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Savannah River Site Environmental Report for 1995

Environmental Monitoring Section
Environmental Protection Department

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

Front Cover—*Nymphaea odorata*, the water lily, thrives at Ellenton Bay, one of approximately 300 Carolina bays on the Savannah River Site. Carolina bays are unique, naturally occurring wetlands found only on the southeastern Coastal Plain. Important aquatic habitats for numerous species of plants and animals, they are shallow and may dry up seasonally; thus, they do not support fish populations. These fish-free bays are especially conducive to amphibians; more than 25 species of frogs, toads, and salamanders on site depend on the bays as breeding locations. The bays are elliptical in shape and are oriented northwest to southeast along their long axes. Their origin is unknown. The photograph was taken by David Scott of the Savannah River Ecology Laboratory. Cover design is by Eleanor Justice of Westinghouse Savannah River Company's Multimedia/Network Publishing group.

Facing Page—Nature at the Savannah River Site comes in an wide variety of textures and colors, a few of which are represented here. In the upper left photo is *callicarpa americana*, the American beauty berry; in the top center photo is *erianthus giganteus*, or plume grass; in the upper right photo are *papilio polyxenes*, the black swallowtail butterfly, and *rhododendron nudiflorum*, or wild azalea; in the foreground of the lower right photo is *sabal minor*, the dwarf palmetto; and in the lower left photo are leaves of *liquidambar styraciflua*, the sweetgum. The photographs were taken by Al Mamatey of the Westinghouse Savannah River Company's Environmental Monitoring Section; the photo collage was designed by Eleanor Justice of the company's Multimedia/Network Publishing group.

Savannah River Site Environmental Report for 1995

by

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MASTER

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Savannah River Site Environmental Report for 1995

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Prepared for the U.S. Department of Energy
Under Contract No. DE-ACO9-89SR18035
Westinghouse Savannah River Company
Savannah River Site, Aiken, SC 29808

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Preface

The Savannah River Site (SRS) conducts effluent monitoring and environmental surveillance to ensure the safety of the public and the well-being of the environment. U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program," requires SRS to submit an environmental report documenting the impact of facility operations on the environment and on public health. The report's purpose is to present summary environmental data that characterizes site environmental management performance, confirms compliance with environmental standards and requirements, and highlights significant programs and efforts.

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

The *Savannah River Site Environmental Report for 1995* is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 1995.^a It is prepared by the Environmental Monitoring Section (EMS) of the Westinghouse Savannah River Company (WSRC). The "SRS Environmental Monitoring Plan" (WSRC-3Q1-2-1000) and the "SRS Environmental Monitoring Program" (WSRC-3Q1-2-1100) provide complete program descriptions and document the rationale and design criteria for the monitoring program, the frequency of monitoring and analysis, the specific analytical and sampling procedures, and the quality assurance requirements.

Variations in the environmental report's content from year to year reflect changes in the routine program or difficulties encountered in obtaining or analyzing some samples. Examples of such problems include adverse environmental conditions (such as flooding or drought), sampling or analytical equipment malfunctions, and compromise of the samples in the preparation laboratories or counting room.

Unless otherwise indicated, the figures and tables in this report are generated using information about the routine monitoring program. No attempt has been made to include all data from environmental research programs. A more complete listing of data can be found in *Savannah River Site Environmental Data for 1995* (WSRC-TR-96-0077).

The following information should aid the reader in interpreting data in this report:

- Analytical results and their corresponding uncertainty terms generally are reported with up to three significant figures. The last significant figure of a result is determined by the quantification of the uncertainty term. EMS attempts to report the appropriate confidence in the result with the correct number of significant figures.
- The reported uncertainty reflects only the counting error—not other components of random and systematic error in the measurement process—so some results may imply a greater confidence than the determination would suggest.
- Uncertainties quoted with means represent the deviation of measurements about the mean value. This number is calculated from the results themselves and is not weighted by the uncertainties of the individual results.
- For gamma-emitting radionuclides, lower limit of detection (LLD) values are not reported or considered in the averages. Detection limits based on typical sample parameters are not reported.
- A value is reported for all other analyses, although it may be below the LLD value. Negative values also are reported. Averages are calculated using both positive and negative results.
- The generic term "dose," as used in the report, refers to the committed effective dose equivalent (50-year committed dose) from internal deposition of radionuclides and to the effective dose equivalent attributable to penetrating radiation from sources external to the body.

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^a The reader should note that the purpose of this report is to document effluent monitoring and environmental surveillance for a calendar year; no attempt has been made to produce a comprehensive report of all environmental activities conducted at SRS.

 

Contents

List of Figures	vii
List of Tables	xi
Acronyms and Abbreviations	xiii
Sampling Location Abbreviations	xvii
Authors	xix
Executive Summary	xxi
Chapter 1. Introduction	1
History of the Site	1
Description of Locale	2
Production Activities from the Past	5
Production Activities for the Present and Future	5
Environmental Management	7
Research and Development	8
Economic Development Through Technology Transfer	9
Environmental Research and Natural Resources Management	10
Emergency Preparedness and Training	11
Educational Outreach	12
Economic Impact	12
Policy of the 1990s	12
Chapter 2. Environmental Compliance	13
Compliance Activities	13
Environmental Release Response and Reporting	30
Assessments/Inspections	31
Environmental Permits	33
Environmental Training	34
Transition and Decontamination and Decommissioning	34
Other Major Environmental Issues and Actions	34

Chapter 3. Environmental Program Information	35
Environmental Monitoring	35
Dose Reconstruction Study	40
Pollution Prevention	40
Employee Awareness/Training	42
Information Exchange	43
Public Outreach	43
Chapter 4. Environmental Restoration and Waste Management	45
Regulatory Compliance	45
Environmental Restoration	46
Solid Waste Management	48
High-Level Waste Management	51
Public Involvement	52
Chapter 5. Radiological Effluent Monitoring	55
Airborne Emissions	55
Liquid Discharges	58
Settleable Solids	63
Chapter 6. Radiological Environmental Surveillance	69
Air	70
Rainwater	72
Gamma Radiation	73
Seepage Basins	74
Site Streams	76
Savannah River	79
Drinking Water	82
Terrestrial Food Products	83
Aquatic Food Products	84
Deer and Hogs	86
Turkeys	87
Beavers	87
Soil	88
Sediment	89
Terrestrial Vegetation	89

Chapter 7. Potential Radiation Doses	95
Calculating Dose	96
Dose Calculation Results	99
Radiological Assessment Program	110
Chapter 8. Nonradiological Effluent Monitoring	111
Airborne Emissions	111
Liquid Discharges	114
Chapter 9. Nonradiological Environmental Surveillance	119
Site Streams	119
Savannah River	120
Drinking Water	120
Sediment	122
Mercury in Fish	122
Chapter 10. Groundwater	127
Groundwater Hydrology	127
Geological and Hydrogeological Setting at SRS	131
Description of Monitoring Program	133
Groundwater Monitoring Results	137
Chapter 11. Quality Assurance	177
QA/QC for EMS Laboratories	177
QA/QC for Subcontracted Laboratories	180
Chapter 12. Special Surveys and Projects	185
Savannah River Swamp Survey	185
Trans-River Flow Project	185
Mitigation Action Plan for Pen Branch Reforestation	189
Academy of Natural Sciences of Philadelphia River Quality Surveys	191
Appendix A. Applicable Guidelines, Standards, and Regulations	201
Air	201
Liquid	202
Site Streams	203
Savannah River	204

Drinking Water -----	204
Groundwater -----	204
Potential Dose -----	205
Environmental Restoration and Waste Management -----	206
Quality Assurance/Quality Control -----	206
 Appendix B. SRS Environmental Permits -----	207
 Appendix C. Radionuclide and Chemical Nomenclature -----	235
 Appendix D. Drinking Water Standards -----	237
 Appendix E. Environmental Monitoring Reports -----	243
 Errata from 1994 Report -----	245
 Glossary -----	247
 References -----	259
 Index -----	263

List of Figures

Executive Summary

Figure 1	SRS Annual Atmospheric Tritium Releases, 1987–1995-----	xxiii
----------	---	-------

Chapter 1. Site and Operations Overview

Figure 1–1	Regional Location of SRS -----	3
Figure 1–2	The Savannah River Site -----	6

Chapter 2. Environmental Compliance

Figure 2–1	Total Toxic Chemical Releases at SRS, 1987–1994-----	18
------------	--	----

Chapter 3. Environmental Program Information

Figure 3–1	Typical Airborne Effluent Monitoring and Environmental Surveillance -----	36
Figure 3–2	Typical Liquid Effluent Monitoring and Environmental Surveillance -----	37
Figure 3–3	Potential Exposure Pathways -----	39

Chapter 4. Environmental Restoration and Waste Management

Figure 4–1	Environmental Program Map -----	47
------------	---------------------------------	----

Chapter 5. Radiological Effluent Monitoring

Figure 5–1	SRS Annual Atmospheric Tritium Releases, 1987–1995-----	58
Figure 5–2	Direct Releases of Tritium to SRS Streams, 1988–1995 -----	60
Figure 5–3	Tritium Migration from Seepage Basins and SWDF to SRS Streams, 1988–1995 -----	62
Figure 5–4	Total Tritium Releases to SRS Streams (Direct Discharges and Migration), 1988–1995 -----	63
Figure 5–5	Past, Current, and Projected Tritium Migration Releases to Four Mile Creek from the F-Area and H-Area Seepage Basins and SWDF -----	64

Chapter 6. Radiological Environmental Surveillance

Figure 6–1	Radiological Air-Surveillance Stations -----	71
Figure 6–2	Average Concentration of Tritium in Rainwater -----	73
Figure 6–3	Offsite TLD Surveillance Locations -----	76
Figure 6–4	Radiological Surface-Water Sampling Locations -----	77
Figure 6–5	Average Tritium Concentration in SRS Streams, 1988–1995 -----	80
Figure 6–6	SRS Tritium Transport Summary, 1960–1995 -----	81

Figure 6-7	Radiological Offsite Drinking-Water Sampling Locations -----	82
Figure 6-8	Fish Sampling Points on the Savannah River -----	85
Figure 6-9	Radiological Soil Sampling Locations -----	88
Figure 6-10	Radiological Sediment Sampling Locations -----	90
Figure 6-11	Vegetation Sampling (Except Inside SWDF) -----	91
Figure 6-12	Vegetation Sampling – Inside SWDF -----	94
 Chapter 7. Dose		
Figure 7-1	Wind Rose for SRS, 1987-1991 -----	98
Figure 7-2	Sector-Specific Adult Maximally Exposed Individual Doses (mrem) for 1995 -----	104
Figure 7-3	SRS Maximum Potential All-Pathway Doses to the Maximally Exposed Individual (Airborne plus Liquid Pathways) Since 1986 -----	105
Figure 7-4	Contributions to the Average Individual Dose -----	106
 Chapter 8. Nonradiological Effluent Monitoring		
Figure 8-1	History of NPDES Exceedances, 1986-1995 -----	116
 Chapter 9. Nonradiological Environmental Surveillance		
Figure 9-1	SRS Streams and Savannah River Water Quality Sampling Locations ----	121
Figure 9-2	SRS Stream and Savannah River Nonradiological Sediment Sampling Locations -----	123
 Chapter 10. Groundwater		
Figure 10-1	Facilities Monitored by the SRS Monitoring Well Network, Including Areas Having Constituents Exceeding Drinking Water Standards in 1995 -----	128
Figure 10-2	Potentiometric Surface and Horizontal Groundwater Flow Directions of the Gordon Aquifer at SRS During the First Quarter of 1995 -----	162
Figure 10-3	Potentiometric Surface and Horizontal Groundwater Flow Directions of the Dublin-Midville Aquifer System at SRS During the First Quarter of 1995 -----	163
Figure 10-4	Geologic Cross Section of Coastal Plain Sediments at SRS -----	164
Figure 10-5	Vertical Gradient Relationships Between the Gordon Aquifer and the Dublin-Midville Aquifer System at SRS During the First Quarter of 1995. -----	165
Figure 10-6	Overall View of the Savannah River Site, Showing Areas Covered by Other Figures -----	166
Figure 10-7	Separations and Waste Management Areas: Major Facilities and Groundwater Monitoring Wells -----	167
Figure 10-8	K-Area and L-Area and the Chemicals, Metals, and Pesticides Pits: Major Facilities and Groundwater Monitoring Wells -----	168

Figure 10-9	P-Area and PAR Pond: Major facilities and Groundwater Monitoring Wells -----	169
Figure 10-10	R-Area: Major Facilities and Groundwater Monitoring Wells-----	170
Figure 10-11	A-Area and M-Area: Major Facilities and Groundwater Monitoring Wells ---	171
Figure 10-12	C-Area and N-Area: Major Facilities and Groundwater Monitoring Wells ---	172
Figure 10-13	D-Area and T-Area (TNX): Major Facilities and Groundwater Monitoring Wells -----	173
Figure 10-14	Tritium Purges and Groundwater Activities in Downgradient Wells at the L-Area Seepage Basin -----	174
Figure 10-15	Tritium Purges and Groundwater Activities in Downgradient Wells at the P-Area Seepage Basins -----	175
Figure 10-16	Sanitary Landfill and Sludge Sites: Major Facilities and Groundwater Monitoring Wells -----	176

Chapter 11. Quality Assurance

Figure 11-1	SRS EM Program QA/QC Document Hierarchy/ Relevant Guidance Documents -----	178
-------------	---	-----

Chapter 12. Special Surveys and Projects

Figure 12-1	Study Area -----	186
Figure 12-2	Groundwater Flow -----	187
Figure 12-3	Comparison of Contours -----	188
Figure 12-4	Academy Survey Sampling Sites -----	192
Figure 12-5	Long-term Biological Data -----	193
Figure 12-6	Station 5 Diatom Species -----	194
Figure 12-7	Algal Taxa-----	195
Figure 12-8	Long-Term Trends -----	197
Figure 12-9	Total Phosphorous -----	199
Figure 12-10	Biochemical Oxygen Demand -----	199

List of Tables

Executive Summary

Table 1	1995 Potential Radiation Doses from SRS Releases Compared with Applicable Dose Standards and Estimated Doses from Naturally Occurring Radiation	xviii
---------	---	-------

Chapter 2. Environmental Compliance

Table 2-1	Releases of Toxic Chemicals (in Pounds) by SRS During 1992, 1993, 1994 Reporting Years (Reported Under EPCRA Section 313)	19
Table 2-2	Summary (in Pounds) of 33/50 Chemicals Exceeding Reporting Threshold at SRS for Reporting Year (1994), Prior Year (1993), and Base Year (1988) ---	20
Table 2-3	Types of NEPA Activities at SRS During 1995	21
Table 2-4	SRS Project NEPA Documentation Activities During 1995	22
Table 2-5	CERCLA Releases Reported to Regulatory Agencies in 1995	31
Table 2-6	Environmentally Related Unusual Occurrences Reported Through SIRIM in 1995	32
Table 2-7	SRS Construction and Operating Permits	33

Chapter 5. Radiological Effluent Monitoring

Table 5-1	1995 Radioactive Atmospheric Releases by Source	65
Table 5-2	1995 Radioactive Liquid Releases by Source (Including Direct and Seepage Basin Migration Releases)	67

Chapter 6. Radiological Environmental Surveillance

Table 6-1	1995 Radiological Environmental Surveillance Program Changes	70
Table 6-2	Average Gross Alpha and Gross Beta Measured in Air (mCi/mL), 1990-1995	72
Table 6-3	1995 Gamma Radiation Surveillance Program Changes	74
Table 6-4	TLD Surveillance Results Summary for 1995	78
Table 6-5	Average 1995 Concentration of Radioactivity in SRS and Surveillance Station Waters (mCi/mL)	79
Table 6-6	Average 1995 Concentration of Radioactivity in the Savannah River (mCi/mL)	80
Table 6-7	Maximum Radionuclide Concentrations in Vegetation from Quarterly Surveillance Samples (pCi/g)	92
Table 6-8	Maximum Radionuclide Concentrations in Vegetation from Seepage and Retention Basins (pCi/g)	93
Table 6-9	Maximum Radionuclide Concentrations in Vegetation from Inside and Outside the Solid Waste Disposal Facility (pCi/g)	94

Chapter 7. Potential Radiation Doses

Table 7-1	1995 Radioactive Liquid Release Source Terms and Downriver Radionuclide Concentrations (Calculated Concentrations Based on Effective River Flow Rates) -----	100
Table 7-2	Potential Dose to the Maximally Exposed Individual from SRS Liquid Releases in 1995 -----	101
Table 7-3	Ten-Year History of SRS Atmospheric Tritium and Tritium Oxide Releases and Average Measured Tritium Oxide Concentrations in Air Compared to Calculated Concentrations in Air -----	103
Table 7-4	Potential Dose to the Maximally Exposed Individual from SRS Atmospheric Releases in 1995 -----	104
Table 7-5	1995 All-Pathway and Sportsman Doses Compared to the DOE All-Pathway Dose Standard -----	107
Table 7-6	Potential Lifetime Risks from the Consumption of Savannah River Fish for 1993, 1994, and 1995 Compared to Dose Standards -----	109

Chapter 8. Nonradiological Effluent Monitoring

Table 8-1	Nonradiological Airborne Emissions Standards for SRS Coal-Fired Boilers ---	112
Table 8-2	SRS Power Plant Boiler Capacities -----	112
Table 8-3	Boiler Stack Test Results (D-Area, A-Area) -----	113
Table 8-4	SRS Package Steam Boiler Capacities -----	113
Table 8-5	1994 Criteria Pollutant Air Emissions -----	113
Table 8-6	Soil Vapor Extraction Unit (SVEU)/Catalytic Oxidation Stack Test Results ----	114

Chapter 10. Groundwater

Table 10-1	Environmental-Screening Constituents -----	134
Table 10-2	Aquifer and Gradient Assignments of Wells-----	158

Chapter 11. Quality Assurance

Table 11-1	Subcontracted Laboratories for 1995 -----	180
------------	---	-----

Acronyms and Abbreviations

A

ALARA – As low as reasonably achievable

ANSP – Academy of Natural Sciences of Philadelphia

B

BTU – British thermal unit

BSRI – Bechtel Savannah River, Inc.

