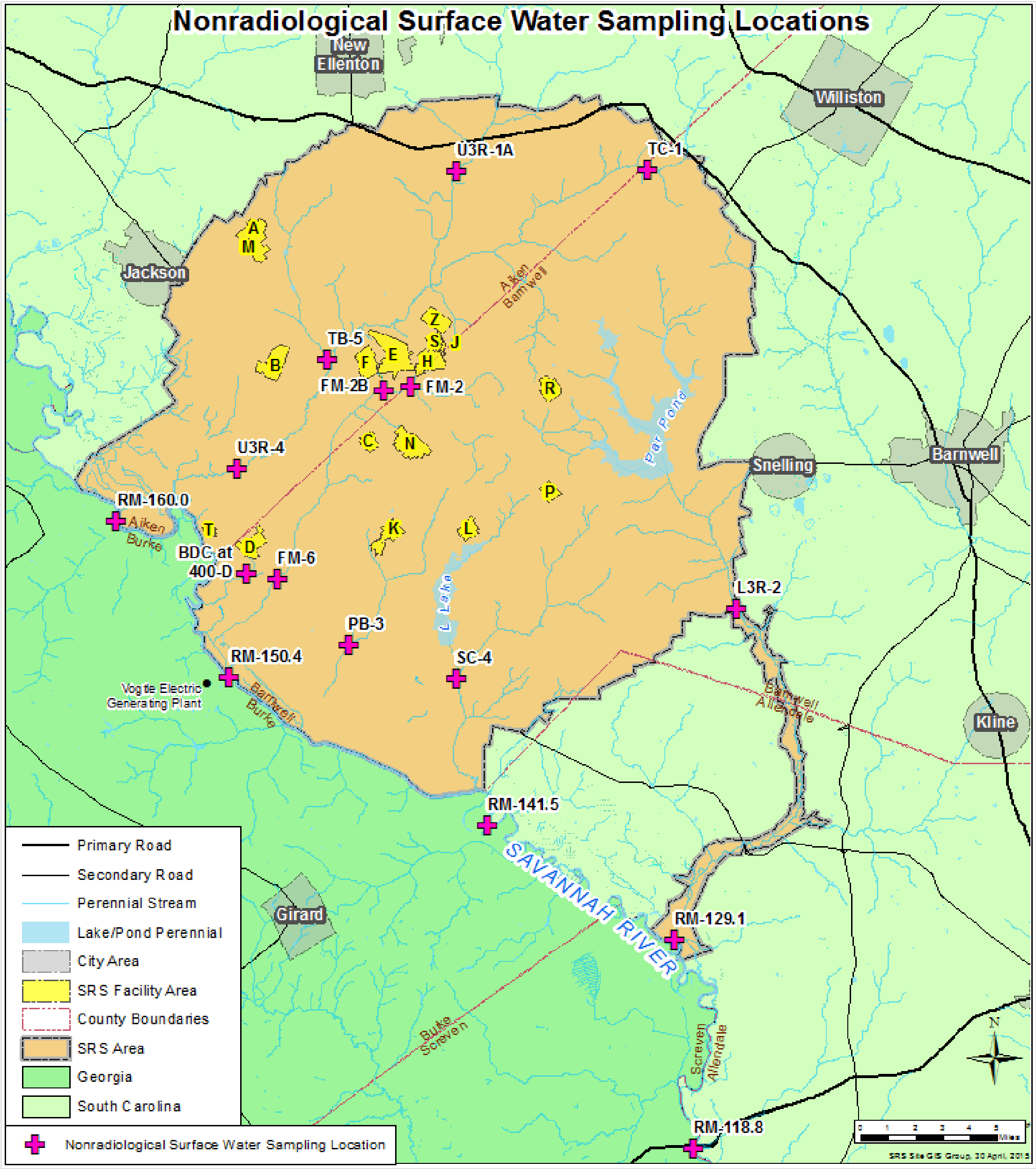


Figure 5-13 Nonradiological Surface Water Sampling Locations

Onsite Drinking Water Surveillance

The treatment plant in A Area supplies most of the drinking water at SRS. The SRS also has nine small drinking water facilities, each of which serves populations of fewer than 25 people.

All samples collected in 2014 from SRS drinking water systems were in compliance with SCDHEC and EPA water quality standards.

Results Summary

All samples collected from SRS drinking water systems during 2014 were in compliance with SCDHEC and EPA water quality standards. The Safe Drinking Water Act section of Chapter 3, "Compliance Summary" provides additional information.

Sediment Surveillance

SRS's nonradiological sediment surveillance program provides a method to determine the deposition and accumulation of nonradiological contaminants in stream systems (Maps Figure 10).

The nonradiological sediment program consists of the collection of sediment samples at eight onsite stream locations and three Savannah River locations. The samples are analyzed for various inorganic contaminants (metals, such as mercury) and pesticides/herbicides. This method analyzes for the soluble constituents in sediment. The program is designed to check for the existence and possible buildup of the inorganic contaminants as well as for pesticides and herbicides. SCDHEC performs duplicate sampling at various locations onsite as a quality control check of the SRS program. Those results are included with the routine SRS sediment sampling results in Data Table 5-27.

Sediment sample metal and mercury results from 2014 were consistent with the results of the previous five years.

Results Summary

In 2014, no mercury was detected at any of the locations, as in previous years. Metals analysis showed some metals with levels greater than the practical quantitation limit for 2014 but were consistent with those seen in soil samples and comparable to those of the previous five years (Data Table 5-27).

Fish Surveillance

SRS collects and analyzes fish caught from the Savannah River to determine concentrations of mercury, arsenic, cadmium, chromium, copper, lead, manganese, nickel, zinc, and antimony in the fish.

Results Summary

In 2014, SRS analyzed 285 freshwater fish from six locations on the Savannah River where SRS streams enter the river. Twenty-eight fish were sampled from one saltwater location at the mouth of the Savannah River and analyzed. Two hundred seventy freshwater fish samples and 27 saltwater fish samples were analyzed for mercury. Results for mercury and metals in fish are included in Data Tables 5-28 and 5-29, respectively.

A summary of the 2014 results for freshwater and saltwater fish are provided in Tables 5-17 and 5-18, respectively. For freshwater fish, all antimony and lead results were nondetect. The maximum concentration of each metal is distributed among the six freshwater locations. As indicated in Table 5-17, the maximum concentration of the various metals was distributed across all three species of freshwater fish. For saltwater fish, all antimony, cadmium, lead, and nickel results were nondetect.

Table 5-17 Summary of Metal Results for Freshwater Fish[1] Tissue Collected from the Savannah River

Analyte	Number of Detections	Number of Estimated Values	Maximum Concentration (ug/g)	SQL (ug/g)	MDC (ug/g)	Fish Type with Maximum Concentration	Location of Maximum Concentration
Mercury[2]	171	99	1.46	0.2	0.02	Bass	New Savannah Bluff Lock & Dam
Arsenic	0	14	1.38	9.47	0.95	Bass	Highway 301
Cadmium	0	6	0.224	0.824	0.082	Catfish	Steel Creek Mouth
Chromium	2	101	3.450	0.810	0.081	Panfish	Lower Three Runs Creek Mouth
Copper	0	204	1.450	1.570	0.157	Catfish	Upper Three Runs Creek Mouth
Manganese	8	193	4.580	0.724	0.072	Catfish	Four Mile Creek Mouth
Nickel	0	2	0.481	1.620	0.162	Panfish	Lower Three Runs Creek Mouth
Zinc	284	0	11.100	1.49	0.149	Catfish	New Savannah Bluff Lock & Dam

NOTES

1: 285 freshwater tissue samples were collected and analyzed for metals. 270 freshwater tissue samples were collected and analyzed for mercury.

2: In the case of mercury, the SQL is reported as the result for non-detects.

Table 5-18 Summary of Metal Results for Saltwater Fish[1] Tissue Collected from the Savannah River between River Miles 0-8, Near Savannah, GA

Analyte	Number of Detections	Number of Estimated Values	Maximum Concentration (ug/g)	SQL (ug/g)	MDC (ug/g)	Fish Type with Maximum Concentration
Mercury[2]	14	13	0.20	0.20	0.02	Mullet
Arsenic	0	2	0.970	8.60	0.86	Mullet
Chromium	0	12	0.180	0.616	0.062	Red Drum
Copper	0	15	1.110	1.390	0.139	Mullet
Manganese	0	27	0.366	0.882	0.088	Mullet
Zinc	28	0	6.52	1.59	0.159	Red Drum

NOTES

1: 28 saltwater tissue samples were collected and analyzed for metals. 27 saltwater tissue samples were collected and analyzed for mercury.

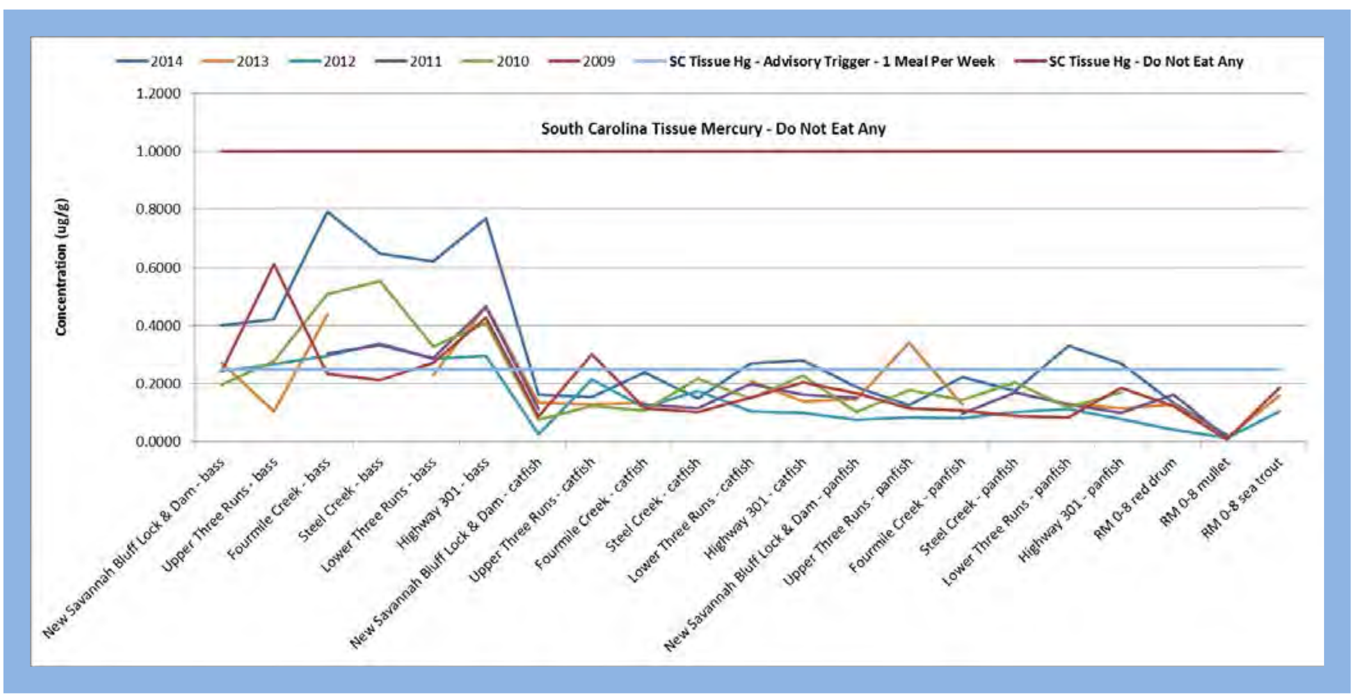
2: In the case of mercury, the SQL is reported as the result for non-detects.

Review of mercury data for the period 2009 through 2014 (Figure 5-14) shows levels higher levels in the 2014 data than previous years in bass at all locations and in catfish and panfish at Lower Three Runs Creek Mouth and Highway 301. Catfish and panfish at all other locations and all saltwater fish are consistent with the historical trend. SRS compared the data to the trigger levels used by SCDHEC and the South Carolina Department of Natural Resources to issue fish advisories (SCDHEC 2014).

Precipitation Chemistry and Deposition

SRS sponsors a collection station in support of the National Atmospheric Deposition Program (NADP). This station is located near the center of the SRS at the Savannah River National Laboratory Central Climatology facility. Weekly precipitation samples from this station are collected and submitted to NADP laboratories for chemical analysis. Beginning in 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. It 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 from rain and dry particulates.

Figure 5-14 Mercury Concentrations in Fish by Location and Species



Sample analysis associated with this 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.

Results Summary

During calendar year 2013 (the last year for which data are available) the average (volume weighted) concentration of total mercury in precipitation was 9.3 ng/L and the wet deposition rate was 13.4 µg/m^2. Data from 2014 will not be available until the fall of 2015. Additional information on the MDN is accessible via the following link: http://nadp.sws.uiuc.edu/mdn/.

The results from this surveillance for calendar year 2013 are presented in the Table 5-19. Additional information on the NTN is accessible via the following link: http://nadp.sws.uiuc.edu/NTN/.

Table 5-19 Precipitation Results of SRS National Trends Network Station for Calendar Year 2013

Analyte	Precipitation Weighted Concentration	Deposition
Calcium (Ca^{2+})	0.057 mg/L	0.82 kg/ha
Magnesium (Mg^{2+})	0.026 mg/L	0.375 kg/ha
Potassium (K^+)	0.020 mg/L	0.288 kg/ha
Sodium (Na^+)	0.182 mg/L	2.624 kg/ha
Ammonium (NH_4^+)	0.139 mg/L	2.00 kg/ha
Nitrate (NO_3^-)	0.464 mg/L	6.69 kg/ha
Chloride (Cl^-)	0.328 mg/L	4.73 kg/ha
Sulfate (SO_4^{2-})	0.509 mg/L	7.34 kg/ha
pH (free acidity H^+)	5.04	0.130 kg/ha

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

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6 RADIOLOGICAL DOSE ASSESSMENTS

OVERVIEW

U.S. Department of Energy (DOE) Order 458.1, "Radiation Protection of the Public and the Environment," establishes an annual public dose limit for humans 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 and from special-case exposure scenarios, such as the consumption of onsite wildlife, to verify that these releases and exposures do not exceed the DOE public dose limits.