C

CAA – Clean Air Act

CAAA – Clean Air Act Amendments of 1990

CAB – Citizens Advisory Board

CDC – Centers for Disease Control and Prevention

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)

CFC – Chlorofluorocarbon

CFR – Code of Federal Regulations

Ci – Curie

CIF – Consolidated Incineration Facility

CSRA – Central Savannah River Area

CSWTF – Central Sanitary Wastewater Treatment Facility

CWA – Clean Water Act

CX – Categorical exclusion

D

D&D – Decontamination and decommissioning

DCG – Derived concentration guide

DNC – Department National Environmental Policy Act Coordinator

DOE – U.S. Department of Energy

DOE-HQ – U.S. Department of Energy-Headquarters

DOE-SR – U.S. Department of Energy-Savannah River Operations Office

DWPF – Defense Waste Processing Facility

DWS – Drinking water standards

E

EA – Environmental Assessment

ECD – Environmental Compliance Division of the U.S. Department of Energy-Savannah River Operations Office

EIS – Environmental Impact Statement

EMCAP – Environmental Monitoring Computer Automation Project

EMS – Environmental Monitoring Section of the Environmental Protection Department (of Westinghouse Savannah River Company)

EPA – U.S. Environmental Protection Agency

EPCRA – Emergency Planning and Community Right-to-Know Act

EPD – Environmental Protection Department (of Westinghouse Savannah River Company)

ERDA – Education, Research and Development Association of Georgia Universities

ETF – Effluent Treatment Facility

F

FDA – U.S. Food and Drug Administration

FFA – Federal Facility Agreement

FFCA – Federal Facility Compliance Agreement

FFCAct – Federal Facility Compliance Act

FONSI – Finding of No Significant Impact

G

GDNR – Georgia Department of Natural Resources

GOCO – Government-owned, contractor-operated

Gy – Gray; unit of absorbed dose

H

HBFC – Hydrobromofluorocarbon

HCFC – Hydrochlorofluorocarbon

HVAC – Heating, ventilation, and air conditioning

I

ICRP – International Commission on Radiological Protection

L

LDR – Land disposal restrictions

LETF – Liquid Effluent Treatment Facility

LLD – Lower limit of detection

LLRWDF – Low-Level Radioactive Waste Disposal Facility

M

MAP – Mitigation Action Plan

mR – Milliroentgen

MRD – Mean relative difference

mrem – Dose equivalent that is one-thousandth of a rem

MWMF – Mixed Waste Management Facility

N

NASA – National Aeronautics and Space Administration

NCRP – National Council on Radiation Protection and Measurements

NEPA – National Environmental Policy Act

NESHAP – National Emission Standards for Hazardous Air Pollutants

NOV – Notice of Violation

NPDES – National Pollutant Discharge Elimination System

NRC – U.S. Nuclear Regulatory Commission

O

ODS – Ozone-depleting substances

P

PAR Pond – Pond constructed at Savannah River Site in 1958 to provide cooling water for P-Reactor and R-Reactor (P and R; hence, PAR)

PCB – Polychlorinated biphenyl

PEIS – Programmatic Environmental Impact Statement

pH – Measure of the hydrogen ion concentration in an aqueous solution (acidic solutions, pH from 0–6; basic solutions, pH > 7; and neutral solutions, pH = 7)

ppb – Parts per billion

ppm – Parts per million

PVC – Polyvinyl chloride

Q

QA – Quality assurance

QAD – Quality Assurance Division (Environmental Protection Agency)

QAP – Quality Assurance Program (Department of Energy)

QA/QC – Quality assurance/quality control

QC – Quality control (in environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes)

R

RBOF – Receiving Basin for Offsite Fuel

RCO – Radiological Control Operations

RCRA – Resource Conservation and Recovery Act

RFI/RI – RCRA Facility Investigation/Remedial Investigation

ROD – Record of Decision

RQ – Reportable quantity

RTF – Replacement Tritium Facility

S

SARA – Superfund Amendments and Reauthorization Act

SCDHEC – South Carolina Department of Health and Environmental Control

SCUREF – South Carolina Universities Research and Education Foundation

SDWA – Safe Drinking Water Act

SEA – Special Environmental Analysis

SEIS – Supplemental Environmental Impact Statement

SIRIM – Site Item Reportability and Issues Management

SRARP – Savannah River Archaeological Research Program

SREL – Savannah River Ecology Laboratory (University of Georgia)

SRFS – Savannah River Forest Station (U.S. Department of Agriculture Forest Service)

SRP – Savannah River Plant

SRS – Savannah River Site

SRTC – Savannah River Technology Center

Sv – Sievert

SWDF – Solid Waste Disposal Facility

T

TLD – Thermoluminescent dosimeter

TRAC – Tracking Radioactive Atmospheric Contaminants

TRI – Toxic Release Inventory

TSCA – Toxic Substances Control Act

U

USGS – U.S. Geological Survey

UV – Ultraviolet

W

WSRC – Westinghouse Savannah River Company

WIND – Weather Information and Display

Sampling Location Abbreviations

Abbreviation	Location Name/Other Applicable Information
4M	Four Mile
4MC	Four Mile Creek
681-5G	Georgia Department of Natural Resources and Environmental Monitoring Section sampling location
BDC	Beaver Dam Creek
BG	Burial Ground
FM	Four Mile
FMC	Four Mile Creek
HP	HP
IBG	Indian Burial Ground
IGB	Indian Grave Branch
L3R	Lower Three Run
LTR	Lower Three Run
PB	Pen Branch
PMR	Patterson Mill Road
RM	River Mile
SC	Steel Creek
TB	Tims Branch
TCR	Tabernacle Church Road
TNX	Multipurpose Pilot Plant Campus
U3R	Upper Three Runs
UTR	Upper Three Runs

Sample Locations Known By More Than One Abbreviation

Beaver Dam Creek; 400-D
 Four Mile Creek-6; FM-6; 4MC-6
 Four Mile Creek at Road A7; FM-A7; 4M-A7
 River Mile 120; RM-120; River 10
 River Mile 160; RM-160; River 2
 Steel Creek-4; SC-4; Steel Creek-4 at Road A
 Upper Three Runs-4 at Road A; U3R-4; U3R-Rd A

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Executive Summary

THE mission at the Savannah River Site (SRS) has changed from the production of nuclear weapons materials for national defense to the management of site-generated waste, restoration of the surrounding environment, and the development of industry in and around the site. However, SRS—through its prime operating contractor, Westinghouse Savannah River Company (WSRC)—continues to maintain a comprehensive environmental monitoring program.

In 1995, effluent monitoring and environmental surveillance were conducted within a 31,000-square-mile area in and around SRS that includes neighboring cities, towns, and counties in Georgia and South Carolina and extends up to 100 miles from the site. Though budget constraints and changing missions reduced the site's monitoring and surveillance activities during 1995, thousands of samples of air, surface water, groundwater, food products, drinking water, wildlife, rainwater, soil, sediment, and vegetation were collected and analyzed for radioactive and nonradioactive contaminants.

Potential Radiation Doses

Table 1 shows the 1995 potential radiation doses from SRS releases compared with the applicable federal dose standards and with estimated doses from naturally occurring background radiation. All potential radiation doses attributed to SRS in 1995 were below applicable regulatory standards.

Potential Liquid Pathway Dose

The potential dose to the maximally exposed individual from liquid releases of radioactivity to the Savannah River was estimated to be 0.14 mrem (0.0014 mSv), which was the same as the 1994 maximum potential dose. The dose remained the same—even though the amount of tritium oxide released from SRS during 1995 was about 5 percent more than during 1994 (11,400 Ci in 1995 versus 10,900 Ci in 1994)—because of increased dilution in the Savannah River due to a 4 percent increase in river flow during 1995.

Approximately 47 percent of this potential dose resulted from the ingestion of cesium-137 in Savannah River fish, and about 43 percent resulted from the ingestion (via drinking river water) of tritium oxide.

The 1995 collective dose from liquid releases was estimated to be 1.6 person-rem (0.016 person-Sv).

Potential Drinking Water Pathway Dose

Offsite doses were calculated for persons consuming drinking water from two water treatment plants located downriver of SRS near Beaufort, South Carolina, and Port Wentworth, Georgia. The maximum doses were 0.04 mrem (0.0004 mSv) at Beaufort and 0.05 mrem (0.0005 mSv) at Port Wentworth. These doses are 1.00 percent and 1.25 percent, respectively, of the drinking water standard of 4 mrem per year (0.04 mSv per year). Tritium oxide in the drinking water represents the majority of the dose (about 85 percent).

Potential Airborne Pathway Dose

For 1995, the potential dose to the maximally exposed individual from airborne releases of radioactive materials was 0.06 mrem (0.0006 mSv). This dose is 0.6 percent of the 10-mrem per year (0.1-mSv per year) limit for exposure to airborne releases from a U.S. Department of Energy (DOE) facility. The 1995 dose was approximately 33 percent lower than the 1994 dose of 0.09 mrem (0.0009 mSv) because of a 49-percent decrease in tritium oxide releases from 1994 to 1995.

Tritium oxide comprised approximately 78 percent of the potential airborne pathway dose.

The collective dose (population dose) to the 620,100 persons living within 80 kilometers (50 miles) of the center of the site was estimated to be 3.5 person-rem (0.035 person-Sv), which is less than 0.01 percent of the collective dose received from naturally occurring sources of radiation (about 195,000 person-rem).

Potential All-Pathway Dose

To demonstrate compliance with DOE Order 5400.5 all-pathway dose standard of 100 mrem per year (1.0 mSv per year), SRS conservatively combines the maximally exposed individual airborne pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations.

For 1995, the potential maximally exposed individual all-pathway dose was 0.20 mrem (0.0020 mSv) (0.06 mrem from airborne pathway plus 0.14 mrem from liquid pathway). This dose is about 13 percent lower than the 1994 all-pathway dose of 0.23 mrem (0.0023 mSv), mainly because of the decrease in atmospheric tritium oxide releases during 1995.

Table 1 1995 Potential Radiation Doses from SRS Releases Compared with Applicable Dose Standards and Estimated Doses from Naturally Occurring Radiation

Maximally Exposed Individual Doses				
Exposure Pathway	Maximum Potential Dose from 1995 Releases ^a	Applicable Dose Standard ^b	Percent of Standard	Percent of Natural ^c
Airborne Releases				
Total Airborne	0.06 mrem	10 mrem ^d	0.60	0.02
Liquid Releases				
Total Liquid	0.14 mrem	None ^e	N/A ^e	0.05
All Pathways^f	0.20 mrem	100 mrem	0.20	0.07
Treated Drinking Water				
Beaufort-Jasper	0.04 mrem	4 mrem ^g	1.00	0.01
Port Wentworth	0.05 mrem	4 mrem ^g	1.25	0.02
Special-Case Exposure Scenarios				
Sportsman Dose				
Deer and hog consumption				
Onsite hunter	30.0 mrem	100 mrem	30.0	10
Offsite hunter	15.0 mrem	100 mrem	15.0	5
Fish consumption				
Steel Creek fish	1.2 mrem	100 mrem	1.2	0.4
Goat Milk Consumption Dose				
Max. individual	0.06 mrem	10 mrem	0.6	0.02
Irrigation Pathway Dose				
Max. individual	0.09 mrem	100 mrem	0.09	0.03
Population (Collective) Doses				
Exposure Pathway	Maximum Potential Dose from 1995 Releases ^a	Applicable Dose Standard ^b	Percent of Standard	Percent of Natural ^c
Airborne Releases				
Total Airborne	3.5 person-rem	None ^e	N/A ^e	0.01
Liquid Releases				
Total Liquid	1.6 person-rem	None ^e	N/A ^e	0.01
a Committed effective dose equivalent.				
b All the standards listed are given in DOE Order 5400.5, February 8, 1990, "Radiation Protection of the Public and the Environment."				
c Estimate of average dose received from naturally occurring radiation is 300 mrem per year [NCRP, 1987]. The population (collective) dose due to naturally occurring radiation is estimated to be about 195,000 person-rem.				
d The standard for airborne effluents applies to the sum of the doses from all airborne pathways: inhalation, submersion in a plume, exposure to radionuclides deposited on the ground surface, and consumption of foods contaminated as a result of the deposition of radionuclides.				
e There is no separate standard for population dose or for all liquid pathways alone; liquid releases are included in the 100-mrem standard for all pathways.				
f The total airborne and liquid exposure pathways are added in order to compare maximum calculated doses from SRS releases with the DOE "all pathways" standard. This total includes the maximum airborne pathway dose of 0.06 mrem (0.0006 mSv) and the maximum liquid pathway dose of 0.14 mrem (0.0014 mSv).				
g The drinking water standard applies to public drinking water systems and to drinking water supplies operated by DOE or DOE contractors.				

Potential Sportsman Dose

In 1995, the maximum dose to an actual onsite hunter could have been as high as 30 mrem (0.30 mSv), which is 30 percent of DOE's 100-mrem all-pathway dose standard. During the onsite deer hunts, this individual harvested 3 animals—the edible portion totaled about 71 kilograms (156 pounds)—and was assumed to have eaten all the meat himself.

If a hypothetical offsite hunter living near the site boundary consumed 81 kg (179 pounds) of meat—the annual maximum adult consumption rate for meat—taken from deer living on site prior to being harvested, the individual's maximum dose could have been 15 mrem (0.15 mSv). This dose was based on the average concentration of cesium-137 (4.6 pCi/g) measured in animals harvested at SRS during 1995.

The potential maximum dose for a recreational fisherman was based on the consumption of 19 kg (42 pounds)—the maximum adult consumption rate for fish—of Savannah River fish having the highest measured concentrations of radionuclides. In 1995, bass caught at the mouth of Steel Creek had the highest concentrations. Consumption of these bass could have resulted in a dose of 1.2 mrem (0.012 mSv).

Compliance Activities

Compliance with environmental regulations and with DOE orders related to environmental protection is a critical part of the operations at SRS. Assurance that onsite processes do not impact the environment adversely is a top priority, and management of the environmental programs at SRS is a major activity. All site activities are overseen by one or more regulatory bodies, including the U.S. Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC).

SRS operations in 1995 continued to involve a wide variety of processes and chemicals subject to compliance with an increasing number of environmental statutes, regulations, policies, and permits. (For example, SRS had 627 construction and operating permits in 1995 that specified operating levels for each permitted source.) Compliance with all of these requirements ensures that the site, the public, and the surrounding environment are protected from any adverse effects generated by site operations. This section addresses environmental compliance issues with which the site was involved during 1995.

SRS's goal is positive environmental stewardship and full regulatory compliance, with zero violations. The

site's employees maintained progress toward achievement of this goal in 1995.

A systematic effort is in place to identify and address all evolving regulatory responsibilities that concern SRS. As part of the process, communications are maintained with all appropriate regulatory agencies to emphasize the site's commitment to environmental compliance.

A vast majority of the site's compliance efforts were successful in 1995. For example, under the Clean Water Act (CWA), the site's National Pollutant Discharge Elimination System (NPDES) compliance rate was 99.8 percent, and under the Clean Air Act (CAA), the compliance rate was 99.3 percent.

The site did receive two Notices of Violation (NOVs) from SCDHEC. One involved failure to maintain continuous-emissions monitors properly at the D-Area powerhouse; the other involved failure to obtain appropriate Bureau of Air Quality permits for several diesel powered air compressors prior to placing them into operation.

Also, concrete actions were taken by SRS in 1995 to improve environmental protection, including the use of more environmentally friendly disinfection and wastewater treatment technologies.

Federal Facility Agreement

In accordance with Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE, EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee), and SCDHEC entered into a Federal Facility Agreement (FFA), which became effective August 16, 1993. The FFA, which sets the milestones for environmental remediation at SRS, coordinates site cleanup activities into one comprehensive strategy.

Releases or potential releases from Resource Conservation and Recovery Act (RCRA)/CERCLA waste management units are evaluated under the FFA. Work plans detailing the proposed investigations for the RCRA/CERCLA units must be approved by both EPA and SCDHEC prior to implementation. During 1995, five field starts were initiated according to approved work plans and the schedule in Appendix D of the FFA.

Federal Facility Compliance Act

The Federal Facility Compliance Act (FFCA) was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act to clarify provisions

concerning the application of certain requirements and sanctions to federal facilities.

On March 30, 1995, DOE's Savannah River Operations Office (DOE-SR) submitted a proposed Site Treatment Plan—developed with State of South Carolina involvement—that addressed the development of capacities and technologies for treating SRS mixed wastes according to land disposal restrictions (LDRs), as required by the FFCAct. This plan was approved with modifications, and the FFCAct consent order was issued September 29, 1995.

National Pollutant Discharge Elimination System

The Clean Water Act (CWA) of 1972 created the NPDES program, which is regulated by SCDHEC under EPA authority. The program is designed to protect surface waters by limiting all nonradiological releases of effluents into streams, reservoirs, and other wetlands. (Radiological effluents are covered under other acts.) Discharge limits are set for each facility to ensure that SRS operations do not impact aquatic life adversely or degrade water quality. NPDES permit compliance at SRS has exceeded 99 percent during the past 10 years.

NESHAP Radionuclide Program

The SRS National Emission Standards for Hazardous Air Pollutants (NESHAP) radionuclide program continues to change to incorporate sampling, monitoring, and dose assessment practices that meet or exceed the requirements of 40 CFR 61, Subpart H. Work is proceeding on schedule under the radionuclide Federal Facility Compliance Agreement (FFCA), which was signed October 31, 1991.

The first amendment to the FFCA for radionuclide NESHAP was signed by EPA Region IV on August 16, 1993. This amendment provided SRS an extension of the original FFCA through February 10, 1995, to accomplish monitoring equipment upgrades to several additional sources. These upgrades were completed on time, and the FFCA was officially closed by EPA Region IV on May 10, 1995.

NESHAP Asbestos Removal Program

The site implemented an asbestos removal program in 1988. Asbestos is removed during maintenance and renovations of equipment and buildings. During 1995, SRS removed 9,253 square feet of transite panel, which contains asbestos. Also removed were 3,486 linear feet and 1,678 square feet of asbestos pipe and surface insulation. The 1995 amounts were

significantly less than those in 1994 because no asbestos-containing materials were disposed of during the first 6 months of the year, when arrangements were being developed for offsite disposal of these materials. Estimates of the percentage of total friable asbestos (a form that can be crumbled or pulverized with hand pressure when dry) removed from SRS cannot be accurately determined because it is not known exactly how much exists on site. SRS will continue to identify and remove such asbestos according to state (SCDHEC R.61–86.1) and federal (40 CFR 61, Subpart M) regulations and “best management practices.”

PAR Pond Repair/Refill

PAR Pond, a 2,640-acre reservoir constructed in 1958 on Lower Three Runs Creek, served as a recirculating cooling reservoir for P-Reactor and R-Reactor. In March 1991, an inspection of the pond's earthen dam revealed a depression on the downstream face. The reservoir was drawn down to about one-third of its original volume so that repairs could be made. Work on the dam was completed in August 1994, and the Interim Action PAR Pond Record of Decision, which supported refilling of the pond, was issued in February 1995. The refill began that month and was completed by mid-March 1995.

Radiological Effluent Monitoring

During 1995, SRS collected and analyzed more than 4,300 effluent samples to quantify radiological releases to the environment from site operations. Tritium again was the major contributor to air and liquid releases, accounting for more than 99 percent of the total radioactivity released in 1995.

Airborne Emissions

Tritium was the primary radionuclide released to the atmosphere in 1995; approximately 96,700 Ci ($3.6\text{E}+15$ Bq) were released. This compares with 160,000 Ci ($5.9\text{E}+15$ Bq) released in 1994. The sharp (40 percent) decrease is attributed to (1) reduced throughput in the tritium facilities and (2) a full year of Replacement Tritium Facility (RTF) operation in 1995. Figure 1 shows SRS tritium releases for the period 1987–1995.

Liquid Discharges

Tritium constitutes more than 99 percent of the radioactivity released to the Savannah River from direct, seepage basin, and Solid Waste Disposal Facility migration discharges. In 1995, about 9,900 Ci ($3.7\text{E}+14$ Bq) of tritium was released in liquid discharges from SRS, based on point-of-release concentrations and flow rates, compared to about

Curies

leaf Graphic

Figure 1 SRS Annual Atmospheric Tritium Releases, 1987–1995

8,800 Ci ($3.3\text{E}+14$ Bq) in 1994. The total amount of tritium released directly from process areas (i.e., reactor, separations, heavy water rework) to site streams during 1995 was 1,340 Ci ($5.0\text{E}+13$ Bq), which was more than 11 percent greater than the 1994 total of 1,210 Ci ($4.5\text{E}+13$ Bq).

Radiological Environmental Surveillance

The radiological environmental surveillance program at SRS surveys and quantifies any effects routine and nonroutine operations may have had on the site, the surrounding area, and those populations living in or near the site. Sampled media include air, seepage basins, site streams, the Savannah River, drinking water, rainwater, sediment, soil, vegetation, food products, fish, deer, hogs, turkeys, and beavers.

In 1995, more than 100,000 radiological analyses were performed on more than 25,000 samples, and measurements of gamma radiation levels were made at 392 locations on and off site. Activity levels generally were consistent with 1994 levels.

Radionuclide activity levels, such as tritium, cesium, and strontium, were at or slightly above their limits of detection and were consistent with observed historical levels in sampled media. In air and surface water, some onsite activity levels were, as expected, slightly higher than observed in offsite media. Because of production slowdown, most tritium transport in site streams, which has been decreasing in recent years, was attributed to outcropping from

retired seepage basins. No samples collected exceeded EPA drinking water standards.

As a result of budget cuts and changing site missions, a number of changes were implemented during mid-1995, including reductions in radiological environmental surveillance programs covering air, ambient gamma, and foodstuffs. Additional reductions are expected in 1996.

Nonradiological Effluent Monitoring

Nonradioactive airborne emissions of sulfur dioxide, oxides of nitrogen, carbon monoxide, and total particulate matter less than 10 microns released from SRS stacks were within applicable (SCDHEC) standards.

SRS maintained its NPDES compliance rating for liquid releases above 99 percent for the 10th straight year. Results from only 19 of the 7,515 analyses performed in 1995 exceeded permit limits. This resulted in a compliance rating of 99.8 percent—higher than the DOE-mandated rate of 98 percent.

Nonradiological Environmental Surveillance

The nonradiological environmental surveillance program at SRS involves sampling and analyzing surface waters (site streams and the Savannah River), drinking water, sediment, groundwater, and fish. In 1995, more than 15,800 analyses for specific

chemicals and metals were performed on more than 3,900 samples, not including groundwater.

The 1995 stream water quality data showed normal fluctuations expected for surface water. Comparison with published historical data did not indicate any abnormal deviations. Analysis for pesticides, herbicides, and volatile organic compounds in SRS streams yielded positive results for pesticides at two locations; for herbicides at one location; and for volatile organic compounds at two locations. Coliform analysis results exceeded recommended standards 36 times in 1995.

A comparison of Savannah River water quality analyses upriver and downriver of SRS showed no significant differences, and a comparison with historical data shows that the coliform data are within normal fluctuations for river water in this area. However, river locations did have an increase in the number of sample analyses in which coliforms did not achieve recommended standards. The monitoring data for the river locations generally met the Freshwaters standard guides, and a comparison of the 1995 data with published historical analytical results and measurements for river samples did not show any abnormal deviations.

All SRS drinking water systems complied with SCDHEC chemical, bacteriological, synthetic organic, and volatile organic water quality standards in 1995.

In Savannah River sediment samples, no pesticides or herbicides were found to be above the practical quantitation limits in 1995. All river sample results were below the detection limits of the EPA analytical procedures used. However, samples from two onsite streams showed detectable pesticides.

The mercury concentrations in fish analyzed from onsite waters ranged from a high of 1.70 $\mu\text{g Hg/g}$ in an L-Lake bass to lows below the lower limit of detection (0.17) at several locations. Mercury concentrations in offsite fish ranged from a high of 0.83 $\mu\text{g Hg/g}$ in a bass from the mouth of Beaver Dam Creek to lows below the lower limit of detection (0.17) at several locations.

The U.S. Food and Drug Administration (FDA) has established an action limit of 1.0 $\mu\text{g Hg/g}$. Action limits reflect maximum allowable concentrations for fish destined for interstate commerce. SRS uses the FDA guideline, also adopted by SCDHEC, to gauge concentrations of mercury in fish from onsite streams.

Groundwater

SRS monitors groundwater for radioactive and nonradioactive constituents to identify contamination that may have occurred because of site operations. Groundwater beneath 5 to 10 percent of the site has been contaminated by industrial solvents, tritium, metals, or other constituents used or generated by SRS operations. This report describes groundwater monitoring results for approximately 1,600 wells in 94 locations within designated areas at SRS. Approximately 46,000 radiological analyses and 347,000 nonradiological analyses were performed on groundwater samples.

For the groundwater monitoring program, 1995 was a year of refinement. Although no new sites were monitored during the year, additional wells were installed at several sites to improve detection monitoring and plume definition. Also, numerous wells were abandoned in and around the Burial Grounds for closure activities.

Nonroutine Occurrences

The SRS environmental monitoring program extends beyond routine effluent monitoring and environmental surveillance activities. Upon notification by area operations personnel, the Environmental Protection Department's Environmental Monitoring Section (EMS) is prepared to respond to unplanned environmental releases—both radiological and nonradiological—as required.

If EMS is notified of a suspected unplanned environmental release, personnel are dispatched to collect appropriate samples. These samples are given priority in preparation and, if radiological in nature, priority in analysis. The data are validated, and a determination is made as to whether there was an actual release. If there was, then consequences to the public and the environment are determined.

A number of unplanned environmental releases occurred during 1995, but only one required EMS action. Approximately 10,700 Ci of elemental tritium was released from H-Area on June 16. The release resulted in a calculated site boundary dose of 3.4E-06 mrem (3.4E-08 mSv), which is significantly below the 10-mrem-per-year DOE/EPA dose limit.

Special Surveys

Savannah River Swamp

During the 1960s, an area of the Savannah River Swamp was contaminated with approximately 25 Ci

of cesium-137 and 1 Ci of cobalt-60. The contamination resulted from failed fuel elements that leaked radioactivity into the P-Area storage basin; occasionally, this water was discharged to Steel Creek. Periodic radiological surveys of the swamp have been conducted since 1974 to characterize the amount and movement of this activity. A comprehensive survey scheduled for 1995 could not be conducted because of safety concerns resulting from high water levels in the swamp; however, the survey has been rescheduled for 1996.

Academy of Natural Sciences of Philadelphia

The Environmental Research Division of the Academy of Natural Sciences of Philadelphia (ANSP) has been conducting biological and water quality surveys of the Savannah River since 1951. These surveys are designed to assess potential effects of SRS contaminants and warm water discharges on the general health of the river and its tributaries.

The 1995 ANSP studies on the Savannah River included biweekly diatometer monitoring throughout the year, cursory surveys in the vicinity of SRS (algae, aquatic macrophytes, insects, and fish), and sampling near Vogtle Electric Generating Plant in

September (algae, protozoa, noninsect macroinvertebrates, insects, and fish). Analyses of samples from these studies is under way. According to preliminary indications, the quality of the Savannah River's water generally remains similar to that of previous years.

Education, Research and Development Association of Georgia Universities

SRS contracted with the Education, Research and Development Association of Georgia Universities (ERDA) to conduct a study in 1993 and 1994 that compared pollutants released from the site with those that entered the environment from other sources [ERDA, 1995]. The levels of these pollutants then were considered in terms of impact on the health of the environment and of the public.

Information was gathered by researchers at the Georgia Institute of Technology in Atlanta and evaluated on three topics pertinent to preparation of the annual *Savannah River Site Environmental Report*—Savannah River water quality, foodstuffs, and general surveillance data. Results of the study are expected to be published at an undetermined future date.

Chapter 1

Introduction

To Read About . . .

Turn to Page . . .

<i>Site History</i>	1
<i>Production from the Past</i>	5
<i>Production – Present and Future</i>	5
<i>Research and Development</i>	8
<i>Technology Transfer</i>	9
<i>Natural Resources Management</i>	10
<i>Educational Outreach</i>	12
<i>Policy of the 1990s</i>	12

THE 1990s have brought dramatic change to the Savannah River Site (SRS) in its role as a key part of the U.S. Department of Energy's (DOE) weapons complex. Shrinking federal budgets, sharp workforce reductions, the end of the Cold War, and a major shift in mission objectives have combined to severely test the mettle of SRS—South Carolina's largest employer. But the sprawling 310-square-mile site's employees have responded to the test in admirable fashion, effectively shifting their emphasis from weapons production to environmental restoration.

This chapter examines the site's history, geography, climate, and economic impact, as well as the developing new technologies and operations that are expected to help SRS bolster its position as a leader in the DOE complex.

History of the Site

Responding to a 1950 directive from President Harry S. Truman to the U.S. Atomic Energy Commission, E.I. du Pont de Nemours and Company and the commission negotiated a contract whereby Du Pont would design, construct, and operate what was to become the Savannah River Plant (SRP).

On November 22 of that year, the Atomic Energy Commission approved the present site and purchased the land for approximately \$19 million. By February 1, 1951, construction had begun. The first facility to begin operating, the heavy water plant, started up August 17, 1952, and the first of five production reactors achieved criticality December 28,

1953. All five reactors had achieved criticality by March 1955. [Bebbington, 1990].

In less than 5 years, initial construction—consisting of the five production reactors, two chemical separations facilities, a heavy water extraction plant, a nuclear fuel and target fabrication facility, and waste management facilities—was complete. It was the largest single construction project ever undertaken in the United States at that time, with a peak work force of 38,500 in 1952. From the onset of construction in 1951 until completion of the basic site in 1956, the project used a third of the country's concrete supply—enough to build a highway from Atlanta to Philadelphia—and half of its stainless steel supply. The total cost (including land): \$1.1 billion. Several other facilities necessary to support operations have been constructed since that time, including test reactors, uranium fuel processing facilities, and a process development laboratory to support production operations [WSRC, 1990].

Until it was disbanded by the Energy Reorganization Act of 1974, the Atomic Energy Commission oversaw and regulated site activities. In 1975, its functions were transferred to two newly established agencies: the Energy Research and Development Administration, overseeing government operations, and the Nuclear Regulatory Commission, overseeing commercial operations. By 1977, the Energy Research and Development Administration had evolved into DOE, which has overseen all facility activities since that time.

Du Pont operated the plant until March 31, 1989. On April 1, 1989, Westinghouse Savannah River

Company (WSRC) became the prime operating contractor, and SRP became SRS.

Description of Locale

Several criteria were developed during the process of determining the most suitable location for the site:

- a large land area for safety and security
- a buffer zone large enough to provide land around each operating facility for protection of human health and the environment
- land somewhat isolated yet near communities that could handle construction and operations personnel
- access to adequate transportation
- land not subject to floods and major storms
- millions of gallons of available water, low in mineral content, for cooling and process use
- suitable terrain and topography

Du Pont, the Atomic Energy Commission, and the U.S. Army Corps of Engineers considered 114 sites in 18 states before recommending the current site, which met all the established criteria.

Several thousand people lived on the site at the time of its acquisition. The 310 square miles (almost 200,000 acres) were purchased from about 1,600 landowners (1,711 separate tracts of land were purchased, and 699 were acquired through condemnation procedures) [SRFS, 1982; SRFS, 1991]. The residents of the area's farms and towns, including Ellenton, Dunbarton, Hawthorne, Meyers Mill, Robbins, and Leigh, were relocated. In all, 6,000 people, or approximately 1,500 families, were moved, along with many houses and 122 cemeteries (36 cemeteries remain on site) [Bebbington, 1990; SRFS, 1991]. Of the total acreage, approximately 68,000 acres were farm fields; 29,000 were swamp and stream bottom; and 103,000 were covered by mixed pine and scrub oak [SRFS, 1982].

Location

SRS covers 198,344 acres adjacent to the Savannah River in Aiken (72,686 acres), Allendale (4,155 acres), and Barnwell (121,503 acres) counties of South Carolina (figure 1-1). The average population density in the counties surrounding SRS is 85 people per square mile, with the largest concentration in the Augusta, Georgia, metropolitan area. Based on 1990 U.S. Census Bureau data, the

population within a 50-mile radius of SRS is approximately 620,100.

Various industrial, manufacturing, medical, and farming operations are conducted near the site. Major industrial and manufacturing facilities in the area include textile mills, polystyrene foam and paper products plants, chemical processing facilities, and a commercial nuclear power plant. Farming is diversified and includes crops such as cotton, soybeans, corn, and small grains.

Climate

SRS has a relatively mild climate, with an average frost-free season of approximately 246 days. The average annual rainfall, about 48 inches, is fairly evenly distributed throughout the year. There is no strong prevailing wind direction; however, there is a relatively high frequency of east-through-northeast winds during the summer and fall and of south-through-northwest winds during the late fall, winter, and spring [Hunter, 1990]. No unusual topographic features significantly influence the general climate, except for the Savannah River.

Water Resources

SRS, bounded on its southwestern border for about 35 river miles (as measured from the upriver boundary of the site, near Jackson, South Carolina, to the Lower Three Runs Creek corridor) by the Savannah River, is approximately 160 river miles from the Atlantic Ocean. Five major SRS streams feed into the river: Upper Three Runs Creek, Four Mile Creek (also referred to as Fourmile Branch), Pen Branch, Steel Creek, and Lower Three Runs Creek.

Typical Climate at SRS

- ◆ **Summer**
Hot and humid
Temperatures reach upper 90s (°F)
33 percent of annual rainfall
- ◆ **Fall**
Cool mornings, warm afternoons
Temperatures range from 50 to 76 °F
19 percent of annual rainfall
- ◆ **Winter**
Mild; lasting November through March
Temperatures normally above 32 °F
21 percent of annual rainfall
- ◆ **Spring**
Most variable; cold snap often in March
Temperatures average 65 °F
27 percent of annual rainfall

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Figure 1-1 Regional Location of SRS

SRS is about 25 miles southeast of Augusta, Georgia, and 12 miles south of Aiken, South Carolina. The site, approximately 310 square miles in area, covers about 1 percent of the state of South Carolina.

These streams, which receive effluents from various onsite operations, are not commercial water sources.

The two main bodies of water on site, PAR Pond and L-Lake, are manmade. PAR Pond, constructed in 1958 to provide cooling water for P-Reactor and R-Reactor (hence the name PAR Pond), covers 2,640 acres and is approximately 60 feet deep. The 1,000-acre L-Lake was constructed in 1985 to receive heated cooling water from L-Reactor.

The Savannah River is used as a drinking water supply for approximately 56,000 residents downriver of SRS in Port Wentworth, Georgia, and near Beaufort, South Carolina (Beaufort and Jasper counties) [Fledderman, 1995a]. The City of Savannah Industrial and Domestic Water Supply Plant intake, at Port Wentworth, is approximately 130 river miles from SRS; the Beaufort-Jasper Water Treatment Plant intake, near Beaufort, is approximately 120 river miles from SRS. The Savannah River also is used for

commercial and sport fishing, boating, and other recreational activities. There is no known use of the river for irrigation by farming operations downriver of the site [Hamby, 1991]. SRS uses water from the river for some of its operations.

Geology and Hydrology

SRS is on the Upper Coastal Plain of South Carolina. Coastal Plain deposits at SRS consists of 500 to 1,400 feet of sands, clays, and limestones of Tertiary and Cretaceous age. These sediments are underlain by sandstones of Triassic age and by older metamorphic and igneous rocks.

The sandy sediments of the Coastal Plain contain several productive aquifers, separated by clay-rich units, that drain into the Savannah River, its tributaries, and the Savannah River Swamp. The older, underlying rocks are nearly impermeable and are not a major water source.

Land Resources

The SRS region is part of the Southern Bottomland Hardwood Swamp region, which extends south from Virginia to Florida and west along the Gulf of Mexico to the Mississippi River drainage basin. The main features are river swamps, rarely more than 5 miles wide.

Plant and Animal Life

The area of the site not used for production and production-related activities—about 175,000 acres—has been managed for several decades by the Savannah River Forest Station (SRFS), a unit of the U.S. Department of Agriculture (USDA) Forest Service. In 1951, the Forest Service was asked to establish a reforestation and forest management plan, which was written in 1952. In 1953, SRS had the largest mechanized planting operation in the United States, with 28 planting machines capable of planting 400,000 seedlings a day [SRFS, 1991]. Ten million trees were planted that year, and 100 million had been planted by 1968 [SRFS, 1982]. In all, the Forest Service has planted more than 134 million trees (mainly pines) since 1953, covering almost 80 percent of the site. SRS maintains a forest management program to contribute to environmental protection and research. More about SRFS can be found on page 11.