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 [meteorological] 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 2014.

All dose calculation results are in data tables located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2014* on the SRS webpage.

SRS used the data generated by the programs described in Chapter 4, "Effluent Monitoring," and Chapter 5, "Environmental Surveillance" to calculate the potential doses to the public. For a complete description of how SRS calculates potential doses, see the *SRS Environmental Dose Assessment Manual* (SRS EDAM 2012).

WHAT IS RADIATION DOSE?

Radiation dose to a person is the amount of energy absorbed by the human body as a result of a radioactive source; it is measured in rem (which equals 0.01 sievert (Sv)) or in millirem (mrem), which is one-thousandth of a rem. Millirem is the unit typically used in this report.

Chapter 6 Key Terms

<u>Reference person</u> *is 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.*

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

<u>Typical person</u> *is a hypothetical person receiving a dose that is typical of the population group – established at the 50th percentile (or median) level of national radiation exposure data.*

Unless otherwise noted, the generic term "dose" used in this report is the total effective dose to a person, which includes both the committed effective dose (a dose that accounts for continuing exposures expected to be received over a long period of time (such as 50 or 70 years) from radioactive materials that were deposited inside the body) and the effective dose (the dose from sources external to the body).

Use of total effective dose allows people to express doses from different types of radiation and to different parts of the body on the same basis.

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

DOE has established dose limits to protect the public against undue risk from radiation associated with radiological activities conducted under the control of DOE. DOE Order 458.1 (DOE 2011) 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,
- Ingestion,
- Skin absorption, and
- Direct (external) exposure to radionuclides in soil, air, and water.

CALCULATING DOSE

In compliance with DOE Order 458.1, dose is 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 usage parameters (at the 95th percentile of national and regional data) developed specifically for SRS. The applicable national and regional data used are from the U.S. Environmental Protection Agency's *EPA Exposure Factor Handbook*, 2011 Edition (EPA 2011).

The reference person is weighted based on sex and age and this weighting is based on the six age groups documented in International Commission on Radiation Protection (ICRP) Publication 89, (2002): Infant (0 years), 1 year, 5 years, 10 years, 15 years, and Adult.

To correspond with these age groupings, SRS used proportional amounts from the various age- and gender-specific intake rates from the U.S. Environmental Protection Agency (EPA) (EPA 2011). SRS also developed usage parameters at the 50th percentile to use in calculating dose to a "typical" person for determining collective doses. Stone and Jannik (2013) developed the SRS-specific reference and typical person usage parameters (summarized in Table 6-1).

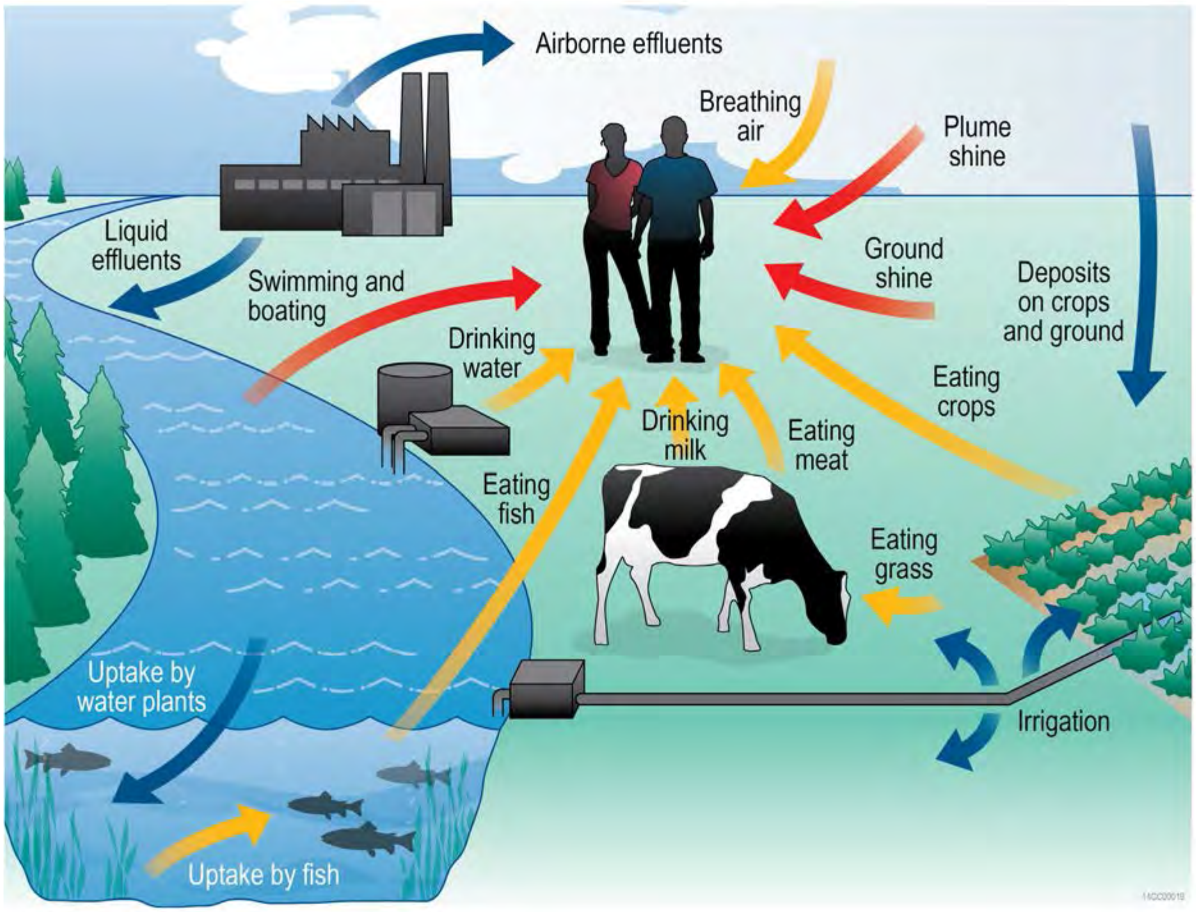


Figure 6-1 Exposure Pathways to Humans from Atmospheric and Liquid Effluents

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., 2010). These parameters include local characteristics of food production, river recreational activities, and other human usage parameters required in the SRS dosimetry models. In addition, SRS documents the preferred elemental bioaccumulation and transfer factors to be used in human health exposure calculations in this report.

Data Tables 6-1 and 6-2 provide a summary of the site-specific input parameters that are the most important to the dose calculations for the liquid and airborne pathways, respectively.

Table 6-1 SRS Reference and Typical Person Usage Parameters

	Unit	Reference Person	Typical Person
Air	m^3/y	6,400	5,000 [a]
Water	L/y	800	300 [b]
Meat	kg/y	81	32 [c]
Leafy Vegetables	kg/y	31	11
Other Produce	kg/y	289	89
Milk/Dairy	L/y	260	69
Freshwater Fish	kg/y	24	3.7
Saltwater Invertebrate	kg/y	9.0	1.5

[a] **1 cubic meter = 1.3 cubic yards**

[b] **1 liter = 1.06 quarts**

[c] **1 kilogram = 2.2 pounds**

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.

To show compliance with the DOE Order 458.1 all pathway dose standard of 100 mrem/yr, SRS conservatively combines the airborne pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations.

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

SRS has assessed the potential effects of routine radioactive releases annually since operations began. Since 1972, SRS has published annual offsite dose estimates in Site environmental reports made available to the public. For all routine environmental dose calculations performed since 1978, SRS has used environmental transport models based on 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. At SRS, the MAXDOSE-SR and POPDOSE-SR codes are used for atmospheric releases (representative person and population, respectively) and LADTAP XL© is used for liquid releases.

The *SRS Environmental Dose Assessment Manual* (SRS EDAM 2012) describes these models.

From 1988 through 2009, SRS used the internal and external dose conversion factors provided in DOE [1988]. In 2010, the internal dose conversion factors were updated to use the dose factors from ICRP Publication 72, (ICRP 1995) and the external dose conversion factors were updated to the dose factors provided in *Federal Guidance Report 12*, (EPA 1993). Beginning in 2012, 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 2011a), and 3) the external dose coefficients provided in the DC_PAK3 toolbox, which can be accessed at http://www2.epa.gov/radiation/tools-calculating-radiation-dose-and-risk. Currently, there are no age-specific external dose factors available.

Meteorological Database

SRS uses quality-assured meteorological data from three onsite weather stations for the annual dose calculations.

Potential offsite doses from releases of radioactivity to the atmosphere were calculated with quality-assured meteorological data for A Area, K Area (for combined releases from C Area, K Area, and L Area), and H Area (for combined releases from all other areas). To show compliance with EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations (EPA 2002), only the H-Area meteorological database was used in the calculations because the EPA-required dosimetry code (CAP88 PC version 4.0.1.17), is limited to a single release location.

For the 2014 dose calculations, SRS used the meteorological datasets covering the period 2007 through 2011. Data Table 6-3 shows the 2007-2011 meteorological dataset for H Area. 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%).

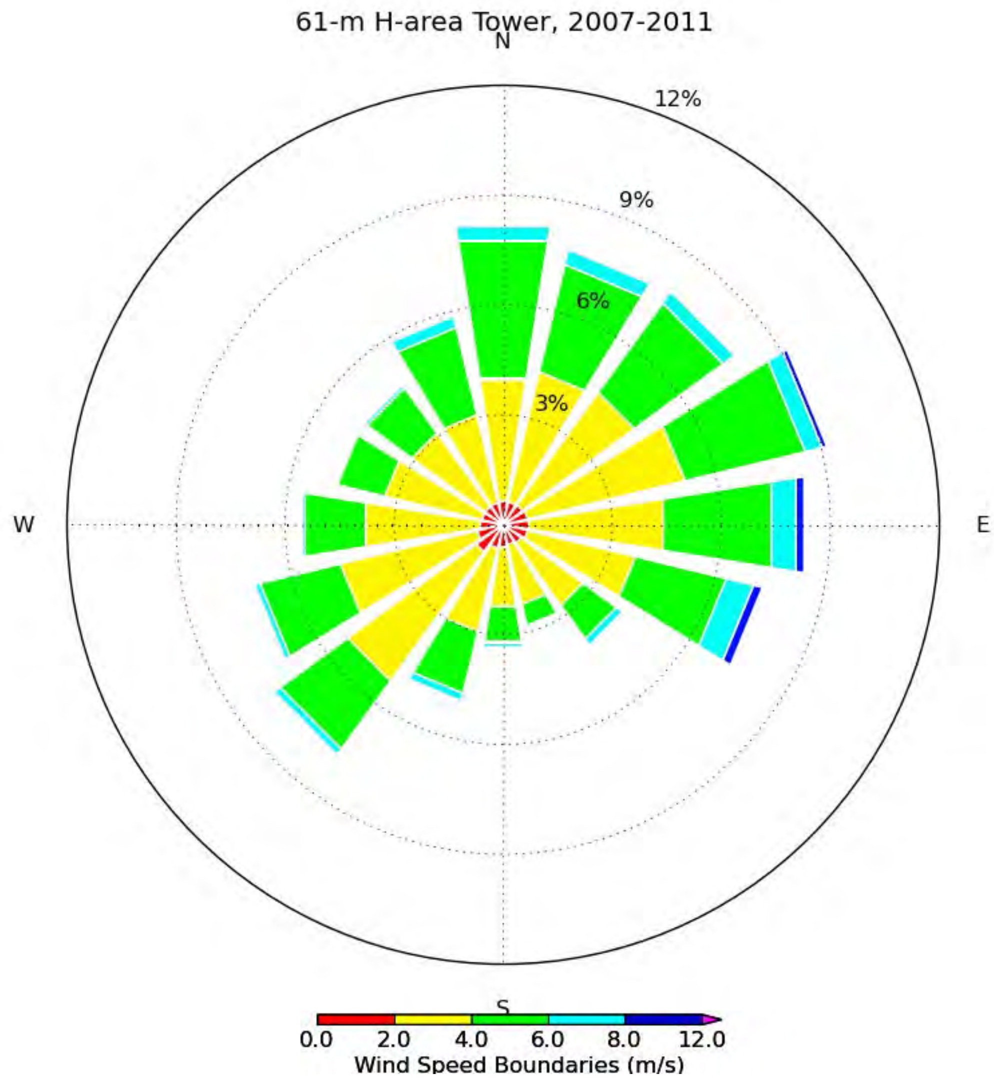


Figure 6-2 2007-2011 Wind Rose for H Area (Direction is toward which the wind blows)

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 an average population density of about 104 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area. Data Table 6-4 shows the population distribution around SRS.

Some of the collective doses resulting from SRS liquid releases are calculated for the populations served by the City of Savannah Industrial and Domestic Water Supply Plant (City of Savannah I&D), near Port Wentworth, Georgia, and for the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea and Purrysburg Water

Treatment Plants, both near Beaufort, South Carolina. According to the treatment plant operators, the population served by the City of Savannah I&D facility during 2014 was 35,000 people, while the population served by the BJWSA Chelsea facility was 82,900 people and by the BJWSA Purrysburg facility, 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).

River Flow Rate Data

Savannah River flow rates are determined using the recorded water elevation at a gauging station near RM 118.8. The river flow rates measured at this location from 1954 through 2014 are provided in Data Table 6-5 and show that the mean river flow rate for these years is 10,014 cubic feet per second (cfs). However, the SRS liquid dose calculations typically do not use these data. Instead, SRS uses "effective" flow rates based on 1) the measured annual release of tritium and 2) the annual average tritium concentrations measured from RM 118.8 and from the downriver water treatment plants. Data Table 6-6 provides the effective river flow rate calculations. The use of effective flow rates in the dose calculations is usually more conservative (that is, it results in higher estimates) than the use of measured flow rates because it accounts for less dilution. However, if SRS calculates an effective flow that is more than the measured value at RM 118.8, then the measured value is used for conservatism.

In 2014, the Savannah River flow rate of 8,531 cubic feet per second (cfs) was 48% more than the 2013 flow rate of 5,752 cfs.

For 2014, SRS used the RM 118.8 calculated (effective) flow rate of 8,531 cfs in the dose calculations. This flow rate is 48% more than the 2013 effective flow rate of 5,752 cfs. For comparison, the 2014 annual average flow rate, as measured by the U.S. Geological Survey (USGS), was 9,440 cfs. The 2014 calculated effective flow rate for the three downriver drinking water plants was 12,480 cfs. This is more than the USGS measured flow rate. Therefore, to be conservative, SRS used the USGS RM 118.8 measured flow rate of 9,440 cfs for these locations.

DOSE CALCULATION RESULTS

Liquid Pathway

Liquid Release Source Terms

Table 6-2 shows, by radionuclide, the 2014 radioactive liquid release quantities used as the source term in SRS dose calculations and Data Table 6-7 shows the liquid releases by Site stream.

Discussions of the sources of these data are in Chapter 4, "Effluent Monitoring," and Chapter 5, "Environmental Surveillance."

Data Table 6-8 provides a five-year history of SRS liquid radioactive releases. Tritium accounts for more than 99% of the total amount of radioactivity released from the Site to the Savannah River.

In 2014, SRS released a total of 701 curies of tritium to the river, a 35% decrease from the 2013 amount of 1,082 curies (see Chapter 5, "Environmental Surveillance" for details).

In 2014, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 2,142 curies of tritium to the Savannah River and 90 curies migrated from the Barnwell Low-Level Disposal Facility (BLLDF) for an overall total of 2,931 curies of tritium (SRS plus VEGP plus BLLDF). This is a small decrease from the combined total of 2,979 curies in 2013.

Table 6-2 2014 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 Chelsea [(b)]	EPA MCL[(d)]
H-3[(c)]	7.01E+02	3.85E+02	2.63E+02	2.00E+04
C-14	6.40E-03	8.41E-04	7.59E-04	2.00E+03
Sr-90	5.36E-02	7.04E-03	6.36E-03	8.00E+00
Tc-99	2.64E-02	3.47E-03	3.13E-03	9.00E+02
I-129	2.45E-02	3.22E-03	2.91E-03	1.00E+00
Cs-137	5.09E-02	6.69E-03	6.04E-03	2.00E+02
U-234	7.22E-02	9.48E-03	8.56E-03	1.03E+01
U-235	3.65E-03	4.79E-04	4.33E-04	4.67E-01
U-238	8.45E-02	1.11E-02	1.00E-02	1.00E+01
Np-237	5.97E-06	7.84E-07	7.08E-07	1.50E+01
Pu-238	3.65E-04	4.79E-05	4.33E-05	1.50E+01
Pu-239	1.56E-04	2.05E-05	1.85E-05	1.50E+01
Am-241	3.36E-03	4.41E-04	3.99E-04	1.50E+01
Cm-244	4.83E-04	6.34E-05	5.73E-05	1.50E+01
Alpha	3.56E-03	4.68E-04	4.22E-04	1.50E+01
Beta	2.87E-02	3.77E-03	3.40E-03	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 Chelsea 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

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

At several locations along the Savannah River, SRS can measure the concentrations of tritium in the river water and cesium-137 in fish. SRS uses these measured concentrations directly in the 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. Therefore, their concentrations in the river are calculated using the LADTAP XL© code, based on the annual release amounts and on the applicable effective flow rate.

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 Chelsea water treatment facility, which is representative of the BJWSA Purrysburg and the City of Savannah I&D water treatment plants. These downriver tritium concentrations include tritium releases from SRS and the neighboring 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.

The 2014 concentrations of tritium at the BJWSA Chelsea and Purrysburg facilities and at the City of Savannah I&D water treatment plants were well below the EPA drinking water MCL of 20,000 pCi/L.

In 2014, the 12-month average tritium concentration measured in Savannah River water near RM 118.8 was 385 picocuries per liter (pCi/L). This reflects a 34% decrease from the 580 pCi/L measured in 2013. Even though the amount of tritium released to the Savannah River from SRS, VEGP, and BLLDF remained about the same in 2014, there was a decrease in the annual average tritium concentration because of the 48% increase in effective river flow from 2013 to 2014. The 2014 concentration (263 pCi/L) measured at the BJWSA Chelsea water treatment plant was proportionately lower than in 2013 and remained well below the EPA drinking water MCL of 20,000 pCi/L.

Table 6-2 indicates that all individual radionuclide concentrations at the three downriver community drinking water systems, as well as at RM 118.8, were below the EPA MCLs. Because SRS releases more than one radionuclide, the sum of the fractions of the reported concentration of each radionuclide divided by its corresponding MCL must not exceed 1.0. As shown in Data Table 6-9, the sum of the fractions for the water treatment plants (determined at the BJWSA Chelsea plant) was 0.020, which is below the 1.0 sum-of-the-fractions requirement.

For 2014, the sum of the fractions at the RM 118.8 location was 0.027. SRS provides this information only for comparison because RM 118.8 is not a community drinking water system location.

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), 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 radioanalysis of the fish collected near RM 118.8, the assumed location of the hypothetical representative person. As shown in Data Table 6-10, the 2014 actual measured concentration of cesium-137 in fish (0.0155 pCi/g) was determined to be less than the dose model calculated concentration in fish. To be conservative, the higher calculated concentration of cesium-137 in fish (0.0201 pCi/g) was used in the 2014 dose determinations.

Dose to the Representative Person

SRS estimated that the 2014 dose to the representative person from all liquid pathways was 0.12 mrem, 14% less than in 2013.

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

As shown in Data Table 6-11, the 2014 dose to the representative person from all liquid pathways including irrigation was estimated at 0.12 mrem (0.0012 mSv), which was about 14% less than the comparable dose in 2013 of 0.14 mrem (0.0014 mSv). SRS attributes this to the 35% decrease in liquid tritium releases from the Site and the increase in effective Savannah River flow rate during 2014. Table 6-3 shows that this total dose is 0.12% of the all-pathway public dose standard of 100 mrem/yr (1 mSv/yr). Data Table 6-12 provides a five-year history of SRS liquid pathway doses.

Table 6-3 Potential Dose to the Representative Person from SRS Liquid Releases in 2014

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.041		
Irrigation Pathways	0.074		
Total Liquid Pathways	0.12	100[a]	0.12

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

Over 64% of the 2014 total dose to the representative person resulted from the irrigation pathway (ingestion of meat, milk, and vegetables). The fish consumption pathway accounted for 24% and the drinking water pathway, 11%. As shown in Figure 6-3, cesium-137 (23%) and technetium-99 (22%) were the major contributors to the total dose (Data Table 6-11).

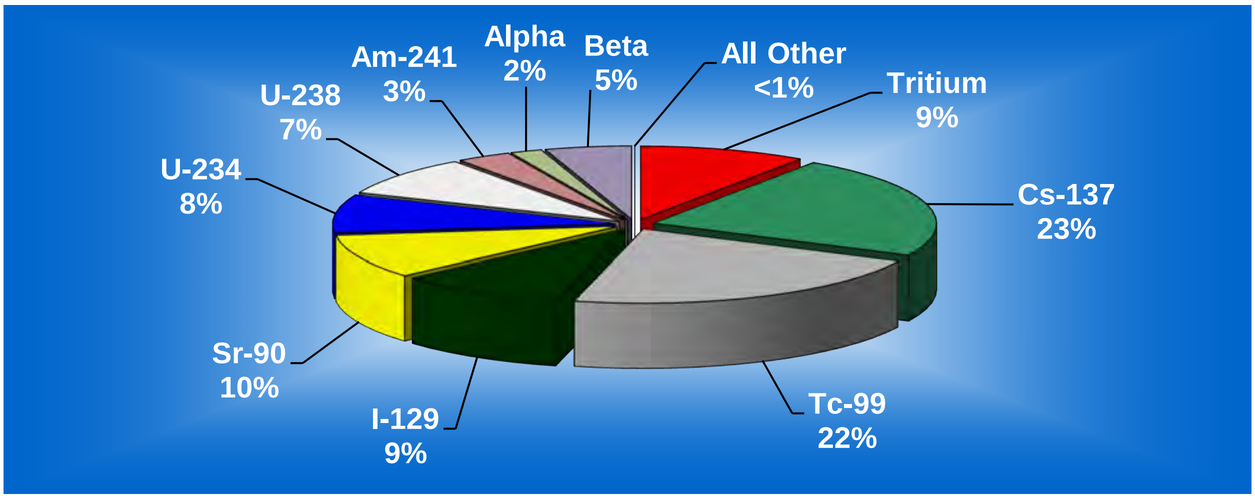


Figure 6-3 Radionuclide Contributions to the 2014 SRS Total Liquid Pathway Dose of 0.12 mrem (0.0012mSv)

Drinking Water Pathway Dose

People living downriver of SRS may receive some dose by consuming drinking water that contains radioactivity released from the Site. Tritium in downriver drinking water represented the majority of the dose (about 53%) received by customers of the three downriver water treatment plants (Data Table 6-13).

Based on SRS-only releases, the maximum potential drinking water dose during 2014 was determined to be 0.011 mrem (0.00011 mSv) (Data Table 6-13). This dose is 35% less than the 2013 dose of 0.017 mrem (0.00017 mSv). There is not a separate drinking water dose standard. Offsite public drinking water systems are regulated by the EPA under 40 CFR 141 (EPA 2000).

Collective (Population) Dose

SRS calculates the collective drinking water consumption dose for the discrete population groups served by the BJWSA and City of Savannah I&D water treatment plants (Data Table 6-14). Calculations of collective doses from agricultural irrigation assume that 1,000 acres of land are devoted to 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.

SRS calculates the collective dose from other pathways for a diffuse population that makes use of the Savannah River; however, this population cannot be described as being in a specific geographical location. As shown in Data Table 6-15, the collective dose from all pathways was 2.0 person-rem (0.020 person-Sv) in 2014. This is 20% less than the comparable 2013 collective dose of 2.5 person-rem (0.025 person-Sv). SRS attributes this to the 35% decrease in liquid tritium releases from the Site and the increase in effective Savannah River flow rate during 2014.

Air Pathway

Atmospheric Source Terms

Chapter 4, "Effluent Monitoring," discusses the 2014 radioactive atmospheric release quantities used as the source term in SRS dose calculations. Data Table 6-16 documents the releases by Site area and Data Table 6-17 provides a five-year history of SRS atmospheric releases. Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required, for demonstrating compliance with EPA regulations.

SRS estimated that the 2014 dose to the representative person from all atmospheric releases was 0.044 mrem.

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 oxide at the Site perimeter locations and compares these results with the calculated concentrations as a verification of the dose models. In Data Table 6-18, this comparison shows that the dose models used at SRS are about two to three times more conservative than the actual measured tritium oxide concentrations.

Dose to the Representative Person

The 2014 estimated dose from atmospheric releases to the representative person (calculated with MAXDOSE-SR) was 0.044 mrem (0.00044 mSv), 0.44% of the DOE Order 458.1 air pathway standard of 10 mrem per year. Table 6-4 compares the representative person dose with the DOE standard. The 2014 dose was about 15% less than the 2013 dose of 0.052 mrem (0.000527 mSv). SRS attributes this decrease to substantial reductions in releases of cesium, strontium, uranium, plutonium, and unidentified alpha and beta emitters. Refer to Data Table 6-17 and to Chapter 4, "Effluent Monitoring" for additional information. A five-year history of SRS air pathway doses is in Data Table 6-12.

Table 6-4 Potential Doses to the Representative Person and to the MEI from SRS Atmospheric Releases in 2014 and Comparison to the Applicable Dose Standard

	MAXDOSE-SR	CAP88-PC NESHAP
Calculated dose (mrem)	0.044	0.031
Applicable Standard	10[a]	10[b]
Percent of Standard (%)	0.44	0.31

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

Data Table 6-19 shows the 2014 atmospheric doses by both radionuclide and pathway. As shown in Figure 6-4, tritium oxide releases accounted for over 91% of the dose to the representative person. Cesium-137 and iodine-129 accounted for 4% and 2%, respectively. No other individual radionuclide accounted for more than 1% of the representative person dose.