In 1972, SRS was designated as the first National Environmental Research Park. These parks are used as outdoor laboratories to study the impact of human activity on the environment. This designation has created a unique environment for preserving and

Al Mamatey Photo (96X02586.01)

These longleaf pines are located alongside S.C. Highway 125 at SRS. The U.S. Forest Service has planted more than 134 million trees (mainly pines) on site since 1953.

studying vegetation and wildlife. More about the National Environmental Research Park can be found on page 10.

Vegetation

Most of the site's environs are rural. Approximately 40 percent of the countryside is forested with longleaf and loblolly pines and sweet gum, maple, birch, and various oak-hickory hardwood trees.

Major plant communities at SRS include cypress-gum and lowland hardwood swamps, sandhills, and old agricultural fields, as well as aquatic and semiaquatic areas. These habitats range from very sandy, dry hilltops to continually flooded swamps.

Wildlife

SRS is populated with more than 50 species of mammals, including deer, feral hogs, beavers, rabbits, foxes, raccoons, bobcats, river otters, and opossums. In 1952, there were fewer than three dozen white-tailed deer on site. Since then, however, the population has increased dramatically, and the site

now is home to several thousand white-tailed deer [SRFS, 1982]. Since 1965, managed public deer hunts have been held annually on site to reduce the number of animal-vehicle accidents and to maintain the health of the herd.

More than 100 species of reptiles and amphibians—including turtles, alligators, lizards, snakes, frogs, and salamanders—and more than 200 species of birds also inhabit the site.

The area also provides refuge for approximately 50 endangered, threatened, and sensitive species, such as the red-cockaded woodpecker, the southern bald eagle, the smooth purple coneflower, the Bachman's sparrow, the American alligator, the wood stork, the shortnose sturgeon, and the bog spice bush. Many site research projects are designed to protect and increase the populations of these species.

Production Activities from the Past

The original mission of SRS—production of nuclear materials for national defense—eventually was expanded to include production of

- materials (primarily plutonium-238) for space applications
- special isotopes for research and for medical uses

Located in separate areas near the center of the site, SRS's five reactors—C, K, L, P, and R—all began operations between 1953 and 1955 and produced plutonium and tritium for national defense during various periods until 1988. As the reactors aged, each was shut down briefly for maintenance and repair or because of reduced production demands. R-Reactor was shut down permanently in 1964 because of reduced production demands, and C-Reactor was placed on cold standby in 1985. By 1988, the other three reactors had been shut down and placed under review to determine their future status. By 1991, C-Reactor had been shut down permanently; P-Reactor had been placed on cold standby to be used for spare parts for L-Reactor and K-Reactor; L-Reactor had been placed on warm standby to be used as a backup to K-Reactor; and plans had been made to restart K-Reactor.

Initial steps were taken to restart K-Reactor in December 1991. After power ascension testing was completed successfully in July 1992, the reactor was taken offline for tie-in to a new cooling tower. The operating permit for this project was issued in December 1992, and the cooling tower was tested in 1993. However, K-Reactor was never restarted and

remains on cold standby, with no planned provision for restart. The other four reactors have been shut down permanently, with no capability for restarting, and are being prepared for decontamination and decommissioning. Figure 1–2 is a map showing various production and other areas of the site.

K-Reactor was not restarted because the end of the Cold War brought about a change in the nation's policy toward the need for continued production of a large and diverse nuclear weapons stockpile. It was determined that—because of decreased defense needs—the nation had enough tritium on hand to last until a new production facility could be built. Thus, DOE began to change its mission for SRS.

Production Activities for the Present and Future

Tritium Production

With the site's reactors shut down, a search began for the production source best suited to meet the nation's tritium needs. It was announced in October 1995 that DOE—over a 3-year span—will pursue a two-track approach to this search, including the evaluation of two options:

- use of an existing commercial reactor
- construction of a linear accelerator

Ultimately, the more promising of the two alternatives will be designated the primary method of tritium production for the United States. If the linear accelerator is named, it will be constructed at SRS because of the site's long-standing expertise and capabilities in handling tritium.

Tritium Recycling

The U.S. nuclear arsenal—regardless of its size—depends on a source of pure tritium. Because tritium decays rapidly (5.5 percent a year), it must be purified on a regular basis to enable the nuclear weapons to maintain their designed capabilities. Reprocessing of depleted tritium is conducted at SRS's new Replacement Tritium Facility (RTF), an underground facility that began operations in 1994.

Tritium reservoirs returned from weapons in the field are brought to RTF, where the tritium is removed, purified, and repackaged. These recycling activities are carried out in "gloveboxes," which prevent radioactive gases from leaking into work areas. An elaborate stripper system removes tritium contamination from the "glovebox" atmosphere. Among the most significant new technologies used in this process are the metal hydride beds, into which

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Figure 1-2 The Savannah River Site

SRS includes several operating areas plus the Savannah River Ecology Laboratory (SREL), the Savannah River Forest Station (SRFS), and the Savannah River Technology Center (SRTC). Production areas are primarily in the interior of the site.

the tritium is pumped. The beds, which separate, purify, and store the tritium, consist of metal containers filled with granular metals. When the beds are cold, these metals absorb tritium and other hydrogen atoms; when the beds are heated, the tritium is released.

Spent Fuel

Fuel and production targets that have been withdrawn from a nuclear reactor following irradiation are called spent nuclear fuel. Some of the spent fuel stored at SRS is from the site's production reactors, and some is from domestic and foreign research programs. All of it is stored in water-filled concrete reactor storage basins, which originally were designed as interim storage while the spent fuel awaited processing in one of the site's two canyons.

Until 1988, it was routine for foreign researchers to return spent fuel of United States origin to this country for reprocessing and recycling. For three decades, the SRS Receiving Basin for Offsite Fuels (RBOF) has provided safe receipt and interim storage of the fuel, which is housed in water. The facility also is well-suited for long-term storage until decisions can be made on final disposition of the fuel.

DOE is considering renewal of the agreement to accept foreign spent fuel. Two urgent relief shipments of the fuel—authorized by an Environmental Assessment—were delivered to RBOF from Europe in 1995; however, an Environmental Impact Statement (EIS) is being developed to determine if DOE will accept any additional shipments.

Canyon Operations

The primary facility in each of the SRS's two chemical separations areas is called the "canyon," so named because of its long, narrow shape: approximately 850 feet long, 65 feet high, and 120 feet wide, with 5-foot-thick concrete walls. Nuclear materials have been recovered and purified since the mid-50s in the F-Area and H-Area canyons and in the FB-Line and HB-Line, which are located within the canyons.

The FB-Line is used to process purified plutonium solution. The plutonium is concentrated, precipitated, and reduced to metal form [Fact Sheet, 1990]. The FB-Line shut down in January 1990 for installation of new operating equipment. Because of changes in site missions, it remained down until November 1995.

The HB-Line processes plutonium-238 for the National Aeronautics and Space Administration (NASA). In 1995, SRS completed a 5-year project to

supply fuel for NASA's Cassini mission, which is expected to send a space probe to the planet Saturn in 1997. The facility will continue to process the remaining inventory of plutonium-238 to help meet NASA's future needs.

In March 1992, DOE suspended chemical processing operations in the canyon facilities to address a safety concern regarding the canyon ventilation system in the event of an earthquake. The concern was addressed; however, before canyon operations could resume, the secretary of energy directed that SRS phase out defense-related chemical separations activities in the canyon facilities. DOE recently completed work on two EISs to determine the future role these facilities would play in managing the existing nuclear materials at SRS until decisions on their ultimate disposition are made and implemented. The EISs chart a path for using the canyons and B-Lines to stabilize nuclear materials stored at SRS.

As a result of the first EIS, SRS restarted the F-Area canyon in February 1995 to begin the stabilization process for approximately 80,000 gallons of radioactive solutions that had been stored there since 1992. The FB-Line then was restarted in November to purify and solidify the plutonium-239 solution from the F-Area canyon.

In October 1995, DOE announced—in the Interim Management of Nuclear Materials EIS (DOE/EIS-220)—its preferred alternative for management of the other nuclear materials stored on site, including spent nuclear fuel, irradiated production targets, solutions, scrap and residues, and production materials. Most of the materials were classified as "stable"; these will continue to be stored. Various other materials were classified as "candidates for stabilization"; DOE has evaluated alternatives to stabilize these materials in the interim until disposition decisions are made.

Environmental Management

With post-Cold War efforts across the DOE complex increasingly turning away from weapons production and toward environmental restoration and waste management, SRS has adjusted its priorities accordingly. Through the development and application of a wide variety of new technologies, the site has made significant strides in the cleanup and restoration of inactive waste disposal sites. And firm policies have been established not only for the effective reduction of waste, but for its safe handling, treatment, and disposal.

DOE uses the term "environmental restoration" to refer to the assessment and cleanup of facilities

(decontamination and decommissioning) and of inactive waste sites (i.e., "units"), including remediation of contaminated groundwater. "Cleanup" means actions taken to deal with previous releases or to control potential future releases of hazardous substances. This may involve complete removal of a substance—or stabilizing, containing, or otherwise treating the substance so it does not affect human health or the environment [DOE EM, 1991]. Determining the most environmentally sound method of cleaning up facilities or waste units is a major component of the SRS environmental restoration program.

DOE uses the term "waste management" to refer to the safe and effective management of various kinds of nonhazardous, hazardous, and radioactive wastes generated on site. Identifying the need for appropriate waste management facilities and ensuring their availability have been major features of the SRS waste management program.

Chapter 4, "Environmental Restoration and Waste Management," discusses the numerous programs and technologies that enable SRS to effectively carry out these parts of its overall mission.

Research and Development

The Savannah River Technology Center (SRTC), the site's applied research and development arm, focuses on developing viable solutions to the numerous technological challenges faced by SRS personnel. Numerous research and development activities conducted by SRTC are designed to meet environmental and other compliance requirements. Projects include the radiation assessment program, the calculation of dose uncertainties, the meteorological monitoring program, and the development and testing of new equipment.

Sixty percent of the professionals at SRTC hold advanced technical degrees, and many are world renowned in their fields of expertise. SRTC researchers have made significant technological advances in fiber optics, hydrogen technology, robotics, glass technology, spectrometry, and environmental restoration, and there is greater emphasis than ever before at SRTC on sharing the site's expertise with the nation.

Among the facilities within SRTC are

- a weather center
- a specialty glass shop for production of scientific apparatus

- shielded cells (heavily protected rooms in which highly radioactive materials are handled remotely)

Environmental Technologies

SRTC is a leader in the practical application of new technologies to clean up nuclear and industrial wastes. Located near the facility's main building is the Integrated Demonstration Site, where SRTC representatives have joined with those of other laboratories and private industry to demonstrate new methods of cleaning groundwater and soil.

One such technology is in-situ air stripping, in which air is injected through horizontal wells to strip groundwater and soils of volatile organic contamination. Other site-developed technologies use naturally occurring microbes to clean contaminated groundwater and soil in a process called bioremediation. The microbes break down the contaminants into harmless components, such as water and carbon dioxide.

Glass Technologies

Since 1975, SRTC has been perfecting the vitrification process used in the Defense Waste Processing Facility (DWPF) to encapsulate high-level waste in glass. SRTC researchers also have developed techniques for bonding other substances into glass, including some of the materials stored in the site's canyons and a variety of hazardous and radioactive wastes.

Robotics

SRTC has adapted and improved commercially available robotic technology to develop robots for use in a variety of tasks. The site reduces human exposure to hazardous and radioactive atmospheres by using robots for several waste handling, environmental cleanup, and related tasks. For example, one robot can wander corridors looking for stray floor contamination; another can survey warehouses in which hazardous waste is stored, checking for leaks, spills, or contamination; still others can use heavy tools to dismantle radioactively contaminated equipment.

Sensors

Sensors that analyze chemicals, measure acidity, determine temperatures, and provide other data have been developed by SRTC to meet the site's needs in chemical processing and environmental monitoring/cleanup. One such sensor measures temperatures accurately, even in radioactive, corrosive, and high-radio-frequency environments.

SRS is a leader in applied robotics systems that perform work in hazardous or radioactive environments. Savannah River Technology Center engineers have developed various innovative pipe crawlers that have been used successfully at the site. Examples of such uses include (1) characterizing process sewer lines leading to a retention basin and (2) cutting an elbow out of a contaminated ventilation pipe.

Steve Ashe Photo
(92-2013-5E)

Economic Development Through Technology Transfer

A major goal of SRS is to use its technological advances to contribute to the nation's global competitiveness, economic prosperity, and environmental stewardship. SRTC's expertise and facilities are available to communities, other government agencies, national laboratories, and private industry. SRS has partnered with Georgia and South Carolina to carry out a regional technology transfer initiative.

Patents and Licenses

Through the site's aggressive technology transfer program—virtually nonexistent before 1989—firms from outside industries can purchase licenses to use SRS-patented technologies. During the period from

fiscal years 1990 through 1995, more than 1,800 inventions were disclosed and 115 patents allowed. Fifty-six licenses have been issued to allow others to use these patented technologies.

Cooperative Research and Development Agreements

Through cooperative research and development agreements, SRS works with private companies, trade associations, state and local governments, universities, and nonprofit organizations in joint research and development of new technologies that benefit all the partners involved. Each partner provides personnel and equipment to support its portion of the research. Under one agreement, SRS is working with a private firm to research a process that separates and recovers hydrogen from waste streams. The process could provide recycled hydrogen to be

used for petroleum refining or hydrogen energy systems.

User Facilities

In a departure from the days when SRS was shrouded in secrecy, the site now makes certain of its facilities available for hands-on use by outside companies. One example is the multipurpose pilot plant campus known as TNX, a major SRTC facility that has the space and capability for full-size construction and testing of pilot facilities for site missions. The success of the glass vitrification process development project at TNX was a key element in the design and construction of the DWPF.

Today, SRS is "sharing" TNX with companies that use the facility's robotics, bioremediation, and vitrification systems to develop their own technologies. One private corporation is using TNX to develop better ways to clean up landfills using microorganisms. The corporation is licensing SRS processes to combine them with its own proprietary methods, in addition to using the hardware and operators at TNX.

Partnerships

SRS engages in partnerships with other government agencies, industry, academic institutions, and local communities.

An example of a successful SRTC industrial partnership is the Center for Vitrification Research at South Carolina's Clemson University. SRS, private companies, and the university are working together to demonstrate how the technology of stabilizing high-level nuclear waste by turning it into glass can be used to treat other wastes, such as hazardous chemicals.

The Savannah River Research Campus represents one of the most visible ways the site cooperates with private industry and government agencies. The campus is on 430 acres of land donated to Aiken County by Westinghouse Electric Corporation. Its location adjacent to SRS is designed to attract companies interested in sharing the site's technologies, expertise, and facilities. The first campus building, the Cooperative Research Center, opened to tenants in 1995. The campus also has space for companies to construct their own facilities.

Environmental Research and Natural Resources Management

Because public access to SRS is limited, the site has become a unique wildlife refuge for a variety of

plants and animals, including a number of threatened, endangered, or sensitive species. The Atomic Energy Commission designated SRS the first National Environmental Research Park in 1972. In 1995, SRS initiated the process of asking Congress to pass a law that would make this status official and keep the site under federal government control. Since the original designation in 1972, scientists from universities and other organizations have used the site as an outdoor laboratory to study the impact of human activities on the environment. The protected boundaries of the site provide land suitable for long-term research projects. Thirty areas covering 14,230 acres are set aside to protect rare, threatened, and endangered biota, as well as unique habitats, such as Carolina bays. These set-aside areas provide undisturbed land for comparison with areas affected by SRS operations and forest management. Scientists have compiled detailed information on many aspects of the SRS environment, including soil development and inventories of plant and animal species. National Environmental Research Park activities are conducted through SRTC, the Savannah River Ecology Laboratory (SREL), SRFS, and the Savannah River Archaeological Research Program (SRARP). SREL, SRFS, and SRARP are discussed in the following paragraphs: a discussion of SRTC and its activities was presented earlier in this chapter (beginning on page 8). SRFS also is discussed in the section on Plant and Animal Life, page 4.

Savannah River Ecology Laboratory

The University of Georgia at Athens has operated SREL at SRS since 1951 and does so today under contract to DOE. The university's original mission was to conduct a census of site plants and animals before the beginning of production operations. The research continued, and the Atomic Energy Commission established SREL as a permanent laboratory in 1961. The facility now includes a faculty of permanent research scientists, plus postdoctoral research fellows and faculty members on sabbatical.

SREL research concentrates on the environmental effects of SRS operations. Studies include the effects of heated-water discharges to site aquatic systems and of chemicals and radioactive contaminants on ecological systems. The laboratory studies indigenous endangered species and other wildlife, biodiversity, population ecology, and radioecology. Other SREL investigations examine regeneration of cypress and tupelo forests within the site and the population dynamics of zooplankton. Laboratory personnel conduct organic-matter studies in stream floodplains

and are learning how to create or rehabilitate wetland systems.

A 3-year SREL study of Upper Three Runs Creek revealed two previously unknown species of caddisflies, and the laboratory also discovered three more species of the insect that were new to South Carolina.

More information can be obtained by contacting SREL at 803-725-2472.

Savannah River Forest Station

In 1952, the Atomic Energy Commission and the USDA Forest Service formed an interagency agreement to create an onsite forest management organization at SRS. The agreement, which authorizes SRFS to manage SRS's natural resources, was renewed in 1995. Because the site was farmland before it was purchased by the federal government, the Forest Service employees' first task was to plant trees by the thousands—in the world's largest mechanized tree-planting project—on land characterized by weeds, dust, and erosion. This original mission has evolved into a wide range of programs that cover

- forest research support
- timber management
- provision of habitat for several threatened or endangered animal and plant species
- soil erosion control
- secondary road maintenance
- fire suppression
- student education

With the renewal of the interagency agreement, SRFS's new responsibilities now include sitewide leadership in ecosystem research and management; expansion of its Natural Resources Environmental Education Program—which provides onsite mathematics, science, and engineering education for students in grades 3-8—to include grades 9-12; and rural community outreach [Bowen, 1995]. More information can be obtained by contacting SRFS at 803-725-2441.