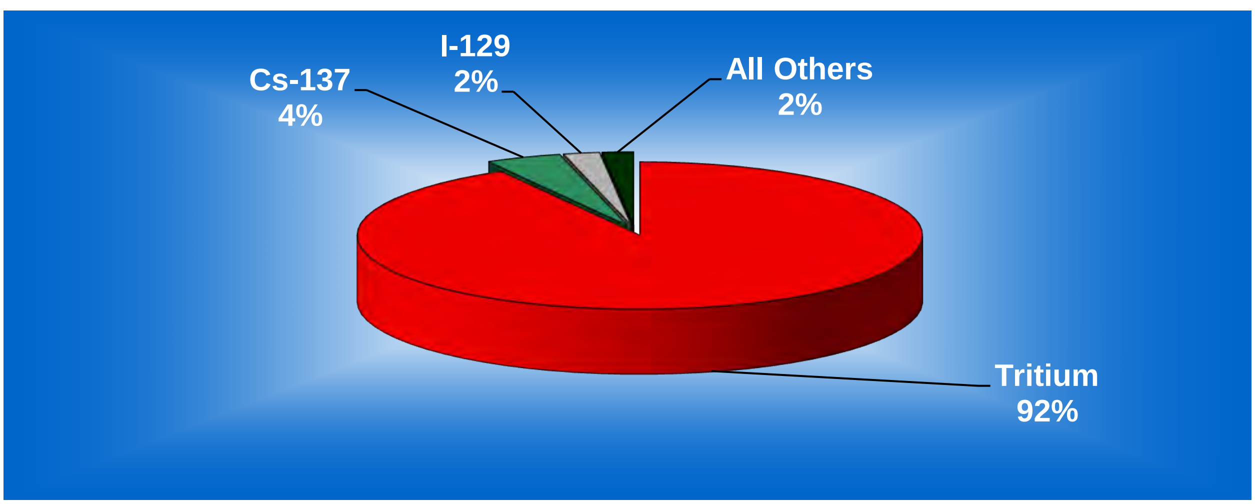


Figure 6-4 Radionuclide Contributions to the 2014 SRS Air Pathway Dose of 0.044 mrem (0.00044 mSv)

The major pathways contributing to the representative person dose from atmospheric releases were inhalation (36%), vegetable consumption (36%), cow milk consumption (24%), and ground shine (4%). As shown in Data Table 6-20 and in Maps Figure 11, the due north sector of the Site was the location of the highest dose to the representative person. Because of the potential in the SRS vicinity for the consumption of goat milk, additional calculations of the dose to the representative person were performed substituting goat milk for the customary cow milk pathway. As shown in Data Table 6-21, SRS estimated that the potential dose to the representative person using the goat milk pathway is 0.049 mrem (0.00049 mSv). SRS provides this dose for reference only.

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.

Data Table 6-4 shows the population distribution around SRS. In 2014, the airborne-pathway collective dose (calculated with POPDOSE-SR) was estimated at 1.7 person-rem (0.017 person-Sv), less than 0.01% of the annual collective dose received from natural sources of radiation (about 234,000 person-rem).

Data Table 6-22 shows the 2014 air-pathway collective doses by radionuclide and pathway. Tritium oxide releases accounted for 89% of the collective dose. The 2014 collective dose was 23% less than the 2013 collective dose of 2.2 person-rem (0.0022 person-Sv). Again, SRS attributes this decrease to substantial reductions in releases of cesium, strontium, uranium, plutonium, and unidentified alpha and beta emitters.

NESHAP Compliance

SRS estimated that the 2014 NESHAP compliance dose (MEI dose) was 0.031 mrem (0.00031 mSv), about 18% less than the 2013 MEI dose.

To demonstrate compliance with NESHAP regulations (EPA 2002), MEI and collective doses were calculated using 1) the CAP88 PC version 4.0.1.17 computer code, 2) the 2014 airborne-release source term (Data Table 6-23), and 3) site-specific input parameters (Data Table 6-24). EPA requires the use of the MEI and does not allow use of the reference person concept at this time. EPA hard codes most of the input parameters in the CAP88 PC program and they cannot be changed without specific EPA approval. The SRS specific parameters used are in Data Table 6-24.

For 2014, SRS implemented the use of CAP88 PC version 4.0.1.17 (version dated September 2014) to demonstrate compliance with EPA's 10 mrem per year (0.1 mSv per year) public dose standard for airborne emissions from DOE sites. For 2014, using the CAP88 PC version 4.0.1.17 code, the MEI dose was estimated at 0.031 mrem (0.00031 mSv), 0.31% of the 10-mrem per year EPA standard, as shown in Table 6-4.

Data Table 6-25 shows the 2014 doses by radionuclide.

Tritium oxide releases accounted for about 79% of the MEI dose and elemental tritium accounted for 10%. The 2014 NESHAP compliance dose (MEI dose) was about 18% less than the 2013 dose of 0.038 mrem (0.00038 mSv). SRS attributes this decrease to substantial reductions in releases of cesium, strontium, uranium, plutonium, and unidentified alpha and beta emitters.

NESHAP regulations require the separate reporting of dose from diffuse and fugitive releases. Data Table 6-26 shows the MEI dose from diffuse and fugitive releases was about 0.0011 mrem (0.000011 mSv) and it accounts for 3.5% of the total 2014 MEI dose. The CAP88 PC-determined collective (population) dose for 2014 was estimated at 4.3 person-rem (0.043 person-Sv), which is 19% less than the 2013 collective dose of 5.3 person-rem (0.053 person-Sv). Tritium releases accounted for nearly 90% and cesium-137 releases accounted for over 6% of the collective dose. Comparisons (by pathway and major radionuclides) of the CAP88 PC-determined MEI and collective doses with the MAXDOSE-SR and POPDOSE-SR representative person doses are provided in Data Tables 6-27 and 6-28, respectively. As shown in Data Table 6-27, the CAP88 PC version 4.0.1.17 code estimates a lower dose for the MEI mainly because of the lower human usage parameters used in the EPA code. However, for the population dose (Data Table 6-28), the CAP88 PC version 4.0.1.17 estimates a higher dose because 1) it assumes the general population has the same inhalation and consumption rates as the maximally exposed individual, and 2) it assumes a one-to-one ratio between tritium oxide in air and tritium oxide in plant leaves, whereas POPDOSE-SR assumes a 50% ratio.

All-Pathway Dose

As stated in the DOE Order 458.1, the all-pathway dose standard is 100 mrem/yr. SRS conservatively combines 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. As previously discussed, the SRS all-pathway liquid dose includes the irrigation pathway dose estimate.

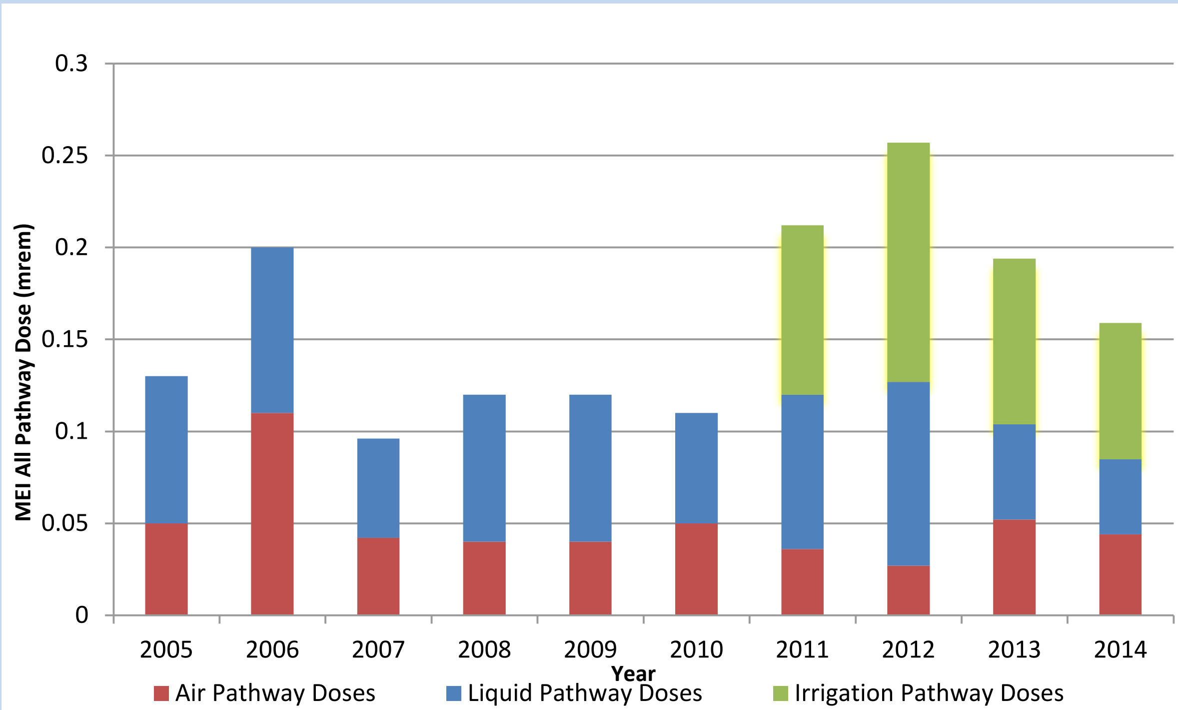
For 2014, the potential representative person all-pathway dose was 0.16 mrem (0.0016 mSv), 0.044 mrem from air pathways plus 0.12 mrem from liquid pathways. The all-pathway dose is 0.16% of the 100 mrem/yr (1 mSv/yr) DOE dose standard.

The 2014 all-pathway dose is about 16% less than the 2013 total dose of 0.19 mrem (0.0019 mSv).

For 2014, the potential representative person all-pathway dose was 0.16 mrem (0.0016 mSv), 0.044 mrem from air pathways plus 0.12 from liquid pathways. The all-pathway dose is 0.16% of the 100 mrem/yr DOE dose standard.

SRS attributes this decrease to 1) the decrease in liquid tritium releases from the Site, 2) the increase in effective Savannah River flow rate during 2014, and 3) the substantial reductions in airborne releases of cesium, strontium, uranium, plutonium, and unidentified alpha and beta emitters.

Figure 6-5 graphically shows a ten-year history of SRS's all-pathway (airborne pathways plus liquid pathways) doses to the MEI/representative person. A five-year history of SRS all-pathway and population doses is in Data Table 6-12.



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 6-5 Ten-Year History of SRS Maximum Potential All-Pathway Doses

Sportsman Dose

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

Onsite Hunter Dose

During 2014, the maximum dose that could have been received by an onsite volunteer hunter was estimated at 18.3 mrem (0.0183 mSv), or 18.3% of DOE's 100 mrem/yr all-pathway dose standard. This dose was determined for an actual hunter who harvested 14 animals during the 2014 hunts.

Deer and Hog Consumption Pathway — Annual hunts, open to the general 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 2014, the maximum dose that could have been received by an onsite hunter was estimated at 18.3 mrem (0.0183 mSv), or 18.3% of DOE's 100 mrem/yr all-pathway dose standard (Table 6-5). This dose was determined for an actual hunter who harvested 14 animals (11 deer and 3 hogs) during the 2014 hunts. For the hunter-dose calculation, SRS conservatively assumes that this hunter individually consumed the entire edible portion, about 369 kilogram (kg) (813 pounds) of the animals that the hunter harvested from SRS in 2014.

Turkey Consumption Pathway — SRS hosts a special turkey hunt during April for hunters with mobility impairments. Hunters harvested 22 turkeys in 2014. The default dose assigned from each turkey was 1.0 mrem (0.01 mSv). One of the hunters harvested four turkeys in 2014, so the maximum potential dose from this pathway was 4.0 mrem (0.04 mSv).

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 low probability assumptions and on the measured average concentration of cesium-137 in all deer (1.29 pCi/g) and hogs (also, 1.29 pCi/g) harvested from SRS during 2014, the potential maximum doses from this pathway were estimated at 3.2 mrem (0.0032 mSv) for both the offsite deer hunter and the offsite hog hunter. Data Table 6-29 documents these dose calculations.

Table 6-5 2014 Representative Person All-Pathways and Sportsman Doses Compared to the DOE All-Pathways Dose Standard

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
Representative Person Dose			
All-Pathways (Liquid Plus Airborne Pathways)	0.16	100	0.16
Sportsman Dose			
Onsite Hunter	18.3	100	18.3
Creek-Mouth Fisherman[b]	0.28	100	0.28
Savannah River Swamp Hunter			
Offsite Hog Consumption	3.2		
Offsite Deer Consumption	3.2		
Soil Exposure[c]	2.9		
Total Offsite Maximum Deer/Hog Hunter Dose	6.1	100	6.1
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.16		
Soil Exposure[d]	0.07		
Total Offsite Fisherman Dose	0.23	100	0.23

[a] **All-pathway dose standard; 100 mrem/yr (DOE Order 458.1)**

[b] **In 2014, the maximum dose to a hypothetical fisherman resulted from the consumption of panfish 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**

Beginning in 2013, a background cesium-137 concentration of 0.5 pCi/g is now subtracted from the onsite average concentrations before calculating the offsite hunter doses. Prior to 2013, the background value was 1.0 pCi/g. The 0.5 pCi/g background concentration is based on the median value determined by South Carolina Department of Health and Environmental Control (SCDHEC) for South Carolina deer from 2008 through 2012 (SCDHEC 2013).

Savannah River Swamp Hunter Soil Exposure Pathway — The potential dose to a recreational hunter exposed to SRS legacy contamination in Savannah River Swamp soil on the privately-owned Creek Plantation in 2014 was estimated using the RESRAD code (Yu et al., 2001 and SRS EDAM 2012). 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.

Using the worst-case radionuclide concentrations from the 2013 comprehensive survey, SRS estimated that the potential dose to a hunter from a combination of 1) external exposure to the contaminated soil, 2) incidental ingestion of the soil, and 3) incidental inhalation of resuspended soil is 2.9 mrem (0.029 mSv).

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 6.1 mrem (0.061 mSv). This potential dose is 6.1% of the DOE 100 mrem/yr all-pathway dose standard.

Offsite Fisherman Dose

For 2014, SRS estimated the maximum potential dose to a creek-mouth fisherman at 0.28 mrem (0.0028 mSv) from the consumption of panfish collected at the mouth of Lower Three Runs.

Creek-Mouth Fish Consumption Pathway — For 2014, radioanalyses were conducted on three species of fish (pan-fish, catfish, and bass) taken from the mouths of four SRS streams. SRS analyzes three composites of up to five fish of each species from each sampling location. Data Table 6-30 shows the resulting estimated doses. An average concentration is reported only when at least one of the three composites has a significant result. SRS reports the maximum dose from this combination of creek-mouth fish. As shown in Table 6-5, SRS estimated the maximum potential dose from this pathway at 0.28 mrem (0.0028 mSv) from the consumption of panfish collected at the mouth of Lower Three Runs. SRS bases this hypothetical dose on the low probability scenario that, during 2014, a fisherman consumed 24 kg (53 lb) of panfish caught exclusively from the mouth of Steel Creek. About 82% of this potential dose was from iodine-129.

Savannah River Swamp Fisherman Soil Exposure Pathway — The potential dose to a recreational fisherman exposed to SRS legacy contamination in Savannah River Swamp soil on the privately-owned Creek Plantation was calculated 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 resuspended soil to be 0.07 mrem (0.007 mSv).

As shown in Table 6-5, the maximum Steel Creek fish consumption dose (0.16 mrem) and the Savannah River Swamp fisherman soil exposure pathway were conservatively added together to obtain a total offsite fisherman dose of 0.23 mrem (0.0023 mSv). This potential dose is 0.23% of the DOE 100 mrem/yr all-pathway dose standard.

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, and SCDHEC.

This plan ensures 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.

Risk Comparisons — For 2014, the maximum potential radiation doses and lifetime fatal and non-fatal cancer risks from the consumption of SRS creek-mouth fish for 1-year, 30-year, and 50-year exposure durations are compared to the radiation risks associated with the DOE Order 458.1 all-pathway dose standard of 100 mrem/yr (1.0 mSv/yr) in Table 6-6. SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (EPA, 1999). The assumed maximum fish consumption rate is 24 kg per year (Table 6-1).

Table 6-6 Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards

	Committed Dose (mrem)	Potential Risk[a]
2014 Savannah River Fish		
1-Year Exposure	0.28	1.4E-07
30-Year Exposure	8.4	4.2E-06
50-Year Exposure	14.0	7.0E-06
Dose Standard		
100 mrem/yr All Pathway		
1-Year Exposure	100	7.3E-05
30-Year Exposure	3,000	2.2E-03
50-Year Exposure	5,000	3.7E-03

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

In 2014, the maximum dose and risk to a hypothetical fisherman resulted from the consumption of panfish from the mouth of Lower Three Runs (Data Table 6-30). Figure 6-6 shows a ten-year history of the annual potential radiation doses from consumption of Savannah River fish. Over the past ten years, there are no apparent trends in these data because of the relatively large variability in the radionuclide concentrations measured in fish from the same location due to differences in the following:

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

At SRS, a program called environmental ALARA (as low as reasonably achievable) is in place to ensure that releases of radioactivity to the environment are maintained below regulatory limits and deliberate efforts are taken to further reduce exposures and releases. It is an approach to radiation protection to manage and control exposures to the work force and to the public to levels as low as reasonable, taking into account social, technical, economic, practical, and public policy considerations. The potential doses and risks from Site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) are as low as reasonably achievable based on these efforts to manage and control radiation (SRS EM Plan 2015).

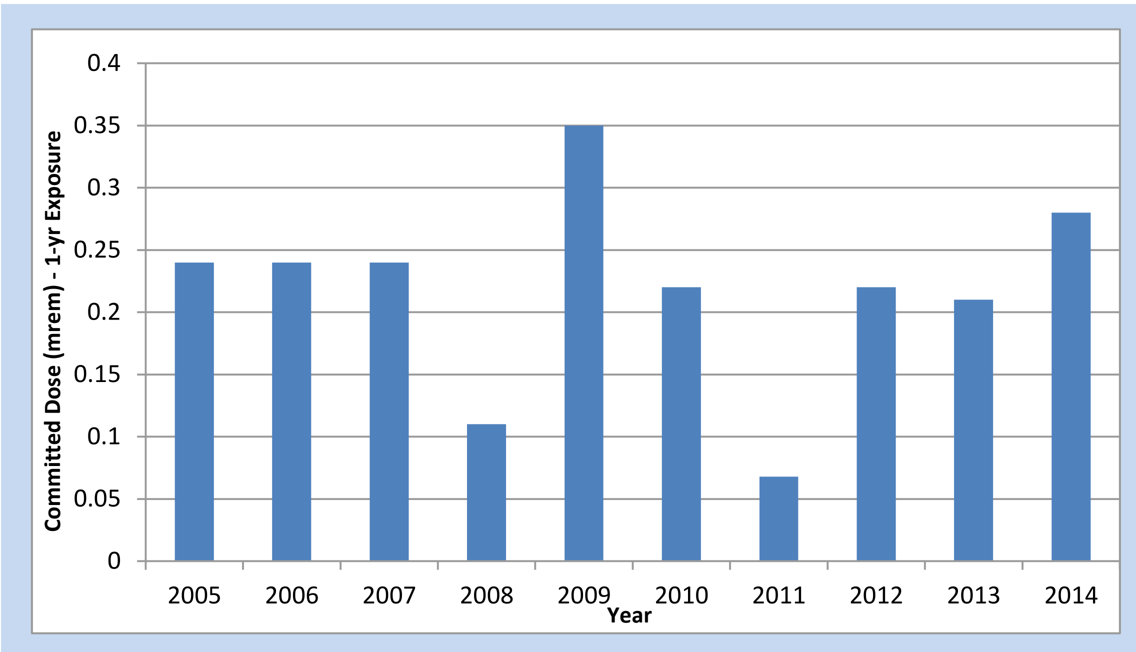


Figure 6-6 Ten-Year History of SRS Creek-Mouth Fisherman's Doses

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 2014, 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).

SRS unconditionally released a total of 5,390 items of personal property from radiological areas in 2014. 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 release criteria.

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 sitewide review to determine the amount of material and equipment released from SRS facilities in 2014.

SRS unconditionally released a total of 5,390 items of personal property from radiological areas in 2014. 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).

SRS has DOE approval to use supplemental limits for releasing material from the Site with no further controls. These supplemental release limits, provided in Data Table 6-31, 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 2014, SRS did not release any material from the Site using the supplemental release limits volume concentration criteria.

DOE prohibits the release of volume-contaminated metals and disallows the release of metals for recycling purposes from DOE radiological areas. SRS released no volume-contaminated metals or metals for recycling purposes during 2014.

These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 458.1.

RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

In addition to human dose assessments, SRS performs annual biota dose assessments. All biota locations passed initial screening; thus, no additional assessments were required.

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).

DOE Biota Concentration Guides

SRS conducts evaluations of biota doses for aquatic and terrestrial systems using the RESRAD Biota model (version 1.5) (SRS EDAM 2012), which directly implements the DOE (2002) guidance.

For aquatic systems, the RESRAD Biota model performs a combined water-plus-sediment evaluation. SRS performed initial screenings in 2014 using maximum radionuclide concentration data from the 13 SRS environmental monitoring stream and sediment sampling locations that are co-located. These screenings determine the biota concentration guide sum of 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.

Data Table 6-32 presents the results of the 2014 biota dose assessment. As shown, all aquatic system locations passed the initial screening and no further assessments were required.

For the terrestrial 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 2014, all terrestrial locations passed their initial pathway screenings (Data Table 6-32).

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7

GROUNDWATER MANAGEMENT PROGRAM

OVERVIEW

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.

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

The SRS monitoring program consists of sampling wells and monitoring contaminant locations. Wells are monitored regularly to meet sampling requirements in the Federal Facilities Agreement (FFA) (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.

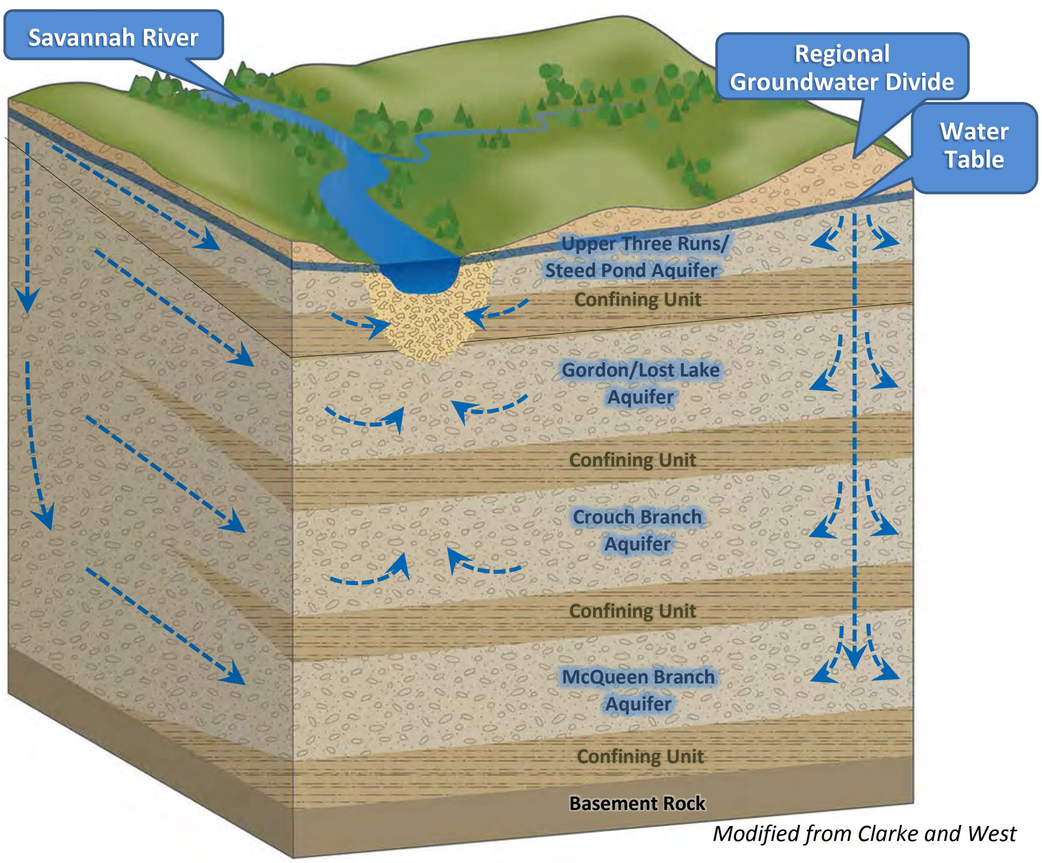
The monitoring data show that the majority of contaminated groundwater is located in the central areas of the SRS and does not extend beyond the SRS boundary. Groundwater contamination at the SRS is primarily limited to the Upper Three Runs/Steed Pond Aquifers and the Gordon/Lost Lake Aquifers (Figure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

The remediation program uses several technologies to remediate groundwater that has unacceptable levels of contaminants (i.e., exceeding maximum contaminant levels [MCLs]). Remediation strategies include closing waste units to reduce the potential for contaminants to reach groundwater and actively treating contaminated water. 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, mainly trichloroethylene (TCE) and tetrachloroethylene (PCE), come from their past use as degreasing agents in industrial operations at SRS. Tritium in groundwater comes from reactor operations, which ceased in 1991. SRS groundwater corrective action operations are successfully removing VOCs from the groundwater and reducing tritium releases from groundwater into SRS streams and the Savannah River using surface water management and phytoremediation (using trees and plants to remove or break down pollutants) technologies.

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, as well as laterally, and eventually discharges 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.



Modified from Clarke and West

Figure 7-1 Groundwater at SRS

> ***Chapter 7 Key Terms***
>
> ***Aquifer*** *is an underground water supply – one found in porous rock, sand, gravel, etc.*
>
> ***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.*
>
> ***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.*
>
> ***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.*

GROUNDWATER PROTECTION PROGRAM AT SRS

SRS has designed and implemented a groundwater protection program to clean up past groundwater contamination and 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
- Using SRS groundwater.

Protecting SRS Groundwater

SRS is committed to preventing pollutants from impacting groundwater. Groundwater related activities focus on preventing groundwater contamination, protecting the public and environment from past contamination, and protecting groundwater quality for future use. A variety of activities contributes to this endeavor, including:

- Prevention or control of groundwater contamination sources from construction sites and hazardous waste management facilities;
- Groundwater and surface water monitoring programs to detect contaminants; and
- Reduction of contaminants via a groundwater cleanup program.

Monitoring SRS Groundwater

The purpose of monitoring groundwater is to observe and evaluate the changes in the groundwater quality over time, and 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 on a regulatory-approved frequency 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:

- Compliance with environmental regulations and DOE directives,
- Evaluation of the current status of groundwater plumes,
- Evaluation of the suitability of a new facility location to ensure facilities are not cited above contaminated groundwater plumes, and
- Basic and applied research projects to enhance groundwater remediation.

Groundwater Contaminant Source Monitoring

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 is the best way to detect and track groundwater contamination so SRS can implement appropriate remedial or corrective actions. Figure 7-3 shows the groundwater plumes associated with SRS.