Savannah River Archaeological Research Program

SRARP was formed in 1973 under a cooperative agreement with DOE and the South Carolina Institute of Archaeology and Anthropology, University of South Carolina. Its primary purpose is to make compliance recommendations to DOE that will

facilitate the management of archaeological resources at SRS. Other functions include compliance activities involving reconnaissance surveys, general intensive watershed surveys, specific intensive surveys, data recovery, coordination with major land users, and reconstruction of the environmental history of the site.

SRARP continued to work with DOE in 1995 to fulfill a threefold mission of cultural resource management, research, and public education at SRS. More than 2,300 acres of SRS land came under cultural resources review during the year. This review entailed 30 field surveys resulting in the recording of 86 new sites. Twenty-two existing sites within survey tract boundaries were revisited to update site file records [SRARP, 1995].

Research conducted by SRARP was reported in 11 papers and monographs published during 1995. SRARP personnel also presented research results in 18 papers at professional meetings. Field research included several testing programs and excavations, remote sensing at area sites, and data collection abroad. Seven grants were acquired by SRARP personnel to support offsite research [SRARP, 1995]. More information about the program can be obtained by contacting SRARP at 803-725-3623.

Emergency Preparedness and Training

Extensive emergency preparedness training, simulated emergency drills, and close cooperation with local governments and other outside agencies are among the keys to success for SRS's emergency preparedness program.

A 90-member fire department that includes ambulances and rescue teams provides 24-hour emergency response, and a new Emergency Operations Center can be activated in the event of major problems.

The Weather Information and Display (WIND) system is used to gather pertinent release and meteorological information, perform appropriate calculations, and predict the consequences of airborne or liquid releases from SRS. The WIND system, which can forecast the movement and dispersion of these releases and provide valuable information to emergency response decision makers, includes a meteorological monitoring network of nine weather towers—eight on site and one off site.

The site's Tracking Radioactive Atmospheric Contaminants (TRAC) vehicle is a mobile laboratory that can provide the identification and measurement

of radioactivity in air, water, vegetation, and soil samples.

SRS training involves hundreds of functions and skills. Before reporting to work, each new employee receives training about the site, radiation, health protection, and other relevant significant topics. In some cases, employees complete specific training as a job prerequisite. Separations plant workers, reactor operators, and DWPF and waste management personnel require intensive training specific to their jobs.

Educational Outreach

SRS has established partnerships with Georgia and South Carolina universities through the Education, Research and Development Association of Georgia Universities (ERDA) and the South Carolina Universities Research and Education Foundation (SCUREF). These partnerships pair the site with universities to conduct site studies and develop new technologies.

The site offers hands-on programs for precollege students and teachers, unique research opportunities for students and faculty, work-based learning experiences for high school students, and various workshops, tours, lectures, and demonstrations that enhance science, mathematics, engineering and technology.

SRTC, SREL, SRFS, and SRARP all contribute significantly to SRS's efforts to educate students, teachers, and the public.

Economic Impact

Major cuts in federal budgets have steadily eroded the size of the SRS workforce since 1993, but the site continues to wield considerable economic clout in the Central Savannah River Area of South Carolina and Georgia.

With approximately 16,000 employees in 1995, SRS remained South Carolina's largest single employer. WSRC and Bechtel Savannah River, Inc. (BSRI), represent about 80 percent of the site's personnel, DOE employees, about 2 percent. The rest are WSRC and DOE subcontractors or are employed by Wackenhut Services, Inc., the site's security contractor; by SREL; or by SRFS.

About 70 percent of the site's employees live in South Carolina—primarily Aiken County—and 30

percent in Georgia. Total WSRC and BSRI payroll for 1995 was about \$839 million.

Policy of the 1990s

With its shift in mission from weapons production to environmental restoration, SRS has seen an equally dramatic change in policy—from one of secrecy to one of openness, one that not only informs the public about decisions but involves it in the decision-making process. The emphasis now is on two-way communication to encourage the open exchange of ideas and opinions, particularly on environmental and health issues.

Various federal laws require SRS to seek public input on activities that could impact the environment, and DOE's policy is to go beyond the minimum legal requirements to provide greater opportunities for stakeholders to take part.

Public hearings are held, as required by law, to record comments on specific proposed actions, and the site sponsors forums, workshops, open houses, and other informal meetings each year in various cities throughout South Carolina and Georgia.

The SRS Citizens Advisory Board, a nonpartisan independent group, has been established to provide informed recommendations to DOE, the U.S. Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) regarding environmental restoration, waste management, and related site issues. The Citizens Advisory Board's members were selected to reflect the demographic diversity of the communities surrounding and impacted by SRS. Categories of stakeholders include public officials, business, academic, labor, general public, minority issues, and environmental/activist representatives.

A broad range of written materials is used to keep people informed, including the *SRS Environmental Bulletin*, which is published several times a year and covers proposed changes to the site's Resource Conservation and Recovery Act (RCRA) hazardous waste permit, dates for public participation opportunities, and a variety of stories on environmental cleanup and waste management. Additional information on specific topics is provided on site fact sheets, while major actions, public meetings, and public comment periods are announced through news releases and paid newspaper/radio advertising.

Environmental Compliance

To Read About . . .

Turn to Page . . .

<i>Key-Regulations Summary</i>	15
<i>Toxic Chemical Releases</i>	19
<i>NEPA Documentation Activities</i>	22
<i>CERCLA-Reportable Releases</i>	31
<i>Unusual Occurrences</i>	32
<i>Construction/Operating Permits</i>	33
<i>Other Major Issues/Actions</i>	34

SAVANNAH River Site (SRS) operations in 1995 continued to involve a wide variety of processes and chemicals subject to compliance with an increasing number of environmental statutes, regulations, and policies. Such compliance ensures that SRS, the public, and the surrounding environment are protected from any adverse effects generated by site operations. This chapter addresses environmental compliance issues with which the site was involved during 1995.

SRS's goal—and that of the U.S. Department of Energy (DOE)—is positive environmental stewardship and full regulatory compliance, with zero violations. The site's employees maintained progress toward achievement of this goal in 1995.

A systematic effort is in place to identify and address all evolving regulatory responsibilities that concern SRS. As part of the process, communications are maintained with all appropriate regulatory agencies to emphasize the site's commitment to environmental compliance.

A vast majority of the site's compliance efforts were successful in 1995. For example, under the Clean Water Act (CWA), almost 8,000 analyses were performed during the year to demonstrate compliance with the site's National Pollutant Discharge Elimination System (NPDES) permits; the site's compliance rate was 99.8 percent. Also, concrete actions were taken by SRS in 1995 to improve environmental protection. These actions—explained in detail on page 24—involved implementation of more environmentally friendly disinfection and wastewater treatment technologies.

Under the Clean Air Act (CAA), the 1995 compliance rate was 99.3 percent, though the site did receive two Notices of Violation (NOVs) from the South Carolina Department of Health and Environmental Control (SCDHEC). One involved failure to maintain continuous-emissions monitors properly at the D-Area powerhouse; the other involved failure to obtain appropriate Bureau of Air Quality permits for several diesel powered air compressors prior to placing them into operation. Additional information about these NOVs is provided later in this chapter. Other key regulations with which the site must comply—and the compliance status of each—are discussed on page 15.

Compliance Activities

Compliance with environmental regulations and with DOE orders related to environmental protection is a critical part of the operations at SRS. Assurance that onsite processes do not impact the environment adversely is a top priority, and management of the environmental programs at SRS is a major activity. All site activities are overseen by one or more regulatory bodies, including the U.S. Environmental Protection Agency (EPA) and SCDHEC. In recent years, the number of regulations affecting site operations has increased dramatically, and significant effort and funding have been dedicated to ensure that site facilities and operations comply with all requirements.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) was passed in 1976 to address the problem

of solid and hazardous waste management. The law requires that EPA regulate spent solvents, batteries, and many other discarded substances deemed potentially harmful to human health and the environment. Amendments to RCRA regulate nonhazardous solid waste, biohazardous medical waste, and some underground storage tanks.

Under RCRA, hazardous waste generators are responsible for controlling every aspect of the generation, treatment, storage, and disposal of the waste; this is referred to as "cradle-to-grave control." Hazardous waste generators, including SRS, must follow specific requirements for handling these wastes. For many waste management activities, RCRA requires that owners and operators of operating or post-closure-care hazardous waste management facilities have a permit.

EPA is responsible for all hazardous waste regulations. However, EPA can delegate this authority to a state when the state passes laws and regulations that meet or exceed EPA regulations and the state plan is approved by EPA. SCDHEC has authority for all aspects of RCRA except some of the rules associated with the 1984 Hazardous and Solid Waste Amendments to RCRA. Also, SCDHEC has been authorized by EPA to play the key role in the implementation of Federal Facility Compliance Act (FFCA) statutes and was the lead regulatory agency for development of the Savannah River Site Treatment Plan, which addresses storage and treatment of mixed waste. More information on waste management at SRS can be found in chapter 4, "Environmental Restoration and Waste Management."

Federal Facility Compliance Act

The FFCA was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act to add provisions concerning the application of certain requirements and sanctions to federal facilities. With respect to federal agencies, the FFCA waives sovereign immunity from all civil and administrative penalties and fines; this includes waiver for both coercive and punitive sanctions for violations of the Solid Waste Disposal Act. For mixed waste, the FFCA provided a 3-year delay (until October 1995) in the imposition of fines and penalties so that DOE sites could investigate mixed waste volumes in storage, evaluate treatment capacities, and develop site treatment plans with schedules for mixed waste treatment for approval by their state or federal regulatory agencies.

On March 30, 1995, DOE's Savannah River Operations Office (DOE-SR) submitted a proposed

Site Treatment Plan—developed with State of South Carolina involvement—that addressed the development of capacities and technologies for treating SRS mixed wastes according to land disposal restrictions (LDRs), as required by the FFCA. This plan was approved with modifications, and the FFCA consent order was issued September 29, 1995.

Also in association with the FFCA, Westinghouse Savannah River Company (WSRC) submitted a mixed waste inventory report January 13, 1993, and DOE Headquarters (DOE-HQ) issued a complexwide report—*U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities, and Technologies*—April 21, 1993, to state governors and to regulatory agencies in states that host DOE sites. This was followed by a comment period for the regulators and states. DOE-HQ provided an update to the mixed waste inventory report in April 1994. DOE-HQ and SRS will be preparing regular updates of the mixed waste inventory report to support the Site Treatment Plan.

Land Disposal Restrictions

The 1984 RCRA amendments established LDRs, often referred to as "land ban." LDRs do not allow storage of restricted hazardous wastes, except for the purpose of accumulating such quantities as are necessary to facilitate proper recovery, treatment, or disposal. The amendments require that, prior to land disposal, all wastes meet treatment standards based on the "best demonstrated available technology."

The same restrictions apply to mixed wastes, which are composed of a mixture of radioactive and hazardous wastes. Because LDRs apply to mixed wastes and SRS does not have adequate mixed waste treatment capacity, regulatory agreements have been executed to achieve compliance. A Federal Facility Compliance Agreement (FFCA) was signed in March 1991 between DOE-SR and EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) to address SRS mixed waste compliance with LDRs. The LDR FFCA has been amended three times. The last amendment, executed June 20, 1994, was called the Bridging Amendment.

The Bridging Amendment allowed for alignment with the Site Treatment Plan and established commitments in the interim until execution of a Site Treatment Plan consent order from the State of South Carolina. The amendment was replaced by the Site Treatment Plan upon execution of that order September 29, 1995.

Treatability variances are an option available to facilities for particular waste streams that either

Some of the Key Regulations SRS Must Follow

Legislation

What It Requires/Compliance Status

RCRA

Resource Conservation and Recovery Act

- ◆ The management of hazardous, nonhazardous, and medical wastes and underground storage tanks containing hazardous substances and petroleum products—in compliance

FFCA

Federal Facility Compliance Act

- ◆ The development by DOE of schedules for mixed waste treatment to avoid waiver of sovereign immunity and to meet LDR requirements—in compliance

CERCLA; SARA

Comprehensive Environmental Response, Compensation, and Liability Act; Superfund Amendments and Reauthorization Act

- ◆ The establishment of liability, compensation, cleanup, and emergency response for hazardous substances released to the environment—SRS placed on National Priority List in December 1989

CERCLA (TITLE III); EPCRA

Emergency Planning and Community Right-to-Know Act

- ◆ The reporting of hazardous substances used on site, and their releases, to EPA, state, and local planning units—in compliance

NEPA

National Environmental Policy Act

- ◆ The evaluation of the potential environmental impact of federal activities and alternatives; in 1995, WSRC conducted 221 reviews for proposed activities—in compliance

SDWA

Safe Drinking Water Act

- ◆ The protection of public drinking water systems; enacted in 1974, amended in 1980, 1986—in compliance

CWA; NPDES

Clean Water Act; National Pollutant Discharge Elimination System

- ◆ The regulation of liquid discharges at outfalls (e.g., drain or pipe) that carry effluents to streams—in compliance

CAA; NESHAP

Clean Air Act; National Emission Standards for Hazardous Air Pollutants

- ◆ The establishment of air quality standards for hazardous air emissions, such as radionuclides and benzene—in compliance

TSCA

Toxic Substances Control Act

- ◆ The regulation of use and disposal of PCBs—nation has inadequate disposal capacity for radioactive PCBs generated and stored at SRS

cannot be treated at the level specified in the regulations or for which the treatment technology is inappropriate for the waste. SRS has identified some mixed waste streams that are potential candidates for a treatability variance. One variance—for in-tank precipitation filters—was granted in October 1993 by EPA Region IV. The Site Treatment Plan contains three additional treatability variances for mixed wastes with special problems that prevent treatment according to LDR standards. Schedules are included

in the Site Treatment Plan for preparation of variance request documents.

Underground Storage Tanks

Underground storage tanks at SRS house petroleum products, such as gasoline and diesel fuel, and hazardous substances (as defined by the Comprehensive Environmental Response,

Compensation, and Liability Act, or CERCLA). All such tanks are regulated under Subtitle I of RCRA.

Underground storage tank regulations require that all regulated existing tanks be closed or upgraded to meet or comply with new tank standards by December 22, 1998. In 1995, WSRC closed five tanks by removal, initiated regulatory proceedings to close four more, and performed tightness tests on 18 tanks and their connective piping. Every tank that was tested passed.

The regulations set standards for upgrading existing tanks based on their age. Existing tanks must be monitored for leaks, and records must be kept for inventory control. In areas where underground tanks are still needed, WSRC will replace single-walled tanks with double-walled tanks that have leak detection systems. During 1995, of the 29 total operational petroleum storage tanks at SRS, 16 met the new tank standards, and the remaining 13 are to be upgraded, replaced, or abandoned to meet the December 1998 deadline.

RCRA 3004(u) Program

The hazardous waste permit issued to SRS in September 1987 requires that the site institute a program for investigating and, if necessary, performing corrective action at solid waste management units under RCRA 3004(u). The RCRA 3004(u) requirements have been integrated with the CERCLA requirements because SRS is on the National Priority List—also known as the Superfund List. The integration of RCRA and CERCLA regulatory requirements will provide a more cost-effective and focused investigation and remediation process. The RCRA/CERCLA program status is detailed under the CERCLA section of this chapter.

Waste Minimization Program

The SRS Waste Minimization Program, a comprehensive plan to prevent pollution and minimize waste from all SRS operations, is designed to meet the requirements of RCRA, of DOE orders, and of applicable executive orders. The program focuses mainly on source reduction, on recycling, and on increasing employee awareness of and participation in pollution prevention. SRS's 1995 municipal solid waste generation was 32 percent below that of 1994, and the disposal volume of other solid wastes, including radioactive and hazardous wastes, was 38 percent below 1994 levels. These reductions are attributed to mission changes, pollution prevention initiatives—such as source reduction and recycling—and improvements in waste

treatment technology. Total solid waste volumes have declined by more than 70 percent since 1991. For more information on this program, refer to chapter 3, "Environmental Program Information," and chapter 4.

Notice of Violation (RCRA)

SCDHEC issued an NOV to SRS on October 14, 1993, alleging storage and disposal of mixed waste without a RCRA permit. The NOV was based on information reported to SCDHEC by SRS in September 1993. The issue still had not been resolved as of December 31, 1995, but negotiations were continuing toward a settlement agreement between DOE and SCDHEC. No NOV was issued under this regulation in 1995.

Comprehensive Environmental Response, Compensation, and Liability Act

SRS was placed on the National Priority List in December 1989, thereby making the site subject to CERCLA (Public Law 96-510), as amended by the Superfund Amendments and Reauthorization Act (SARA, Public Law 99-499). CERCLA assigns liability and provides for compensation, cleanup, and emergency response for hazardous substances released to the environment.

In accordance with Section 120 of CERCLA, DOE, EPA Region IV, and SCDHEC entered into a Federal Facility Agreement (FFA), which became effective August 16, 1993. Declaration of the effective date results in the FFA being an enforceable agreement. The FFA, which sets the milestones for environmental remediation at SRS, consolidates site cleanup activities into one comprehensive strategy.

Releases or potential releases from RCRA/CERCLA waste management units are evaluated under the FFA. Work plans detailing the proposed investigations for the RCRA/CERCLA units must be approved by both EPA and SCDHEC prior to implementation. During 1995, five investigations were initiated according to approved work plans and the schedule in Appendix D of the FFA.

Remediation under CERCLA imposes requirements in addition to existing RCRA requirements. CERCLA requires remedial decisions to be based on the results of a baseline risk assessment, which examines present and future risk to human health and the environment from the waste unit, using conservative, EPA-approved exposure scenarios.

CERCLA also requires public participation in the selection of remediation alternatives. A significant

step in this process is the development of a Proposed Plan, which highlights key aspects of the remedial investigation and feasibility study. The plan also provides a brief analysis of remedial alternatives that were considered, identifies the preferred alternative, and tells the public how it can participate in the remedy selection process. After public comment is received, a Record of Decision (ROD) is issued that presents the selected remedy and provides the rationale for that selection. Also included in this process is the establishment of an administrative record file that documents the remediation alternatives and provides for public review of them.

A Proposed Plan and a ROD were issued in 1995 for M-Area West, as were Interim Action Proposed Plans and Interim Action RODs for PAR Pond and for the H-Area, F-Area, and TNX-Area Groundwater Operable Units. The PAR Pond Interim Action ROD, which supported refill of the pond, was approved in February 1995. For more information on the PAR Pond refill, refer to page 34.

The FFA also identifies more than 300 site evaluation units for which investigations are required. Site evaluation reports for 24 areas were submitted to EPA and SCDHEC during 1995, compared to 28 areas in 1994.

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 was enacted as a provision to SARA. EPCRA requires facilities to notify state and local emergency planning units about their hazardous chemical inventories and to report releases of hazardous chemicals.

Under Section 312 of EPCRA, SRS completes an annual Tier II Inventory Report for all hazardous chemicals present at the site in excess of specified quantities during the calendar year. Hazardous chemical storage information is submitted to state and local authorities by March 1 for the previous calendar year.

Under Section 313 of EPCRA, SRS must file an annual Toxic Chemical Release Inventory report by July 1. SRS calculates chemical releases to the environment and reports aggregate quantities for each regulated chemical that exceeds established threshold amounts. The Pollution Prevention Act of 1990 expanded the Toxic Chemical Release Inventory reports to include source reduction and recycling activities. Pollution prevention information has been reported annually since 1991.

Form R of the Toxic Chemical Release Inventory report for 1994 was submitted to EPA in June 1995. Eight chemicals, with releases totaling 85,658 pounds, were reported to EPA for 1994. This compares with 10 chemicals (79,837 pounds of releases) reported during 1993. Figure 2-1 shows the overall reduction in total toxic chemical releases at SRS for the period 1987-1994. A breakdown of the comparison from 1992 through 1994 is presented in table 2-1.

33/50 Pollution Prevention Program

In September 1992, DOE became the first federal agency to agree formally to participate in EPA's 33/50 Pollution Prevention Program. Under the agreement, DOE voluntarily adopted the program goals that are expected to reduce the use and release of 17 priority chemicals. The first goal, which called for a 50-percent reduction by the end of 1995, applied to SRS and other contractor-operated facilities that already were reporting the releases under EPCRA in 1992. The second goal, which calls for a 33-percent reduction by the end of 1997, applies to the other contractor-operated facilities that met the reporting criteria in 1992 but had not previously reported the releases under EPCRA.

Since 1988, SRS has been required to submit annual release reports by July 1—for the previous calendar year. The site's Toxic Chemical Release Inventory reports indicate that releases of six of the 17 priority chemicals have exceeded a reporting threshold at least once since 1988. In the 1995 report (covering calendar year 1994), four such chemicals—lead, toluene, xylene, and benzene (accounting for 32,194 pounds released to the environment or transferred off site)—were listed as exceeding the threshold during 1994. This compares to four chemicals—lead, toluene, xylene, and methyl ethyl ketone—that exceeded the threshold during 1993, accounting for 28,312 pounds released to the environment or transferred off site. A breakdown of these chemicals and their associated releases in 1994, in the prior year (1993), and in the base year (1988) is presented in table 2-2.

The site's 1995 Toxic Chemical Release Inventory report included benzene, which is a by-product of technology used at the Defense Waste Processing Facility (DWPF) to stabilize high-level radioactive waste. Benzene releases are expected to increase with the startup and operation of the DWPF, but engineered measures have been installed to minimize these releases.

Ileaf Graphic

Figure 2-1 Total Toxic Chemical Releases at SRS, 1987-1994

Through 1994, total toxic chemical releases had been reduced by 97 percent when compared to 1988, with the sharpest drop occurring between 1988 and 1989.

Executive Order 12856

Executive Order 12856, enacted in August 1993, requires that all federal facilities comply with right-to-know laws and pollution prevention requirements. Prior to establishment of the executive order, only private industries in Standard Industrial Classification codes 20-39 were required to comply with EPCRA. The executive order requires that federal facilities meet EPCRA reporting requirements and develop voluntary goals to reduce releases of toxic chemicals 50 percent on a DOE-wide basis by the end of 1999. SRS is meeting compliance requirements for EPCRA.

Executive Order 12856 impacts the site in terms of pollution prevention. Requirements for the reduction in toxic chemical releases go beyond the voluntary 33/50 program and mean that SRS must incorporate into its pollution prevention efforts all the toxic chemicals on the Toxic Chemical Release Inventory report.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) provides a means to evaluate the potential

environmental impact of proposed federal actions and to examine alternatives to those actions. Although implemented on site by the Energy Research and Development Administration during the 1970s, a formal management and operation contractor NEPA compliance group was not established at SRS until 1982. The ongoing mission of this group is to make recommendations regarding the level of NEPA review of a site-proposed action and to prepare draft documentation in support of DOE compliance with NEPA at SRS. In 1995, 221 reviews of new proposed actions were conducted at SRS and formally documented through Categorical Exclusions (CXs), Notices of NEPA Approval, or Environmental Assessments (EAs). WSRC also provided technical support to DOE-SR for the preparation of Environmental Impact Statements (EISs).

The types and numbers of NEPA activities conducted at SRS during 1995 are presented in table 2-3. Among the specific activities were the following:

- The final EIS for processing the F-Canyon plutonium solutions at SRS was issued in December 1994, and the ROD was issued in February 1995. This EIS evaluated the potential impacts, during the next 10 years, of alternatives for stabilization

Table 2-1 Releases of Toxic Chemicals (in Pounds) by SRS During 1992, 1993, 1994 Reporting Years (Reported Under EPCRA Section 313)

1992

Chemical	Air Emissions	Water Discharges	Land Disposal	Offsite Transfers
Ammonia	8,300	654	32	110
Chlorine	1	16	0	0
Freon 113	22,500	960	6	611
Lead	29	1	10,000	18
Nitric acid	790	0	0	643
Sulfuric acid	0	0	0	720
Toluene	3,560	0	4	5,403
Xylene	15,370	0	26	7,009
Totals	50,550	1,631	10,068	14,514

1993

Chemical	Air Emissions	Water Discharges	Land Disposal	Offsite Transfers
Ammonia	11,550	977	0	150
Chlorine	0	15	0	0
Lead	76	9	8,500	66
Manganese compounds	42	0	1,250	0
Methyl ethyl ketone	9,735	0	41	0
Methyl tert-butyl ether	540	0	0	0
Nitric acid	37,000	0	0	0
Sulfuric acid	0	0	0	1
Toluene	2,401	0	4	0
Xylene	7,428	0	52	0
Totals	68,772	1,001	9,847	217

1994

Chemical	Air Emissions	Water Discharges	Land Disposal	Offsite Transfers
Benzene	5,878	0	4	9,276
Chlorodifluoromethane	19,500	0	5	0
Lead	8	172	10,000	2
Manganese compounds	31	53	1,499	23
Nitric acid	32,050	0	120	168
Sulfuric acid	0	0	0	15
Toluene	1,780	0	7	440
Xylene	3,950	0	17	660
Totals	63,197	225	11,652	10,584

Table 2-2 Summary (in Pounds) of 33/50 Chemicals Exceeding Reporting Threshold at SRS for Reporting Year (1994), Prior Year (1993), and Base Year (1988)

	Lead and Compounds	Toluene	Xylene	Benzene	Total
Amount (MPOU ^a)					
Reporting Year	56,536	20,083	23,580	41,801	142,000
Prior Year	78,082	34,278	47,763	12,457	172,580
Total Air Releases	8	1,780	3,950	5,878	11,616
Total Water Releases	172	0	0	0	172
Total Land Releases	10,000	7	17	4	10,024
Total Releases	10,180	1,787	3,967	5,882	21,812
POTW ^b	0	0	0	0	0
Offsite Transfers	2	440	660	9,276	10,378
Summary Total					
Reporting Year	10,182	2,227	4,627	15,158	32,194
Base Year	14,763	^c	1,782	^c	16,545
Percent Change	-31	^c	+160	^c	+95

a Manufactured, processed, or otherwise used

b Publicly owned treatment works

c Reporting threshold not exceeded

of plutonium solutions stored in F-Canyon. Stabilization of these solutions by processing to metal form began in 1995.

- The final EA and Finding of No Significant Impact (FONSI) on upgrading the site road infrastructure at SRS were issued in February. The EA assesses the impacts associated with the proposed replacement of four SRS bridges. These bridges are to be replaced with structures that conform to current design and construction standards used in floodplains and wetlands.
- The final Supplemental EIS (SEIS) for the DWPF assessed the potential environmental impacts of completing and operating the facility with the modified process design changes implemented since the completion of the DWPF EIS in 1982. The final SEIS was issued in November 1994 and the ROD in February 1995.
- An EA and FONSI for the proposed operation of the HB-Line Facility and Frame Waste Recovery Unit for production of Pu-238 oxide at SRS were issued in April. The EA assessed the potential impacts of (1) the proposed continuation of the operation and maintenance of the Pu-238 processing facilities at SRS and (2) the proposed processing of the available inventory of Pu-238 scrap material into usable oxide powder.
- The final Programmatic EIS (PEIS) for programs involving spent nuclear fuel and Idaho National Engineering Laboratory environmental restoration and waste management activities was issued in April, and the ROD was issued in June. This PEIS supported two decisions—one on the DOE programmatic management of spent nuclear fuel (involving SRS) and the other on site-specific alternatives for Idaho National Engineering Laboratory relative to spent nuclear fuel management and to environmental restoration and waste management activities at that site for the next 10 years.
- An EA and FONSI for the proposed Health Physics Site Support Facility at SRS were issued in July. The EA analyzed the impacts and alternatives associated with construction and operation of a new laboratory/office building to replace the existing facilities, which no longer are capable of adequately supporting SRS's current and projected radiological protection needs. The new facility would enable SRS to meet process and quality control parameters associated

with the responsibilities and requirements of the site's radiological protection programs.

- An EA and FONSI for the offsite vendor processing of low-level radioactive waste generated at SRS were issued in July. The proposed action involves the transport of site-generated low-level waste to an offsite vendor facility; processing of these wastes by means of supercompaction, metal melt, and/or decontamination at that facility; and return shipment of the volume-reduced waste to the site for disposal. This action provided SRS an interim means of reducing the volume of site-generated low-level waste prior to issuance of the final EIS and ROD on waste management at SRS.
- The final EA and FONSI for the Independent Waste Handling Facility, Building 211-F, were issued in April. The purpose of the proposed action is to upgrade the 211-F and 776-6A facilities to provide SRS a continuing means of processing radioactive liquid waste. The proposed action would include both high- and low-activity waste to be processed after any transition of F-Canyon to a standby mode of operations. These buildings would become stand-alone units, independent of any future F-Canyon missions or of any reduced scope of the separations facility.
- The final EA and FONSI for the proposed natural fluctuation of the water level in PAR Pond and on the reduced water flow in Steel Creek below L-Lake were issued in August. This project will enable the site to reduce unnecessary operating expenses associated with the mechanical maintenance of full-pool conditions in both of these inactive reactor cooling reservoirs.
- The final EIS on waste management at SRS was issued in July. This EIS assessed the environmental consequences associated with the generation, management, and minimization of low-level, liquid high-level, nonradioactive hazardous, mixed, and transuranic wastes at SRS. The ROD was issued in September.
- The final EIS on interim management of nuclear materials was issued in October and the ROD was issued in December. This EIS evaluated the potential for significant environmental impacts resulting from the implementation of actions necessary to manage nuclear materials at SRS. These actions would stabilize SRS materials that represent environmental, safety, and health vulnerabilities in their current storage condition or that may represent a vulnerability within the next 10 years.
- The final EA and FONSI for the offsite commercial cleaning of SRS laundry potentially contaminated with lead and/or asbestos were issued in December. This action enables SRS to establish a coordinated effort with a contracted vendor to provide offsite services for the commercial cleaning of this type of potentially contaminated laundry generated at SRS.
- The final EA and FONSI for the proposed Three Rivers Solid Waste Authority Regional Waste Management Center were issued in December. The EA evaluated the potential impacts associated with the construction and operation of a landfill and technology center at SRS for regionally generated municipal solid waste. The regional landfill would meet the municipal solid waste disposal needs of SRS and of at least nine of the surrounding counties that comprise the Three Rivers Solid Waste Authority. The function of the technology center would be to provide the infrastructure for the demonstration of innovative technologies for more cost-effective municipal solid waste disposal through volume reduction and recycling.
- The final PEIS for tritium supply and recycling was issued in November, and the ROD was issued in December. This PEIS evaluated the impacts of siting, construction, and operation of alternative tritium production facilities at five candidate sites within the DOE complex. The ROD recommended an accelerator as the new tritium supply technology, with SRS being the preferred site.

Table 2-3 Types of NEPA Activities at SRS During 1995

Activity	Number
Categorical Exclusion (CX) Recommendation	2
Sitewide Categorical Exclusion/Routine Insignificant Actions	197
Environmental Assessment (EA)	17
Environmental Impact Statement (EIS)	4
Supplemental Environmental Impact Statement (SEIS)	1
Programmatic Environmental Impact Statement (PEIS)	6
Total	227

Table 2-4 contains a complete list of NEPA documentation activities at SRS during 1995.

The final revision of the SRS sitewide procedure (Environmental Compliance Manual 3Q, Procedure 5.1, "Implementation of the National Environmental

Table 2-4 SRS Project NEPA Documentation Activities During 1995

Project Name	Level of NEPA Documentation
DOE Waste Management	PEIS
Domestic Spent Nuclear Fuel/INEL ^a Environmental Restoration and Waste Management	PEIS
Storage and Disposition of Weapons-Usable Fissile Materials	PEIS
Foreign Research Reactor Spent Nuclear Fuel	PEIS
Stockpile Stewardship and Management	PEIS
Tritium Supply and Recycling	PEIS
F-Canyon Plutonium Solutions	EIS
Interim Management of Nuclear Materials	EIS
SRS Spent Nuclear Fuel	EIS
SRS Waste Management	EIS
Defense Waste Processing Facility	SEIS
Central Services Works Engineering Borrow Pit	EA
DOE Permission for Off-loading Activities to Support the Movement of Commercial Low-Level Nuclear Waste Across SRS	EA
Environmental Monitoring Laboratory	EA
HB-Line Facility and Frame Waste Recovery Unit	EA
Health Physics Site Support Facility	EA
Humusoil, Inc., Composting Facility	EA
Independent Waste Handling Facility, 211-F	EA
Low-Level Waste Offsite Volume Reduction	EA
Offsite Cleaning of Lead- and Asbestos-Contaminated Laundry	EA
Offsite Processing of Depleted Uranium	EA
Offsite Vitrification of Asbestos-Containing Materials	EA
Par Pond Fluctuation /L-Lake Reduced Flow	EA
Stainless Steel Recycling	EA
Tritium Facility Upgrades	EA
TRSWA ^b Regional Waste Management Center	EA
D-Area Powerhouse Upgrade	EA
Site Road Infrastructure Upgrade	EA

Key: EA — Environmental Assessment
 EIS — Environmental Impact Statement
 PEIS — Programmatic Environmental Impact Statement
 SEIS — Supplemental Environmental Impact Statement

^a Idaho National Engineering Laboratory

^b Three Rivers Solid Waste Authority

Policy Act") for implementation of the revised DOE regulations (10 CFR 1021) concerning NEPA compliance within the DOE complex was issued at the end of June 1995. This revision incorporates an expanded environmental evaluation checklist to include detailed permitting requirements and suggestions from previous appraisals and surveillances. The SRS department NEPA coordinator certification program trained 17 new department NEPA coordinators during 1995, and the site had 34 certified department NEPA coordinators within its various contractor organizations as of December 1995. In 1993, DOE-HQ had approved the use of 47 CXs for sitewide routine insignificant actions at SRS. These CXs require approval only at the department NEPA coordinator level in the field prior to project implementation. SRS was the first site in the DOE complex to be granted such authority within the NEPA compliance process. The site revised its computerized database/tracking system for both completed and ongoing SRS NEPA documentation. This database was developed for reporting and analysis purposes. The revised version includes enhanced access through an SRS NEPA Home Page.

As a result of the DOE NEPA secretarial policy issued in 1994, the site implemented several actions during 1995 that have continued to streamline the SRS NEPA process, resulting in substantial time and cost savings.

Also, SRS was awarded the NEPA Team Award at the DOE NEPA 25th Anniversary Meeting, held during March in the Washington, DC, area. The site received this award in recognition of work performed while preparing the F-Canyon Plutonium Solutions EIS. By the end of 1995, SRS had finalized and issued 38 EAs and 15 EISs for proposed DOE-SR actions.

Safe Drinking Water Act

The federal Safe Drinking Water Act (SDWA) was enacted in 1974 to protect public drinking water systems; it was amended in 1980 and 1986. The SRS drinking water supply is from groundwater sources. Thirteen of the 28 domestic water systems on site regularly serve more than 25 people each and meet the requirements for nontransient, noncommunity systems, which are regulated by SCDHEC. The remaining 15 systems, each of which serves fewer than 25 people, are classified as "state" systems by SCDHEC and receive a lesser degree of regulatory oversight.

SRS provides drinking water to the majority of its employees through the 13 nontransient,

noncommunity systems, which the site continues to work toward upgrading. Approval of the SRS Domestic Water Consolidation Preliminary Engineering Report was issued by SCDHEC May 24, 1993. The report recommended consolidation of 11 of the major site drinking water systems into three systems through the installation of

- three elevated storage tanks
- looped distribution piping
- a centralized water treatment facility

Plans had been to consolidate all 13 of the systems, but it subsequently was decided to reclassify the systems in L-Area and P-Area as small systems by 1997. Drinking water system consolidation, scheduled for completion by September 1997, replaces the upgrade plan submitted to SCDHEC in October 1991.

The consolidation project remains on schedule. As of December 1995, the following projects have been completed as part of system consolidation: K-Area water system (elevated storage tank, treatment, piping); D-Area water system (wells, elevated storage tank, treatment); A-Area water system (elevated storage tank); and piping upgrades in B-Area, N-Area (formerly Central Shops), D-Area, Forest Area, C-Area, and TNX-Area.

On November 15, 1993, WSRC received analysis results indicating that lead and copper concentrations in the domestic water system at the Savannah River Forest Station (SRFS) exceeded SDWA regulatory action levels. As a result of this exceedance, and in accordance with Lead and Copper Rule requirements, WSRC

- notified the system's users of the increased lead and copper levels within 60 days. (Removing the drinking water system from service was not required by the regulations. Bottled water had been made available and was being consumed in this area prior to the exceedance.)
- submitted a corrective action plan to SCDHEC within 6 months. The use of soda ash (pH adjustment) as a corrosion control measure was approved by SCDHEC September 7, 1994. A permit to operate was issued on May 3, 1995, for this soda ash feed system, thus meeting the September 7, 1996, deadline for construction and operation of an approved corrosion control treatment system.