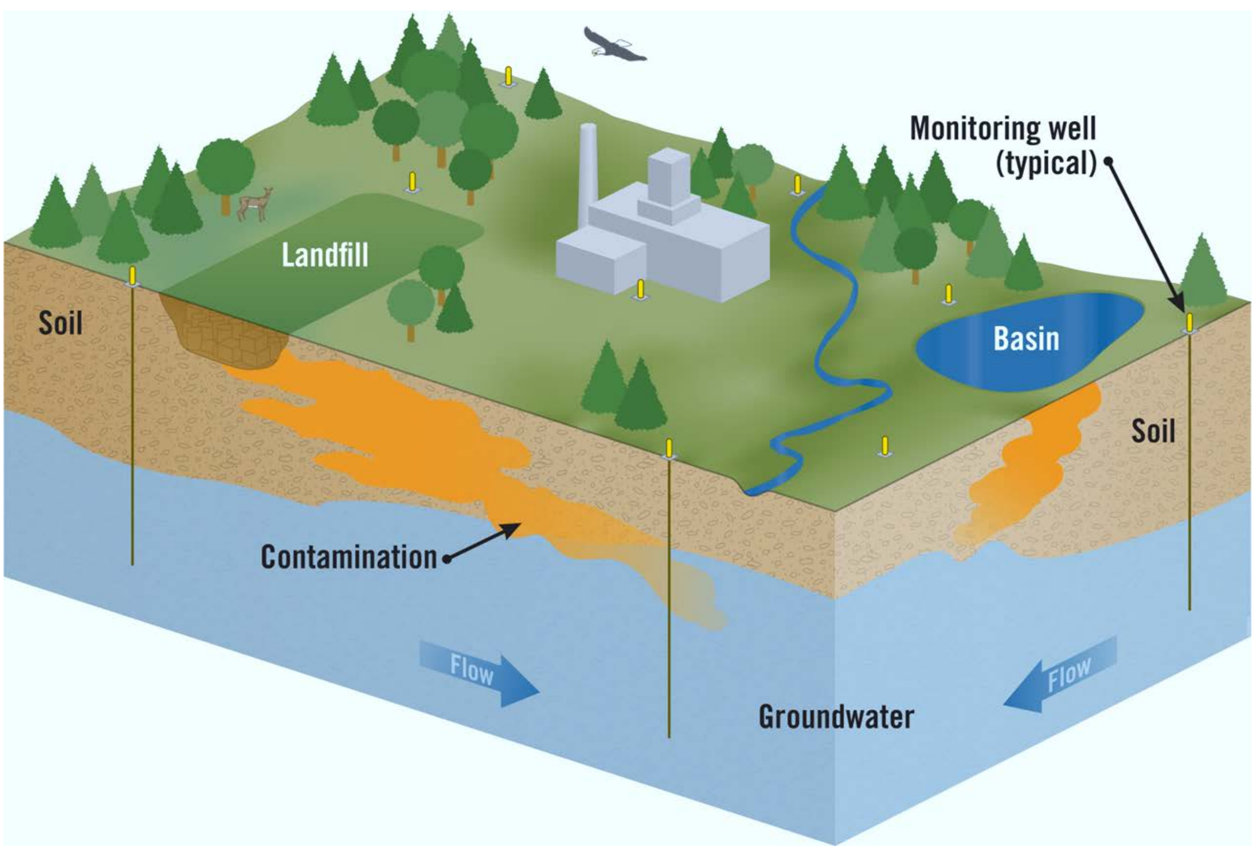


Figure 7-2 How Contamination Gets to Soil and Groundwater

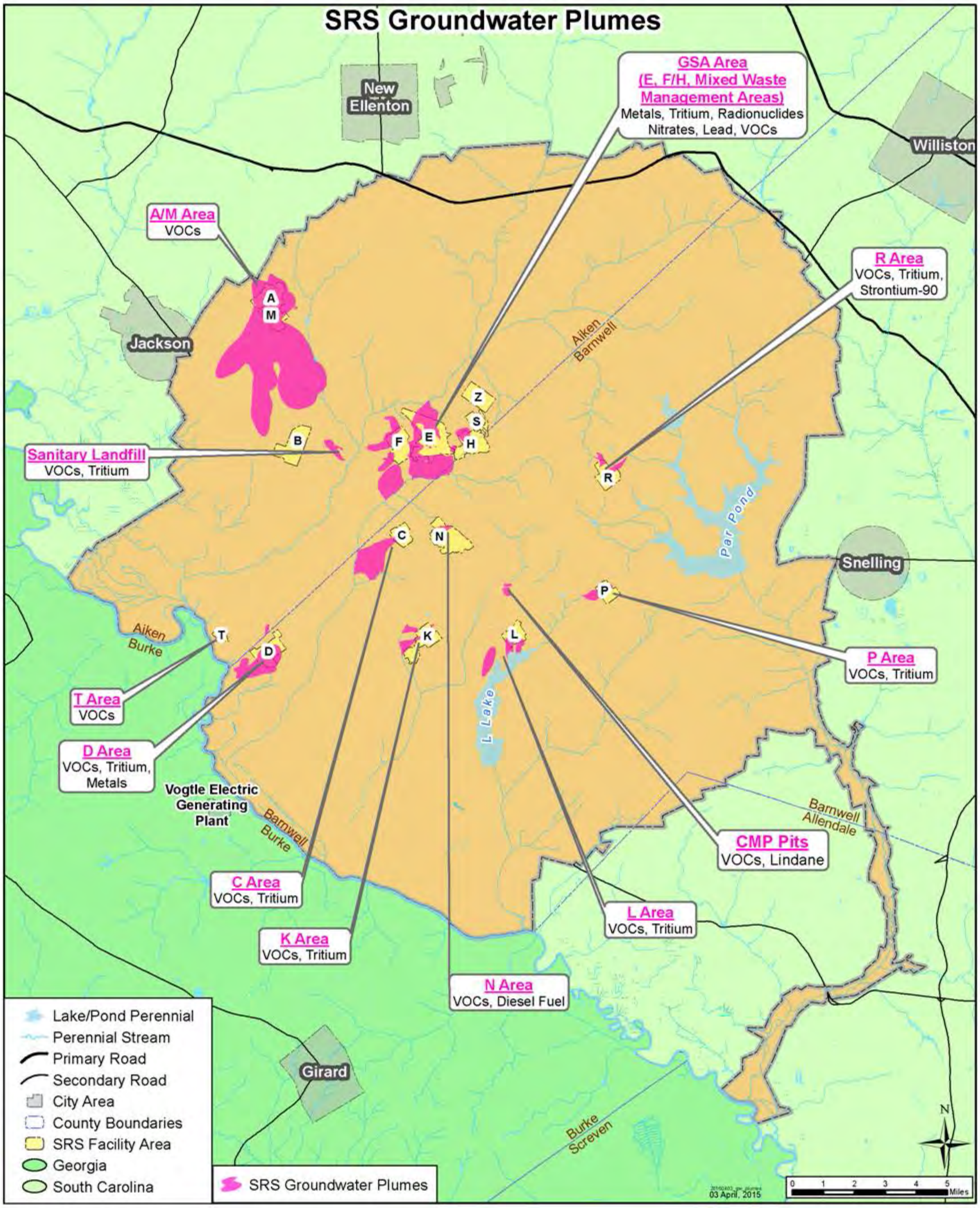


Figure 7-3 Groundwater Plumes at SRS

Results Summary

In 2014, there were no exceedances of drinking water standards in the groundwater wells near the Site boundary.

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, and between A/M Areas and the nearest population center, Jackson, South Carolina (Figure 7-4). The 2014 data show no exceedances of drinking water standards in the groundwater in these wells. In the majority of these wells located near the SRS boundary, 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. In some instances, Site geology allows groundwater to outcrop into nearby streams. SRS monitors, evaluates, and remediates groundwater contamination that outcrops into Site streams, as appropriate. In conjunction with stream monitoring, SRS conducts extensive monitoring adjacent to and near SRS waste units and operating facilities, regardless of their proximity to the boundary. You will find details concerning groundwater monitoring and conditions at individual sites 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 2 (SRS EM Plan 2015).

Table 7-1 describes the common contaminants of concern at SRS and their significance. Table 7-2 presents a general summary of the most common contaminants found in groundwater at SRS facility areas, based on 2014 monitoring data, and compares the maximum concentrations to the appropriate drinking water standards. As shown in Table 7-2, major contaminants of concern in the groundwater include common degreasers (TCE and PCE) and radionuclides (tritium, gross alpha, and nonvolatile beta emitters).

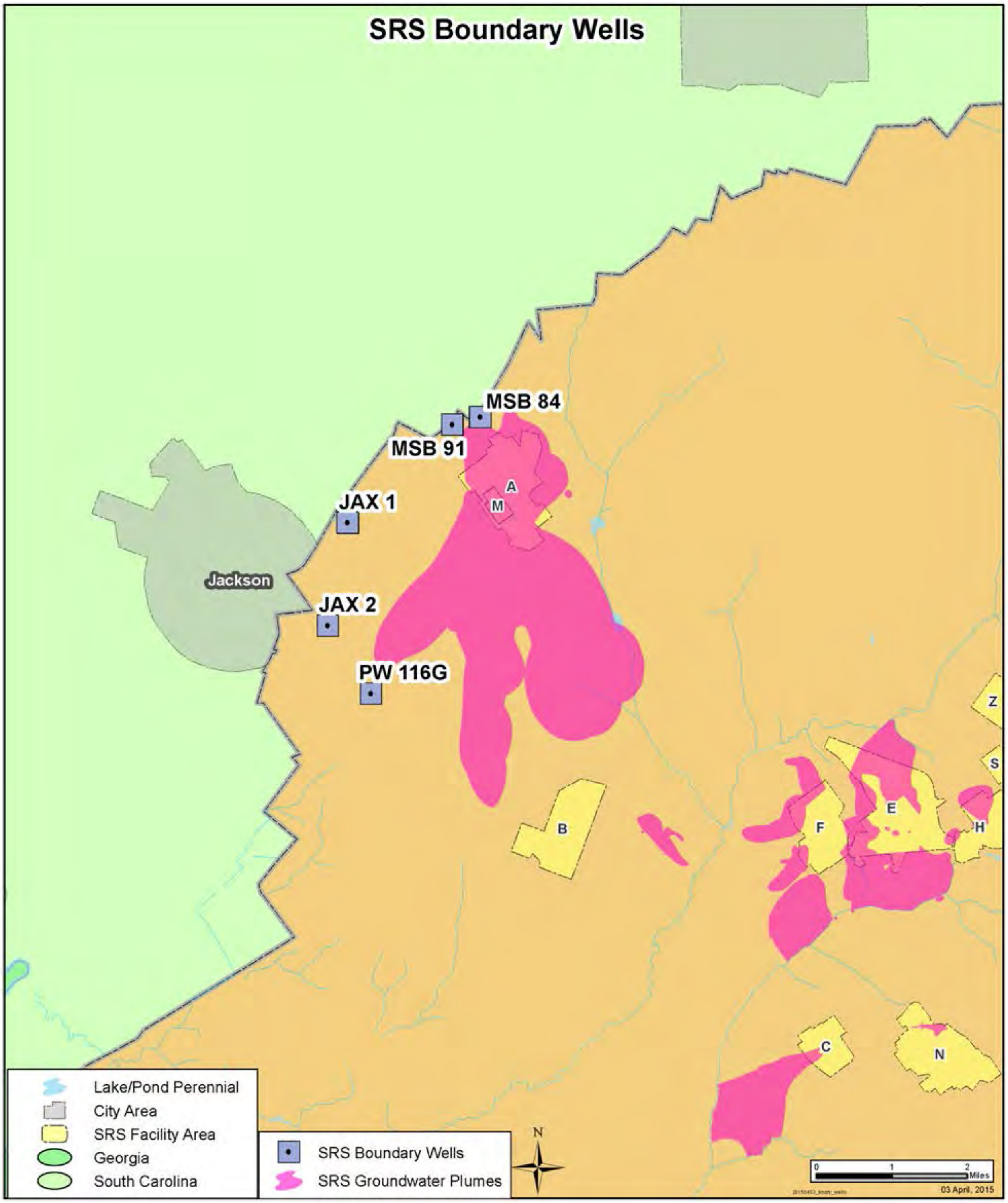


Figure 7-4 Location of Site Boundary Wells at SRS - Between A/M Areas and Jackson, South Carolina (Nearest Population Center)

Table 7-1 Contaminants of Concern at SRS and Their Significance

Contaminants	Sources	Significance
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.	Gross alpha has a primary drinking water standard of 15 pCi/L. An alpha particle cannot penetrate a piece of paper or human skin, but is very dangerous when ingested or inhaled.
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.
Tritium	Radioactive isotope of hydrogen with a half-life of 12.3 years. It emits a very weak beta particle and behaves like water.	Tritium has a MCL of 20 pCi/mL. It primarily enters the body when people swallow tritiated water. Causes increased risk of cancer.
TCE/PCE	Volatile organic compounds used primarily to remove grease from fabricated metal parts.	TCE/PCE have an MCL of 5 µg/L. Causes increased risk of cancer.
Vinyl Chloride	Volatile organic compound; degradation product of TCE/PCE.	Vinyl chloride has an MCL of 2 µg/L. Causes increased risk of cancer.