During April 1994, lead and copper testing results in S-Area indicated a lead action level exceedance, which triggered the SCDHEC requirements for public notification, for development of an acceptable

corrective action plan, and for retesting by a certified laboratory. Corrective actions were completed according to the Lead and Copper Rule requirements.

To confirm the effectiveness of the approved corrective action plans in S-Area and Forestry Area, satisfactory retesting was completed on these systems by September 30, 1995. Both the systems are now compliant with the Lead and Copper Rule because neither exceeded the lead and copper action levels in the 90th percentile. As a result, SCDHEC's approval to proceed with reduced monitoring for the S-Area system was granted.

Clean Water Act

NPDES

The CWA of 1972 created the NPDES program, which is administered by SCDHEC under EPA authority. The program is designed to protect surface waters by limiting releases of effluents into streams, reservoirs, and wetlands. Radiological effluents are limited under DOE orders. Discharge limits are set for each facility to ensure that SRS operations do not adversely impact water quality.

SRS has five NPDES permits—two for industrial wastewater discharge (SC0000175 and SC0044903), two for general stormwater discharge (SCR000000 and SCR100000), and one for land application (ND0072125). Permit SC0000175 regulated 76 active NPDES outfalls at SRS during 1995. Seven additional NPDES outfalls were regulated under permit SC0044903. Of these 83 industrial wastewater outfalls, 72 discharged (operated) during 1995, six did not discharge, and five were not in service. All the operational outfalls were sampled, while the six that did not discharge continued to be monitored [SRS Data, 1996]. All analytical results, including those that indicated zero discharges at the six nondischarging outfalls, were reported to SCDHEC in the monthly discharge monitoring reports, according to the NPDES permit requirements.

NPDES permit compliance at SRS has steadily improved during the past 10 years. The following actions were taken by the site in 1995 to improve environmental protection:

- Chlorine disinfection systems were replaced with ultraviolet (UV) light disinfections systems, which significantly reduced the amount of chlorine released from site operations.
- The Central Sanitary Wastewater Treatment Facility (CSWTF) was placed in service in May. The CSWTF uses state-of-the-art treatment technology, including UV disinfection, and pro-

vides site treatment capacity for future growth. Eight areas were linked to the CSWTF, and associated outfalls were consolidated.

The site's 1995 compliance rate under the CWA was 99.8 percent, based on a permit-required minimum—for calculation purposes—of 8,000 analyses. The total number of analyses performed during 1995 was 7,515, compared to 7,568 in 1994 (fewer than 8,000 because of the six inactive outfalls and because DOE transferred responsibility for six outfalls from WSRC to Primesouth, Inc., the new D-Area Powerhouse contractor, in October). Nineteen of these analyses exceeded NPDES permit limits. A list of exceedances, including the outfall locations, probable causes, and corrective actions, can be found in chapter 8, "Nonradiological Effluent Monitoring."

In October 1995, SCDHEC personnel conducted a 2-week audit of SRS wastewater facilities, during which the facilities were inspected and the permitted NPDES outfalls were sampled for comparative purposes. All the facilities passed the operations/maintenance part of the audit. Sample analysis results will be available in early 1996.

Forty-eight stormwater-only point sources are covered under permit SCR000000 for stormwater discharges associated with industrial activity, excluding construction activity. The permit requires that the stormwater discharges be monitored, the samples evaluated, and the data collected. Of the 48 point sources, 11 representative outfalls are monitored. The outfalls represent a wide range of SRS activities, including

- storage, use, or disposal of EPCRA Section 313 chemicals
- land disposal units
- steam electric generation
- chemical and allied product manufacturing

As required by the general permit, a pollution prevention plan was developed and implemented in 1993 for the identified stormwater outfalls. The plan identifies facility areas where "best management practices" and/or "best available technology" should be implemented to prevent or mitigate the release of pollutants with stormwater runoff.

All construction activity that would result in a land disturbance of 5 or more acres must be permitted. Currently, the 10 land areas associated with industrial activity from construction activity are permitted as required under Permit SCR100000. The pollution prevention plan for this permit also requires a sediment reduction and erosion control plan.

Under the federal Oil Pollution Prevention regulation (40 CFR 112), SRS must report petroleum product

discharges of 1,000 gallons or more into or upon the navigable waters of the United States, or petroleum product discharges in harmful quantities that result in oil sheens. No such incidents occurred at the site during 1995.

SRS has an agreement with SCDHEC to report petroleum product discharges of 25 gallons or more to the environment. Three such incidents occurred at the site during 1995.

In May 1995, SCDHEC sent a formal draft NPDES permit to SRS for review and comment. This permit will combine NPDES permits SC0000175 and SC0044903 into one permit; both of them have expired but have been administratively extended. SRS comments on the formal draft NPDES permit were submitted to SCDHEC in May 1995. Among the changes proposed were

- a reduction in the number of outfalls
- consolidation of two existing NPDES permits into a single site permit

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act restricts the application of pesticides through a state-administered certification program. SRS's pesticide procedure provides guidelines for pesticide use and requires that applicators be state certified. A pesticide-use task group evaluates planned pesticide programs to ensure that they are acceptable and that appropriate pesticides are used so that any impact on the environment is minimal. The task group also

- maintains records of pest control activities
- assists in communicating information about pesticide use to other site contractors
- contacts offsite utility companies to determine the pesticide applications they plan for right-of-way maintenance on SRS property

SRS pesticide programs typically include such activities as the maintenance of roadways and fence lines through the use of herbicides.

Clean Air Act

Regulation, Delegation, and Permits

The CAA provides the basis for protecting and maintaining air quality. Some types of SRS air emissions, such as radioactive sources and ozone-depleting substances (ODS), are regulated by EPA, but most are regulated by SCDHEC, which must ensure that its air pollution regulations are at

least as stringent as the CAA's. This is accomplished through SCDHEC Regulation 61-62, Air Pollution Control Regulations and Standards.

Under the CAA and as defined in federal regulations, SRS is classified as a "major source" and, as such, is assigned one permit number (0080-0041) by SCDHEC. In this permit, each emission source is identified by the area designation, by a point identification number, and by a source description. SRS holds operating and construction permits from SCDHEC's Bureau of Air Quality Control, which regulates nonradioactive toxic and criteria pollutant emissions from approximately 194 point sources, several of which have specific emission limits. As of May 1994, SCDHEC had completed renewal of all SRS operating permits, which are valid for 5 years. Of the 194 point sources, 156 were in operation in some capacity during 1995. The remaining 38 sources either were under construction or were being maintained in a "cold standby" status.

During 1995, SCDHEC conducted 151 source compliance inspections at SRS, including biennial stack tests, initial operation inspections following completion of construction, and annual compliance inspections. As indicated earlier, the 1995 compliance rate was 99.3 percent, though the site did receive two NOV's (discussed in detail on page 28).

National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAP) is a CAA-implementing regulation that sets air quality standards for air emissions containing hazardous air pollutants, such as radionuclides, benzene, and asbestos. The NESHAP regulations found in 40 CFR 61 are divided into subparts based on specific hazardous pollutant categories, such as Subpart H for radionuclides and Subpart M for asbestos. The Clean Air Act Amendments (CAAA) of 1990 revised the original list of hazardous air pollutants. The revised list of 189 air pollutants includes all radionuclides as a single item. Regulation of these pollutants, except for radionuclides, has been delegated to SCDHEC; EPA Region IV regulates radionuclides.

SRS, like most South Carolina industrial complexes, uses a number of chemicals identified by SCDHEC as toxic air pollutants and by EPA as hazardous air pollutants. These include many common consumer products—e.g., off-the-shelf bug sprays, correction fluids, paints, sealers, janitorial cleaning supplies, gasoline for vehicles—as well as a number of typical industrial chemicals, such as degreasers, solvents, metals, batteries, and diesel fuel. But SRS has at least

one category, radionuclides, not found in typical industrial settings. During the course of normal operations, some radionuclides are released to the air.

NESHAP Radionuclide Program The SRS NESHAP radionuclide program continues to change to incorporate sampling, monitoring, and dose assessment practices that meet or exceed the requirements of 40 CFR 61, Subpart H. Work proceeded on schedule in 1995 under the radionuclide FFCA, which was signed October 31, 1991.

The first amendment to the FFCA for radionuclide NESHAP was signed by EPA Region IV on August 16, 1993. This amendment provided SRS an extension of the original FFCA through February 10, 1995, to accomplish monitoring equipment upgrades to several additional sources. These upgrades were completed on time, and the FFCA was officially closed by EPA Region IV on May 10, 1995.

During 1995, the maximally exposed individual effective dose equivalent, calculated using the NESHAP-required CAP88 computer code, was estimated to be 0.08 mrem (0.0008 mSv), which is 0.8 percent of the 10-mrem-per-year (0.10-mSv-per-year) EPA standard (chapter 7, "Potential Radiation Doses").

NESHAP Nonradionuclide Program SRS uses many chemicals identified as toxic or hazardous air pollutants, but the majority of these chemicals are not regulated under the CAA or under federal NESHAP regulations. Except for asbestos, SRS facilities and operations do not fall into any of the "categories" listed in the subparts. Under Title III of the federal CAAA of 1990, EPA in December 1993 issued a final list of hazardous air pollutant-emitting source categories potentially subject to maximum achievable control technology standards. These standards are being developed and issued over a 10-year period that will end in the year 2000, based on a schedule arranged according to

- the effects of each pollutant
- the industry group source category
- the abatement technology available

In an attempt to regulate hazardous or toxic air pollutants in South Carolina, SCDHEC established Air Pollution Control Regulation 61-62.5, Standard No. 8 ("Toxic Air Pollutants") in June 1991. To demonstrate compliance with this standard, SRS completed and submitted an air emissions inventory and air dispersion modeling data for all site sources in 1993. The submitted data demonstrated compliance by computer modeling the accumulated ambient

concentration of individual toxic air pollutants at the boundary line and comparing them to the Standard No. 8 maximum allowable concentrations. To ensure continued compliance with Standard No. 8, new sources of toxic air pollutants must be permitted, which requires submittal of appropriate air permit applications and air dispersion modeling. Sources with emissions below a threshold of 1,000 pounds per month of any single toxic air pollutant may be exempted from permitting requirements. During 1995, 10 sources of toxic air pollutants either were issued a construction permit or exempted from permitting requirements.

NESHAP Asbestos Removal Program Asbestos insulation, considered one of the best boiler and piping insulators, can be found in older buildings throughout SRS. This is because people were unaware of the danger of airborne asbestos fibers in the early 1950s, when SRS was constructed. Today, however, it is known that asbestos can cause cancer in humans. The site implemented an asbestos removal program in 1988.

Asbestos is removed during maintenance and renovations of equipment and buildings. During 1995, SRS removed 9,253 square feet of transite panel, which contains asbestos. Also removed were 3,486 linear feet and 1,678 square feet of asbestos pipe and surface insulation. This compares with 115,323 square feet of transite panel and 18,558 linear feet and 7,566 square feet of asbestos pipe and surface insulation removed during 1994. The 1995 amounts were significantly less than those in 1994 because no asbestos-containing materials were disposed of during the first 6 months of the year, when arrangements were being developed for offsite disposal of these materials. The amounts are expected to return to higher levels in 1996. Estimates of the percentage of total friable asbestos (a form that can be crumbled or pulverized with hand pressure when dry) removed from SRS cannot be accurately determined because it is not known exactly how much exists on site. SRS will continue to identify and remove such asbestos according to state (SCDHEC R.61-86.1) and federal (40 CFR 61, Subpart M) regulations and "best management practices."

Other CAA Requirements Only a few of the major sections of the CAA and its 1990 amendments and regulations have had—or are expected to have—a significant impact on SRS sources and facilities. These include Title V ("Operating Permit Program") and Title VI ("Stratospheric Ozone Protection"). The other regulations having impact on SRS facilities are implemented primarily in SCDHEC Regulation 61-62 and existing operating or construction permits.

Air Emissions Inventory SCDHEC Regulation 61-62.1, Section III ("Emissions Inventory"), requires compilation of an air emissions inventory. To demonstrate compliance, SRS personnel conducted a comprehensive air emissions inventory of all site facilities in 1993. Other purposes of this inventory were

- to ensure that all radiological and nonradiological sources had been accounted for
- to better characterize emission points from site processes
- to provide data for air dispersion modeling that had been required for compliance with Regulation 61-62.5, Standard No. 2 ("Ambient Air Quality Standards") and Standard No. 8.

Guidelines and procedures were written to ensure documentation of all vents and stacks for each building and to calculate emissions based on design capacity, maximum potential emissions, and actual emissions for a selected period of time.

The inventory identified approximately 5,300 radiological and nonradiological air emissions sources. Air emissions data from 1990 established the SRS baseline emissions. Calculations from the 1990 data demonstrated that SRS complied with Standard No. 8. The information from this inventory for all emission sources will be used as input into SRS's Title V permit application, as well as to meet other SCDHEC requirements. One such requirement is that inventory data must be *recorded* annually and *reported* every other year. Data from 1993 were *reported* in March 1994, and 1994 data were compiled and recorded as required in 1995. Compilation of 1995 data will be completed in 1996.

Title V Operating Program As previously indicated, the CAAA of 1990 also include, under Title V, a major new permitting section expected to have a significant impact on the site. The primary purpose of the Title V permitting program is to establish federally enforceable operating permits for major sources of air emissions. The implementation plan for this program, submitted to EPA in 1993 by the State of South Carolina and subsequently approved by EPA in June 1995, will require that SRS submit an extensive application package for air emission sources at SRS by March 15, 1996. The full impact on the site is not yet known because the source information and regulation applicability is still being determined. In addition to sources already on existing SCDHEC operating or construction permits, the new permit resulting from Title V may include sources previously "grandfathered" by existing

regulations and is expected to add a number of new regulatory requirements.

Ozone-Depleting Substances The CAAA of 1990 contained a chapter under Title VI addressing stratospheric ozone protection. This law requires that EPA establish a number of regulations to phase out the production and consumption of ODS. The substances commonly are used as refrigerants in air conditioning and cooling systems; degreasers and cleaners; spray can propellants; fire suppressants (Halon); laboratory extractions; and many other common consumer products.

Several sections of Title VI of the CAAA of 1990, along with recently established EPA regulations, apply to the site. The ODSs are regulated in two general categories: Class I substances—chlorofluorocarbons (CFCs), Halon, carbon tetrachloride, methyl chloroform, methyl bromide, and hydrobromofluorocarbons (HBFCs)—and Class II substances, or hydrochlorofluorocarbons (HCFCs). Class I ODSs are about 10 times more ozone-depleting than HCFCs and thus are more strictly regulated. As required by the CAAA of 1990, most Class I Halon was phased out of production by January 1, 1994, and other Class I ODSs will be phased out by January 1, 1996. This means that several very important refrigerants (CFC 11, 12, 114, and 502) used on site essentially will be unavailable for purchase after 1995. Many of the large chillers on site that use these refrigerants are being scheduled for total replacement or for retrofits that will use HCFCs or other chemical substitutes. The site also is scheduling fire suppression (Halon) system replacements. Many common degreasers are Class I ODSs and have been targeted for replacement. Most major degreasing applications already have been eliminated or replaced with non-ODS. Smaller ODS degreasing applications, such as those in maintenance and electrical shops, are being targeted for phaseout. ODSs used in laboratory extraction procedures will be replaced when EPA approves newly developed processes that use non-ODSs.

The SRS CAAA of 1990 Title V air permit application will include ODS emission sources. All large (greater than or equal to 50-pound charge) heating, ventilation, and air conditioning (HVAC)/chiller systems for which there are recordkeeping requirements will be included as fugitive emission sources.

In 1994, the site formed a CFC steering committee of participants from all the major users of these substances to provide initial direction in the phaseout of Class I ODSs on the site. A number of technical subcommittees also were initiated at that time to

address particular applications, such as refrigeration, fire suppression, degreasers, laboratory applications, and environmental compliance. The ODS Subcommittee of the Central Environmental Committee was created in 1995 to communicate to site organizations—through field representatives—any changes in Title VI regulations that could affect established programs. The “Savannah River Site Refrigerant Management Plan,” completed and issued in September 1994, provides guidance to assist SRS and DOE in the phaseout of CFC refrigerants and equipment.

The site has

- purchased certified recycling equipment
- trained and certified technicians where required
- implemented required recordkeeping and leak-tracking for large cooling systems
- implemented proper labeling and other record-keeping requirements

In 1995, SRS completed a final draft of a subcontract for the offsite reclamation of used refrigerants. By the end of the year, the draft was in the final stages of approval; the subcontract was expected to be let in January 1996.

Notices of Violations – CAA

SCDHEC issued an NOV to SRS under the CAA in March 1995 because operations personnel at the D-Area powerhouse failed to properly maintain continuous opacity monitors required for the coal-fired boilers. The NOV also cited failure to properly report periods of monitor down time or periods of startup and shutdown in the “Continuous Emission Monitor Quarterly Report” submitted to SCDHEC. The permit for the D-Area powerhouse boilers requires that continuous opacity monitors be installed, operated, and maintained and that a quarterly report be submitted to SCDHEC for all exceedances, periods of monitor down time, and startups or shutdowns. During the first quarter of 1995, several periods of monitor malfunctions and down time occurred on the monitor for the No. 4 boiler. A review by SCDHEC personnel of the quarterly report for this period determined that the monitors were not maintained properly and that the periods of monitor malfunctions and down time were not reported properly. The NOV did not result in any civil penalties but required that the cited problems be corrected immediately and noted that a repeat of the problems would result in further enforcement actions by SCDHEC.

SCDHEC issued an NOV to SRS in May 1995 for operation of unpermitted sources identified during annual inspections. An investigation following the inspection identified eight diesel-powered air compressors that had been placed into operation without first having the proper SCDHEC permits. The NOV did not result in any civil penalties but required that SRS submit appropriate permit applications for the unpermitted sources.