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

Location	Major Contaminant	Units	2014 Maximum Concentration	Well	Drinking Water Standard	Likely Discharge Point
A/M Area	Tetrachloroethylene	µg/L	150,000	MSB002BR	5	Tims Branch/Upper Three Runs in Swamp in West
	Trichloroethylene	µg/L	48,300	MSB107B	5	
	Vinyl Chloride	µg/L	7.4	MSB 23BR	2	
C Area	Tetrachloroethylene	µg/L	8	CRP 5C	5	Fourmile Branch and Castor Creek
	Trichloroethylene	µg/L	1,500	CRP 20CU	5	
	Tritium	pCi/mL	3,570	CTA003D	20	
CMP Pits (G-Area)	Tetrachloroethylene	µg/L	680	CMP 45D	5	Pen Branch
	Trichloroethylene	µg/L	315	CMP 10C	5	
	Lindane	µg/L	4.7	CMP 35D	0.2	
D Area	Tetrachloroethylene	µg/L	18	DCB 45C	5	Savannah River Swamp
	Trichloroethylene	µg/L	250	DCB 62	5	
	Vinyl Chloride	µg/L	74.9	DOB 11	2	
	Tritium	pCi/mL	220	DCB 26AR	20	
E Area (MWMF)	Trichloroethylene	µg/L	330	SWP 1C	5	Upper Three Runs/ Crouch Branch in North; Fourmile Branch in South
	Tritium	pCi/mL	22,500	BSW 3D2	20	
	Gross Alpha	pCi/L	46.1	BSW 3D2	15	
	Nonvolatile Beta	pCi/L	61.3	HSP-097B	4 mrem/yr[a]	
F Area	Trichloroethylene	µg/L	28	FGW005C	5	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
	Tritium	pCi/mL	42.6	FGW0012C	20	
	Gross Alpha	pCi/L	1,440	FGW005C	15	
	Nonvolatile Beta	pCi/L	518	FGW005C	4 mrem/yr[a]	
F-Area (HWMF)	Trichloroethylene	µg/L	24.2	FSB 78C	5	Fourmile Branch
	Tritium	pCi/mL	2,370	FSB 94C	20	
	Gross Alpha	pCi/L	599	FSB 94C	15	
	Nonvolatile Beta	pCi/L	1,650	FSB 95DR	4 mrem/yr[a]	
	Manganese	µg/L	2,990	FSB126D	430	

Table 7-2 Summary of the Maximum Concentrations of Contaminants for Major Areas within SRS (continued)

Location	Major Contaminant	Units	2014 Maximum Concentration	Well	Drinking Water Standard	Likely Discharge Point
F-Area Tank Farm	Tritium	pCi/mL	81.3	FTF030D	20	Fourmile Branch
	Nonvolatile Beta	pCi/L	921	FTF 28	4 mrem/yr[a]	
	Manganese	µg/L	697	FTF009R	430	
H Area	Trichloroethylene	µg/L	6.77	HGW 2D	5	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
	Gross Alpha	pCi/L	33.3	HAA 15A	15	
	Nonvolatile Beta	pCi/L	70.5	HAA 15A	4 mrem/yr[a]	
	Tritium	pCi/mL	28.3	HGW2D	20	
H-Area (HWMF)	Trichloroethylene	µg/L	69.1	HSB120C	5	Fourmile Branch
	Tritium	pCi/mL	4,180	HSB 65D	20	
	Gross Alpha	pCi/L	42.2	HSB102D	15	
	Nonvolatile Beta	pCi/L	589	HSB102D	4 mrem/yr[a]	
H-Area Tank Farm	Tritium	pCi/mL	79	HAA 12C	20	Fourmile Branch
	Gross Alpha	pCi/L	15.5	HAA 4D	15	
	Manganese	µg/L	744	HAA017C	430	
K Area	Tetrachloroethylene	µg/L	11	KRP 9	5	Indian Grave Branch
	Trichloroethylene	µg/L	8.9	KRP 9	5	
	Tritium	pCi/mL	7,200	KRB 19D	20	
L Area	Tetrachloroethylene	µg/L	62	LSW 25DL	5	L-Lake
	Trichloroethylene	µg/L	6.2	LAC 8DL	5	
	Tritium	pCi/mL	650	LSW 25DL	20	
P Area	Trichloroethylene	µg/L	13,900	PMP006DL	5	Steel Creek
	Tritium	pCi/mL	16,400	PSB002C	20	
R Area	Trichloroethylene	µg/L	12	RAG008DL	5	Mill Creek in Northwest; Tributaries of PAR Pond
	Tritium	pCi/mL	795	RPS004C	20	
	Strontium-90[b]	pCi/L	NA	NA	8	
Sanitary Landfill	1,4-Dioxane	µg/L	280	LFW 62C	6.1	Upper Three Runs
	Trichloroethylene	µg/L	10.5	LFW 32	5	
	Vinyl Chloride	µg/L	42	LFW 21	2	
TNX	Trichloroethylene	µg/L	146	TBG 3	5	Savannah River Swamp
Z-Area	Technetium-99	pCi/L	173	ZBG 2	4 mrem/yr[a]	Upper Three Runs
	Nonvolatile Beta	pCi/L	110	ZBG 2	4 mrem/yr[a]	

[a] The activity (pCi/L or pCi/mL) equivalent to 4 mrem/yr varies according to which specific beta emitters are present in the sample.
[b] At R Area, strontium-90 is sampled for every five years per agreement with state and federal regulators.
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

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 delineate extent of contamination;
- Obtaining geologic soil cores or seismic profiles to better delineate subsurface structural features, as warranted;
- Installing wells for periodic collection of water-level measurements and groundwater samples;
- Developing maps to help define groundwater flow in the subsurface;

- Performing various types of tests to obtain in situ estimates of hydraulic parameters in order to estimate groundwater velocities;
- Analyzing regional groundwater to provide a comprehensive understanding of SRS groundwater movement and the transport of contaminants near facilities and individual waste units; and
- Characterizing regional surface water flow to assess contaminant risk to perennial streams, the receptors of groundwater discharge.

Since the early 1990s, SRS has directed considerable effort at 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 wells in Georgia (Figure 7-5), collecting samples on an annual basis during the third or fourth quarter of the year (Data Table 7-1). Detections of tritium in groundwater in these offsite wells in GA have been below 1.5 pCi/mL since 1999 (Figure 7-6). The MCL, or drinking water standard, for tritium is 20 pCi/mL. Tritium concentrations of 1 pCi/mL or less are due to atmospheric fallout from nuclear weapons testing conducted in the 1950s. These results are consistent with aquifer recharge from rainfall in the Central Savannah River Area. The overall trend of the data continues to show a gradual decline in levels of tritium in the groundwater samples collected in Georgia.

For the past 15 years, detections of tritium in Georgia groundwater monitoring wells have been well below drinking water standards.

SRS collected groundwater samples from 42 of the 44 offsite wells during 2014. One well was not sampled because it was dry (i.e., no water available) and one well could not be sampled due to damage to the well casing. Of the 42 samples collected in 2014, 41 had no detectable concentrations of tritium. Tritium was detected in one sample at concentrations below 1 pCi/mL (0.598 pCi/mL), which is below the MCL of 20 pCi/mL for tritium.

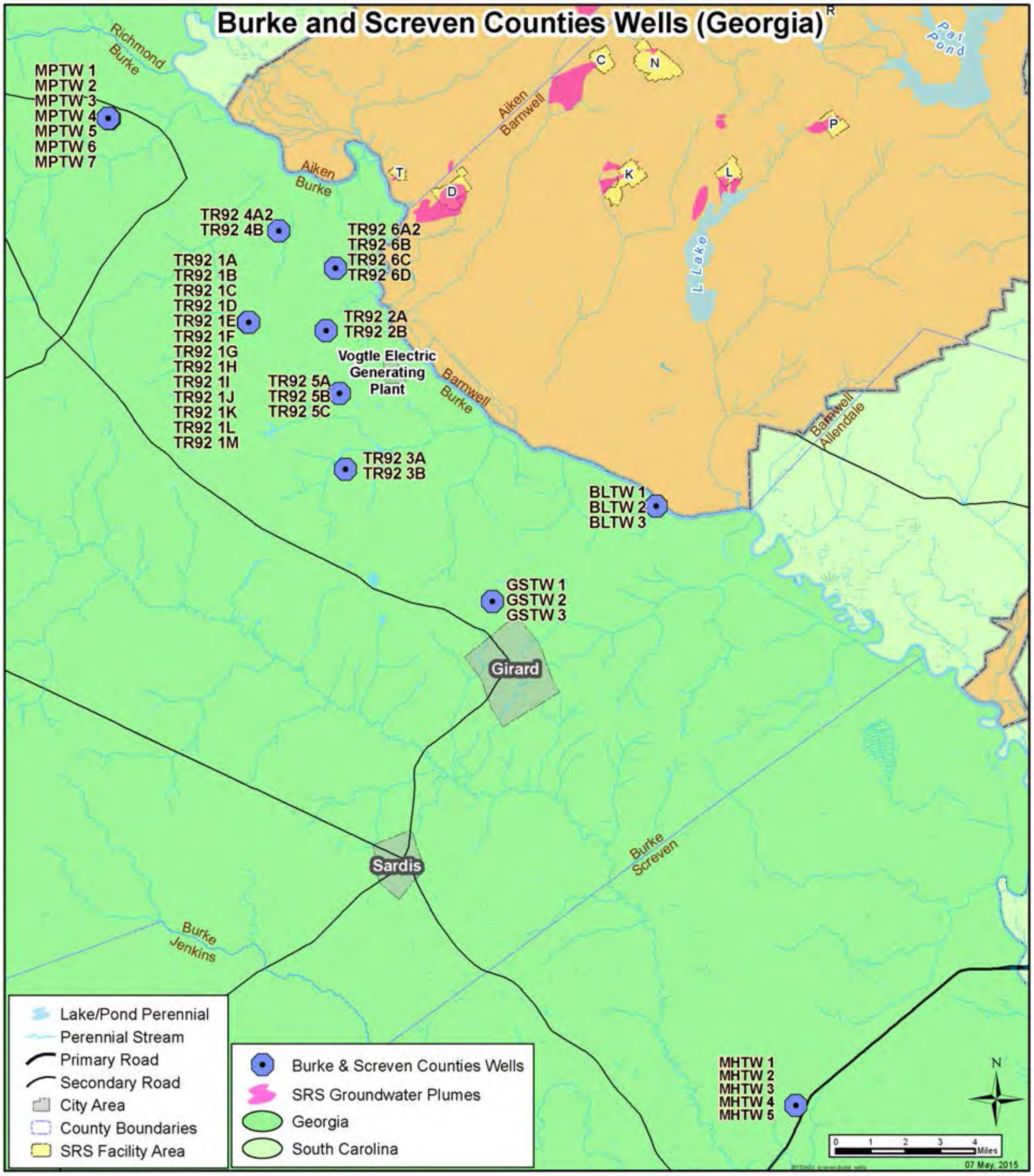


Figure 7-5 Location of Tritium Wells Sampled in Burke and Screven Counties, Georgia

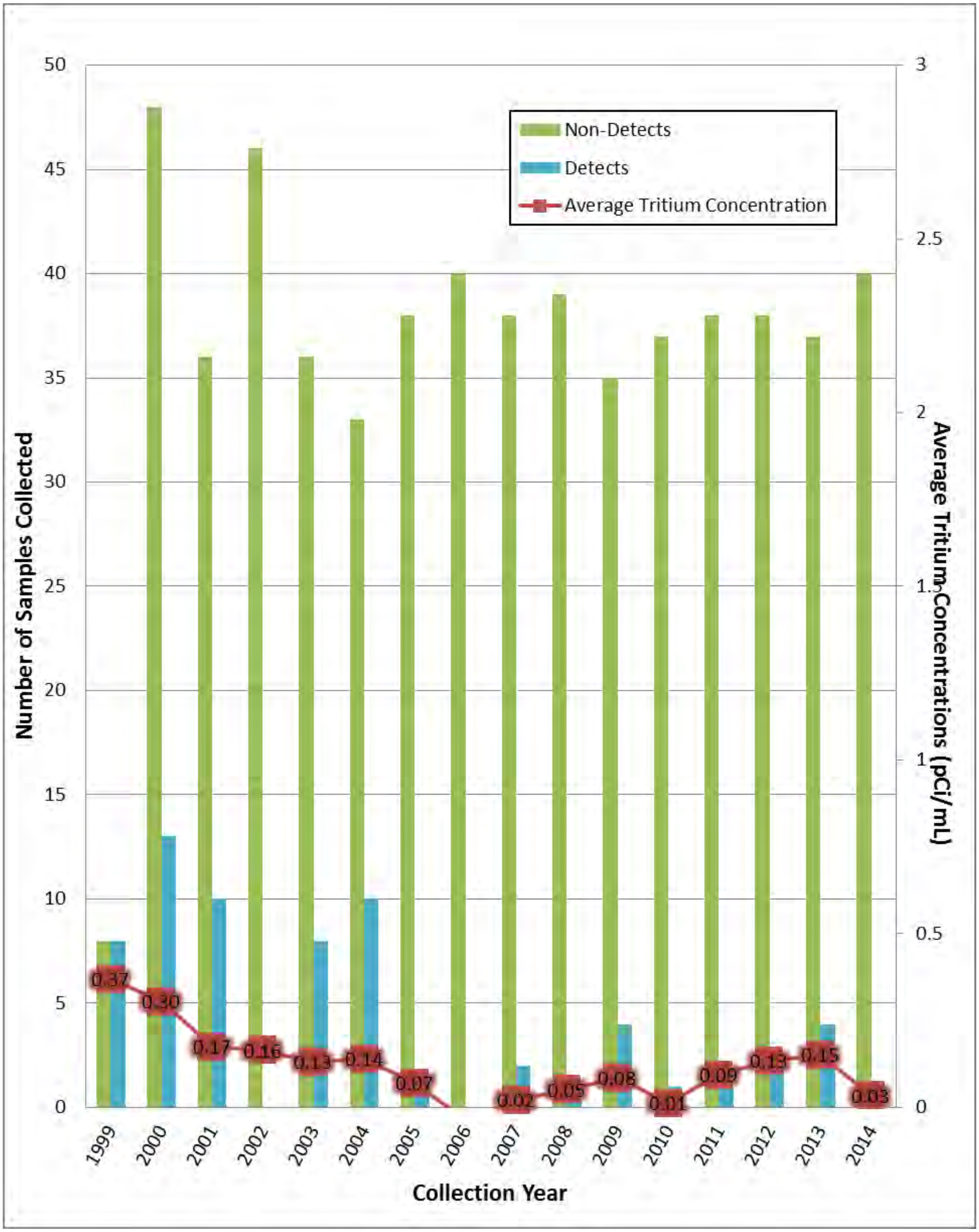


Figure 7-6 Tritium Concentration in Wells Sampled in Burke and Screven Counties, Georgia

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 *Savannah River Site Federal Facility Agreement* (FFA) (FFA 1993).

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

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

In 2014, SRS removed 6,136 lbs of VOCs and 203 curies of tritium from groundwater.

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-eight remediation systems are currently operating. Seventeen groundwater treatment systems are no longer in use. In 2014, SRS removed 6,136 lbs of VOCs and 203 curies of tritium from the groundwater. 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).

Conserving SRS Groundwater

As in the past, SRS continues to report its water usage to SCDHEC. SRS used 3.11 million gallons of water per day in 2014. 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. The Site water systems do not use any contaminated water. 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 supplying drinking water. The other 32 wells provide water for all SRS facility operations. A map of the SRS domestic water system can be found in the "Environmental Data/Maps-2014" folder on the *SRS Environmental Report for 2014* 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 of the A-Area water system for bacteriological analyses occurs monthly. SCDHEC performs sanitary surveys every two years on the A-Area system and inspects the smaller systems every three years. All 2014 water samples complied with SCDHEC and EPA water quality standards.

The process water systems are located in A, F, H, and S Areas and 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.

SUMMARY OF SRS GROUNDWATER MANAGEMENT

At SRS, hazardous and radionuclide contaminants released to the ground over many years has reached the groundwater. Because of these past releases, SRS operates extensive groundwater monitoring and groundwater remediation programs. SRS monitors for hazardous contaminants including trichloroethylene (TCE) and tetrachloroethylene (PCE) and radioactive contaminants including tritium, strontium-90, and technetium-99. Major groundwater remediation activities at SRS focus on volatile organic compounds (VOCs) and tritium. Monitoring well data shows that the majority of contaminated groundwater is located in the central areas of the SRS and does not affect areas beyond the boundaries of SRS.

SRS has implemented and is implementing several groundwater remedial technologies. Thirty-eight remediation systems are currently operating. In 2014, SRS removed 6,136 lbs of VOCs and 203 curies of tritium from the groundwater. 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. SRS continues cleanup activities to restore groundwater to beneficial use and prevent any further exposure to contaminants.

SRS continues to monitor for tritium in groundwater wells in Georgia. Tritium concentrations in these wells are far below the EPA safe drinking water limit. There is no evidence the tritium came from SRS. The tritium detected in these wells is due to atmospheric fallout from nuclear weapons testing conducted in the 1950s.

SRS operates onsite water treatment facilities that supply most of the drinking water at SRS. All samples collected from these systems in 2014 met the state of South Carolina and EPA chemical water quality standards.

You will find details concerning the integrated program for groundwater protection, management, monitoring, and restoration at SRS in the *Savannah River Site Groundwater Protection Program* (SRNS 2012).

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8

QUALITY ASSURANCE

OVERVIEW

The Quality Assurance (QA)/Quality Control (QC) program at the Savannah River Site (SRS) ensures that environmental data accurately represent SRS discharges and the surrounding environment. 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.

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 is comprised of 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 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 presents a summary of improvements identified through QA activities and a summary of performance identified through QC efforts conducted to monitor the performance of the sampling events and the analytical laboratories that support the environmental monitoring program. 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 U.S. Department of Energy Consolidated Audit Program (DOECAP) focuses on the assessment of specific QA/QC program elements. Those elements of Figure 8-1 discussed in this chapter are highlighted in bold text.

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.

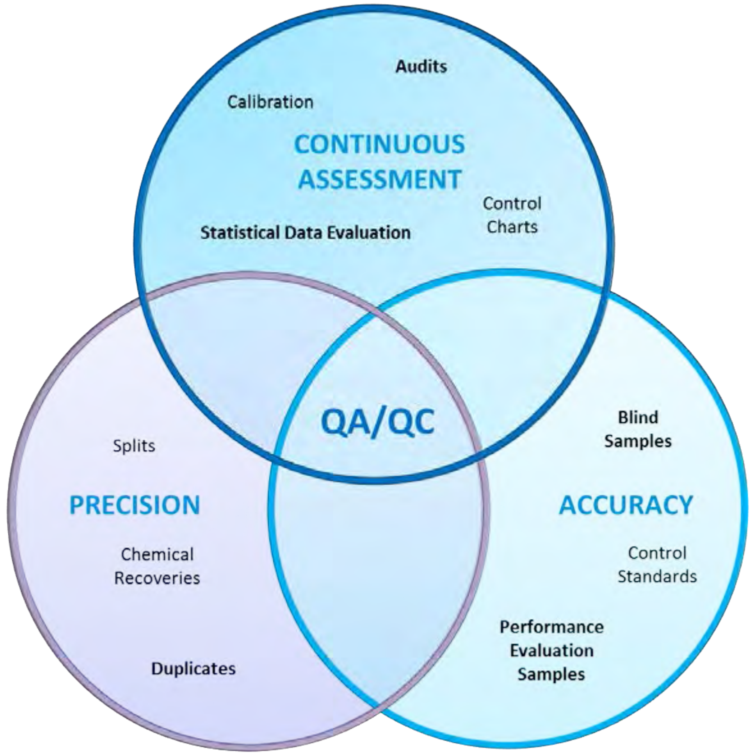

Figure 8-1 Interrelationship of QA/QC Activities

The data tables identified in this chapter are located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2014* on the SRS website.

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 provide a representative evaluation of SRS operational impacts on the health and safety of the public, workers, and the environment.

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.

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 of the problem and changes the process to eliminate the problem and improve product quality.

QA activities focus on the processes implemented to produce the data presented in this report. In 2014, QA efforts associated with the environmental monitoring program that resulted in program improvements were:

- Sample planning and data collection changes,
- Recertification of one 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 2014, these QC activities associated with the environmental monitoring program included:

- Participation in the Mixed Analyte Performance Evaluation Program (MAPEP) by laboratories used by SRS,
- 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.

ENVIRONMENTAL MONITORING PROGRAM QA ACTIVITIES

SRS uses laboratories certified by the SCDHEC Office of Environmental Laboratory Certification for those environmental monitoring program parameters that are reportable to SCDHEC.

In 2014, SRS began storing sample planning, collection, and analytical information in a single database. The transition to a single database for all information and data associated with the environmental samples reduces potential data entry errors; thus, improving reporting integrity. This streamlining of recording data helps maintain the overall quality of the SRS environmental monitoring program.

SRS uses South Carolina Department of Health and Environmental Control (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 2014, SCDHEC performed a recertification evaluation of the Waste Treatment Plant Laboratory, and renewed the certification for another 3 years.

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.

In 2014, 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 DOE.

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 2014, 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 DOE or SRS. There were 30 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 2014. 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. Additionally during the 2014 audit, the audit team was able to verify that the corrective actions that addressed most of the findings identified during the 2013 audit were satisfactory, thereby closing 24 of the 30 Priority II findings. Six Priority II findings from the 2013 audits remain open. Auditors will address these open findings during the 2015 audit. Each of the three laboratories have at least one 2013 Priority II finding that remain open.

ENVIRONMENTAL MONITORING PROGRAM QC ACTIVITIES

QC Sampling

SRS personnel collect several types of QC samples, including blinds and field duplicates, 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. Twenty-three of the twenty-four 2014 blind sample analyses were within the acceptable

The results of the 2014 quality control samples identified no defects affecting the analytical results of the surveillance and monitoring programs.

limit of less than a 0.4 pH unit difference between the original and blind samples. Though results for the pH blinds sampling program indicate there were some differences between blind sample results, there was no impact on conclusions made with the data. A blind sample is a sample with a composition known to the submitter, but not to the analyst. Analysis of blind samples tests the analyst's proficiency in performing the specified analysis. Data Table 8-1 contains the results of the blind pH samples.

The results of SRS onsite and subcontract laboratory blind and duplicate sample analyses associated with the NPDES program, as summarized in Table 8-1, indicate that although there were some differences, there were no consistent problems with the laboratory sample analyses during 2014. Data Tables 8-2 and 8-3 contain the field blind and duplicate sample program results.

SRS's water quality 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 2014, 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 with Difference > 20%
NPDES Blind	70	1
NPDES Duplicate	80	1
Water Quality River/Stream Duplicate	603	37

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. Potential reasons for duplicate results to differ may include the precision of the analytical instruments, results close to the detection limit of the analytical instruments, and original and duplicate samples collected by different samplers. Data Table 8-4 contains detailed SRS stream and Savannah River field duplicate sample results.

Laboratory Proficiency Testing

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

Onsite and subcontract laboratories reported acceptable proficiency and maintained SCDHEC certification for all analyses.

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 testing providers accredited by the American Association of Laboratory Accreditation. During 2014, the onsite and subcontract laboratories participated in various water pollution performance evaluation studies. The onsite and subcontract laboratories reported acceptable proficiency testing results for an average 98.9% and 97.8% of the parameters tested, respectively; therefore, maintaining 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 2014. The SRS Environmental Bioassay Laboratory participated in both studies with 98.6% and 100% acceptable results for all four matrices. MAPEP results for SRS subcontract laboratories were also satisfactory, with an average percent of passing parameters of 98.1% for water matrix and 96.1% for soil matrix. The laboratories evaluate the cause of the failed analyses and develop corrective actions, which may include sample preparation or analytical procedure modifications, to prevent a recurrence.

A Laboratory Technician Prepares Samples for Analysis

APPENDIX A: ENVIRONMENTAL SURVEILLANCE MEDIA AND SAMPLING FREQUENCIES

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	✓				✓

Media		Sampling Frequency				
		Weekly	Bi-Weekly	Monthly	Quarterly	Annually
Sediment	Measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed					✓
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					✓

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 B: RADIONUCLIDE NOMENCLATURE

Nomenclature and Half-Life for Radionuclides					
Radionuclide	**Symbol**	**Half-life[a,b]**	**Radionuclide**	**Symbol**	**Half-life[a,b]**
Actinium-228	Ac-228	6.15 h	Iodine-129	I-129	$1.57x10^7$ y
Americium-241	Am-241	432.7 y	Iodine-131	I-131	8.023 d
Americium-243	Am-243	$7.37x10^3$ y	Iodine-133	I-133	20.8 h
Antimony-124	Sb-124	60.20 d	Krypton-85	Kr-85	10.76 y
Antimony-125	Sb-125	2.758 y	Lead-212	Pb-212	10.64 h
Argon-39	Ar-39	269 y	Lead-214	Pb-214	27 m
Barium-133	Ba-133	10.538 y	Manganese-54	Mn-54	312.1 d
Beryllium-7	Be-7	53.3 d	Mercury-203	Hg-203	46.61 d
Bismuth-212	Bi-212	1.009 h	Neptunium-237	Np-237	$2.14x10^6$ y
Bismuth-214	Bi-214	19.9 m	Neptunium-239	Np-239	2.356 d
Carbon-14	C-14	5,715 y	Nickel-59	Ni-59	$7.6x10^4$ y
Cerium-141	Ce-141	32.50 d	Nickel-63	Ni-63	101 y
Cerium-144	Ce-144	284.6 d	Niobium-94	Nb-94	$2.0x10^4$ y
Cesium-134	Cs-134	2.065 y	Niobium-95	Nb-95	34.99 d
Cesium-137	Cs-137	30.07 y	Plutonium-238	Pu-238	87.7 y
Chromium-51	Cr-51	27.702 d	Plutonium-239	Pu-239	$2.410x10^4$ y
Cobalt-57	Co-57	271.8 d	Plutonium-240	Pu-240	$6.56x10^3$ y
Cobalt-58	Co-58	70.88 d	Plutonium-241	Pu-241	14.29 y
Cobalt-60	Co-60	5.271 y	Plutonium-242	Pu-242	$3.75x10^5$ y
Curium-242	Cm-242	162.8 d	Potassium-40	K-40	$1.25x10^9$ y
Curium-244	Cm-244	18.1 y	Praseodymium-144	Pr-144	17.28 m
Curium-245	Cm-245	$8.5x10^3$ y	Praseodymium-144m	Pr-144m	7.2 m
Curium-246	Cm-246	$4.77x10^3$ y	Promethium-147	Pm-147	2.6234 y
Europium-152	Eu-152	13.54 y	Protactinium-231	Pa-231	$3.28x10^4$ y
Europium-154	Eu-154	8.60 y	Protactinium-233	Pa-233	26.967 d
Europium-155	Eu-155	4.75 y	Protactium-234	Pa-234	6.69 h

[a] m = minute; h = hour; d = day; y = year

[b] Reference: Chart of the Nuclides, 17th edition, revised 2010, Lockheed Martin Company

Nomenclature and Half-Life for Radionuclides (Continued)					
Radionuclide	**Symbol**	**Half-life[a,b]**	**Radionuclide**	**Symbol**	**Half-life[a,b]**
Radium-226	Ra-226	1,599 y	Thorium-234	Th-234	24.10 d
Radium-228	Ra-228	5.76 y	Tin-113	Sn-113	115.1 d
Ruthenium-103	Ru-103	39.27 d	Tin-126	Sn-126	2.3×10^5 y
Ruthenium-106	Ru-106	1.017 y	Tritium (Hydrogen-3)	H-3	12.32 y
Selenium-75	Se-75	119.78 d	Uranium-232	U-232	69.8 y
Selenium-79	Se-79	2.95×10^5 y	Uranium-233	U-233	1.592×10^5 y
Sodium-22	Na-22	2.604 y	Uranium-234	U-234	2.46×10^5 y
Strontium-89	Sr-89	50.61 d	Uranium-235	U-235	7.04×10^8 y
Strontium-90	Sr-90	28.8 y	Uranium-236	U-236	2.342×10^7 y
Technetium-99	Tc-99	2.13×10^5 y	Uranium-238	U-238	4.468×10^9 y
Thallium-208	Tl-208	3.053 m	Xenon-135	Xe-135	9.10 h
Thorium-228	Th-228	1.912 y	Zinc-65	Zn-65	244.0 d
Thorium-230	Th-230	7.56×10^4 y	Zirconium-85	Zr-85	7.9 m
Thorium-232	Th-232	1.40×10^{10} y	Zirconium-95	Zr-95	64.02 d

[a] m = minute; h = hour; d = day; y = year

[b] Reference: Chart of the Nuclides, 17th edition, revised 2010, Lockheed Martin Company

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.

ALARA – As Low As Reasonably Achievable. A documented process that is implemented to optimize control and management of radiological activities so that doses to the public and releases to the environment are kept ALARA.

aliquot – Quantity of sample being used for analysis.

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.

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.

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.

chemical oxygen demand – Indicates the quantity of oxidizable materials present in water.

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

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 – 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 2011a).

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.

mean relative difference – Percentage error based on statistical analysis.

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 nonbeneficial 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

nonroutine 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).

outcrop – Place where groundwater is discharged to the surface. Springs, swamps, and beds of streams and rivers are the outcrops of the water table.

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.

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.

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.

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 Centigrade	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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SAVANNAH RIVER SITE