SCDHEC issued an NOV to SRS in August 1994 for lack of notification to the state for small demolition projects. An enforcement conference was held in September 1994, and SCDHEC submitted a proposed settlement agreement in December 1994. SCDHEC issued Settlement Agreement 95–27–A, which included a civil penalty for lack of notification to the state for small demolition projects, on March 8, 1995.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) gives EPA comprehensive authority to identify and control chemical substances manufactured, imported, processed, or used in the United States. Reporting and recordkeeping are mandated for new chemicals and for any chemical that may present a substantial risk of injury to human health or the environment. The site’s Environmental Protection Department (EPD) and Industrial Hygiene Section coordinate reporting and recordkeeping requirements under TSCA.

Polychlorinated biphenyls (PCBs), which are chemicals specifically regulated under 40 CFR 761 of TSCA, have been used in the past in various SRS processes. PCBs on site are in pre-1979 electrical equipment in the form of transformers, small capacitors, and fluorescent light ballasts. The site has a well-structured PCB program that complies with TSCA regulation 40 CFR 761, with DOE orders, and with WSRC policies. The 1994 PCB Annual Document Log was completed prior to the July 1, 1995, deadline in full compliance with the regulations. Disposal of PCBs from SRS is conducted at EPA-approved disposal facilities within the regulatory time frame.

In August 1993, PCBs were confirmed to be present as a component of dense nonaqueous phase liquids in samples from two groundwater monitoring wells around the M-Area hazardous waste management facility. Regulators were notified and a modification to the RCRA Part B Permit Application to address the discovery of PCBs was submitted to SCDHEC. Any waste generated was handled according to the appropriate TSCA and RCRA requirements. Savannah River Technology Center (SRTC)

continues to study ways to remediate the dense nonaqueous phase liquids. SRS had planned to submit a request to EPA for approval to conduct research and development field activities on the dense nonaqueous phase liquids, but it was determined in 1995 that such a request was not required because SRTC is not developing an alternative PCBs disposal technique.

PCB waste was generated by SRS during the late 1970s and early 1980s, and some of it was radioactively contaminated. Most of the radioactively contaminated waste resulted from a 1978 spill of PCBs from a failed electrical capacitor inside a nuclear materials processing area. TSCA regulations call for annual disposal of PCB waste, but there is insufficient capacity for offsite disposal of radioactively contaminated PCB waste. In July 1994, SRS submitted to EPA a request to conduct a treatability study (to develop an alternative to the regulation-required disposal methods) for this waste. The waste was moved in February 1995 to a vendor facility in Anderson, South Carolina, where the vendor began detailed characterization work, with EPA approval. EPA granted the SRS request (for a TSCA research and development permit) in August 1995, and the vendor subsequently began work on the treatability study.

During 1994, SRS flushed and refilled 20 site electrical transformers containing PCB-contaminated oil. This action was taken in an effort to reduce the PCB concentration in the transformer oil below regulatory limits. Successful conclusion of a regulatory-prescribed period of use and testing will allow the transformers to be reclassified as non-PCB. Work is continuing on this project, and followup PCB testing is expected to be completed in 1996. Work also is continuing in an effort to determine the source of PCB contamination in certain reactor facilities.

Endangered Species Act

The Endangered Species Act of 1973, as amended, provides for the designation and protection of wildlife, fish, and plants in danger of becoming extinct. The act also protects and conserves the ecosystems on which such species depend.

Several threatened and endangered species exist at SRS. The site conducts research on the wood stork, the red-cockaded woodpecker, the bald eagle, the shortnose sturgeon, and the smooth purple coneflower. Studies of the bald eagle on PAR Pond are being formulated to comply with the Endangered Species Act, as requested by the U.S. Fish and Wildlife Service. Programs designed to enhance the

habitat of such species also are in place. NEPA reviews of new projects at SRS in 1995 found no activities that would significantly impact endangered species. However, it was determined in July 1995 that some plants in a colony of smooth purple coneflowers had been impacted by a herbicide application on site utility rights of way earlier during the year. The impact was not extensive, but steps were taken to prevent recurrence, including the installation of additional identification signs around the colony's boundary.

National Historic Preservation Act

The National Historic Preservation Act of 1966, Section 106, governs the protection and preservation of archaeological and historical resources. SRS ensures that the site is in compliance with this act through the site-use process. All sites being considered for activities such as construction are evaluated by the University of South Carolina's archaeology group to ensure that archaeological or historic sites are not impacted. NEPA reviews of new projects at SRS in 1995 found no activities of significant impact in terms of the National Historic Preservation Act.

Floodplains and Wetlands

Under DOE General Provisions, 10 CFR, Part 1022 ("Compliance with Floodplains/Wetlands Environmental Review Requirements"), establishes policies and procedures for implementing DOE's responsibilities in terms of compliance with Executive Orders 11988 ("Floodplain Management") and 11990 ("Protection of Wetlands"). Part 1022 includes DOE policies regarding the consideration of floodplains/wetlands factors in planning and decision making. It also includes DOE procedures for identifying proposed actions involving floodplains/wetlands, providing early public reviews of such proposed actions, preparing floodplains/wetlands assessments, and issuing statements of findings for actions in floodplains.

Executive Order 11988, "Floodplain Management"

Executive Order 11988, "Floodplain Management," was established to avoid long- and short-term impacts associated with the occupancy and modification of floodplains. Evaluation of impacts to SRS floodplains is ensured through the NEPA Evaluation Checklist and the site-use system. Site-use applications are reviewed for potential impacts by WSRC, DOE-SR, SRFS, and the Savannah River Ecology Laboratory (SREL), as well as by professionals from other organizations. NEPA reviews of new projects at SRS

in 1995 found no activities of significant impact with respect to Executive Order 11988.

Executive Order 11990, "Protection of Wetlands"

Executive Order 11990, "Protection of Wetlands," was established to mitigate adverse impacts to wetlands caused by destruction and modification of wetlands and to avoid new construction in wetlands wherever possible. Avoidance of impact to SRS wetlands is ensured through the site-use process, various departmental procedures and checklists, and project reviews by the SRS Wetlands Task Group. Many groups and individuals, including scientists at SRTC, SREL, and EPD, review site-use applications to ensure that proposed projects do not impact wetlands. NEPA reviews of new projects at SRS in 1995 found no activities of significant impact with respect to Executive Order 11990.

Environmental Release Response and Reporting

Response to Unplanned Releases

The SRS environmental monitoring program extends beyond routine effluent monitoring and environmental surveillance activities. Upon notification by area operations personnel, the Environmental Monitoring Section (EMS) is prepared to respond to unplanned environmental releases—both radiological and nonradiological—as required.

If an unplanned environmental release is suspected, EMS personnel are dispatched—upon request—to collect appropriate samples. These samples are given priority in preparation and, if radiological in nature, priority in the count room. The data are validated and a determination is made as to whether there was an actual release. If there was, then consequences to the public and the environment are determined.

In 1995, there were a number of unplanned environmental releases, but only one event required the sampling and analysis services of EMS—the June 16 release of 10,700 curies of tritium (elemental) from H-Area. More information about this release is presented in chapter 5, "Radiological Effluent Monitoring."

Occurrences Reported to Regulatory Agencies

CERCLA requires notification of the National Response Center if a nonpermitted release of a reportable quantity (RQ) or more of a hazardous

substance (including radionuclides) is released to the environment. The CWA requires that the National Response Center be notified if an oil spill causes a "sheen" on navigable waters of the United States, such as rivers, lakes, or streams. Reporting of oil spills was reinforced with liability provisions in CERCLA's National Contingency Plan.

Other CERCLA provisions allow exemptions from reporting a release of an RQ or more of a hazardous substance if the release is covered by a continuous-release notification or if it is "federally permitted." A continuous-release notification provides an exemption from reporting each release of a specific hazardous substance greater than an RQ. The site submitted two continuous-release notifications in 1992—for ethylene glycol and for asbestos, each of which had a statutory RQ of 1 pound. Followup reports were submitted in 1993 for both of the 1992 notifications, but no additional reporting or notifications have been required since that time. EPA increased the RQ for ethylene glycol to 5,000 pounds effective July 1995, and SRS withdrew its request for continuous-release notification status (for ethylene glycol) in September 1995.

The four CERCLA releases reported to regulatory agencies during 1995 are described in table 2-5. This compares with two CERCLA releases reported during 1994, zero during 1993, three during 1992, and four during 1991.

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. There were no EPCRA reportable releases in 1995.

Federally permitted releases comply with a legally enforceable license, permit, regulation, or order. Under the Atomic Energy Act, for example, releases of SRS radionuclides are federally permitted as long as public dose standards in DOE orders are not exceeded.

Other regulations and agreements require that SCDHEC be notified when regulatory thresholds are exceeded. It is SRS policy to notify SCDHEC and the Georgia Department of Natural Resources (GDNR) of any occurrence that may interest state regulatory agencies. Although not required by law, these "courtesy notifications" enhance environmental protection objectives by providing state regulatory agencies the opportunity to review occurrences that may degrade the onsite environment. Five

Table 2-5
CERCLA Releases Reported to Regulatory Agencies in 1995

Date	Applicable Regulation/ Reason for Notification	Agencies Notified	Description
Feb. 13	Exceeded CERCLA RQ of 10 pounds	SCDHEC/ EPA	Approximately 125 gallons of benzene solution spilled in sump
June 16	Exceeded CERCLA RQ of 100 curies	SCDHEC/ EPA	Approximately 10,700 curies of tritium (elemental) released from H-Area
Aug. 5	Exceeded CERCLA RQ of one pound	SCDHEC/ EPA	Approximately 1 gallon of mercury-contaminated wastewater released
Aug. 9	Exceeded CERCLA RQ of visible sheen	SCDHEC/ EPA	Visible oil sheen observed from boat at SRTC boathouse

notifications were made in 1995, based on agreement with the state. Two were for sewage releases of more than 100 gallons and three were for petroleum spills of more than 25 gallons.

Site Item Reportability and Issues Management (SIRIM) Program

The Site Item Reportability and Issues Management (SIRIM) program, mandated by DOE Order 232.1 (which superseded DOE Order 5000.3B), "Occurrence Reporting and Processing of Operations Information," is designed to "... establish a system for reporting of operations information related to DOE-owned or operated facilities and processing of that information to provide for appropriate corrective action" It is the intent of the order that DOE be "... kept fully and currently informed of all events which could: (1) affect the health and safety of the public; (2) seriously impact the intended purpose of DOE facilities; (3) have a noticeable adverse effect on the environment; or (4) endanger the health and safety of workers."

The SIRIM program at SRS is designed to meet the requirements of DOE Order 232.1 by ensuring that

- all occurrences specified are identified in a timely manner, categorized, and reported
- proper corrective actions are taken in a timely manner
- all reportable occurrences are reviewed to assess significance and root causes
- occurrence reports to DOE operations are disseminated to prevent the recurrence of similar events

All SIRIM events are classified in one of the following categories: (1) facility condition; (2) environmental; (3) personnel safety; (4) personnel radiation protection; (5) safeguards and security; (6)

transportation; (7) value-based reporting; 8) facility status; or 9) cross-group items. The impact—or the anticipated impact—of each event is categorized as follows (based on criteria in site procedures):

- **Emergency** – the most serious event; requires increased alert status for onsite and, in specific cases, offsite authorities
- **Unusual occurrence** – a nonemergency event that has significant impact or potential for impact on safety, environment, health, security, or operations
- **Off-normal occurrence** – an abnormal or unplanned event or condition that deviates from established standards or specifications

In 1995, of the approximately 1025 SIRIM events reported to DOE-SR, 33 were categorized as primarily environmental. Of these 33 incidents, none were classified as emergencies, eight were classified as unusual occurrences, and 25 were classified as off-normal occurrences. Table 2-6 lists the eight unusual occurrences reported through SIRIM in 1995.

Assessments/Inspections

The SRS environmental program is overseen by a number of organizations, both outside and within the DOE complex. In 1995, the WSRC environmental appraisal/surveillance program was replaced with a consistent, comprehensive, integrated assessment program of self and independent assessments. The new program employs total-quality management concepts that support the site's four imperatives of safety, disciplined operations, continuous improvement, and cost effectiveness. It also ensures recognition of noteworthy practices, identification of performance deficiencies, and initiation and tracking of associated corrective actions until they are satisfactorily completed. The primary objectives of the WSRC assessment program are to ensure

Table 2-6
Environmentally Related Unusual Occurrences Reported Through SIRIM in 1995

Discovery Date	Occurrence	Report No. (SR--WSRC--)	Cause/Explanation ^a
Feb. 9	Organic liquid leak from precipitate hydrolysis experimental facility	TNX-1995-0003	Frozen water, containing benzene, displaced gasket on discharge side of organic evaporation pump; leak occurred when water thawed
Feb. 24	Waste treatment plan equalization basin overflow	WVIT-1995-0015	Basin overflowed because of human error
March 20	Notice of Violation of opacity monitor requirements	POD-1995-0007	Maintenance of opacity monitors did not meet requirements. Reporting requirements not properly communicated to personnel
June 1	Spill of approximately 60 gallons of hydraulic fluid in 643-E	SLDHZD-1995-0016	Leak caused by failure of worn hydraulic line hoses at crimp point on track hoe
June 7	Unpermitted discharge in 716-1N	CMD-1995-0003	716-1N is closed-loop, heavy-equipment wash station with emergency overflow; facility not permitted by SCDHEC for discharges because it is closed-loop system; heavy rains caused clean-water storage tank to overflow; site NPDES permit required immediate notification of SCDHEC because of unpermitted discharge
Aug. 7	Spill of hazardous material from recycle collection tank	WVIT-1995-0046	Approximately 1 gallon of water, possibly contaminated with mercury, spilled when coupling corroded through and fell from pipe support on recycle collection tank
Aug. 9	Release of fuel contaminants from submerged boat to PAR Pond	LTA-1995-0084	Boat sank at SRTC boathouse because rubber boot (bellows) connecting external drive unit to transom cracked; release was CERCLA reportable because visible oil sheen observed from boat
Oct. 3	Groundwater contamination 75 times above the safe drinking water limit	REACL-1995-0024	Because of past operating practices, soil in the 108-3L fuel unloading area became contaminated with fuel oil; analysis indicated that the groundwater was contaminated

^a SRS takes followup corrective actions to minimize the impact on the environment.

compliance with regulatory requirements and to foster continuous improvement.

In addition to the assessment program, DOE-SR's Environmental Compliance Division (ECD) ensures—through independent reviews of SRS environmental protection programs and activities—that SRS contractors comply with federal and state environmental regulations, applicable DOE orders, and accepted industry standards.

ECD operates under the Comprehensive Environmental Protection Assessment Program to identify proficiencies and deficiencies in SRS environmental protection programs and activities according to DOE Order 5482.1B, "Environment, Safety, and Health Appraisal Program," and other environmental requirements. The goal of these routine assessments is to promote improvement and to ensure the adequacy of environmental programs and operations at SRS. The assessments—program-

matic and sitewide in scope—are the functional equivalent of appraisals, as defined in DOE Order 5482.1B.

Among the environmental activities assessed by ECD in 1995 were

- management of empty aerosol cans containing hazardous materials
- used-oil management
- wastewater characterization
- affirmative procurement
- solid low-level waste management
- investigation-derived waste management
- ambient water quality and watershed management
- pollution prevention/recycling

SCDHEC also inspects the SRS environmental program for regulatory compliance. SCDHEC representatives performed three comprehensive compliance inspections in 1995, as follows:

- During the period April 17-21, annual air compliance inspections were conducted for 59 of the site's 156 operating permitted air emission sources. The air emission sources were in compliance, but an unpermitted, diesel-powered air

compressor was found, and SCDHEC issued an NOV (discussed on page 28) to SRS as a result of the finding.

- During the period April 10-21, the annual comprehensive monitoring evaluation for compliance with hazardous waste management regulations at SRS was conducted. The evaluation generated a satisfactory rating for the site.
- During the period October 9-20, annual operation and maintenance inspections were performed at SRS wastewater treatment facilities, and grab and composite samples were collected at site NPDES discharge points. No deficiencies were noted at the time of the inspection, but SCDHEC is expected to issue a final report—including category ratings—in early 1996.

SCDHEC also performed numerous other routine compliance inspections during the year.

Environmental Permits

SRS has 627 construction and operating permits that specify operating levels for each permitted source. This compares with 591 such permits in 1994, 550 in 1993, 481 in 1992, and 459 in 1991. Table 2-7 summarizes the permits held by the site during the last 5 years. Appendix B ("SRS Environmental Permits") of this report provides a comprehensive list of the permits, including the permit number, type of permit, and permitted source.

Table 2-7
SRS Construction and Operating Permits

Type of Permit	Number of Permits				
	1991	1992	1993	1994	1995
Air	133	134	172	189	200
C.O.E. (Corps of Engineers) 404	1	1	1	1	0
Domestic Water	111	127	146	152	165
Industrial Wastewater	79	75	79	83	90
NPDES—Discharge	2	2	2	2	2
NPDES—No Discharge	0	0	1	1	1
NPDES—Stormwater	0	1	2	2	2
RCRA	1	1	1	1	1
Sanitary Wastewater	112	119	120	133	133
SCWRC 401	1	1	1	1	1
Solid Waste	6	6	6	6	6
Underground Injection Control	2	3	6	7	13
Underground Storage Tanks	11	11	13	13	13
Totals	459	481	550	591	627

The refilling of PAR Pond following repairs to its dam was completed in March 1995. A depression had been discovered on the downstream face of the dam in 1991. This aerial photograph shows the dam's outfall structure and the large siphons draining the pond. The darkened area above the water level indicates the extent to which sediments were exposed during the drawdown.

EG&G/EM, Inc., Photo
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Environmental Training

The site's environmental training program identifies training activities to teach job-specific skills that protect the employee and the environment while satisfying regulatory training requirements. Chapter 3 contains more information about the training program.

Transition and Decontamination and Decommissioning

As the mission for selected facilities at SRS shifts from a national defense initiative to one of cleanup and environmental restoration, efforts and activities continue toward implementing a transition of selected site facilities to the environmental restoration division of DOE and initiating decontamination and decommissioning (D&D) activities.

Other Major Environmental Issues and Actions

Key SRS compliance issues addressed during 1995 included

- PAR Pond repair/refill
- tritium migration

PAR Pond Repair/Refill

PAR Pond, a 2,640-acre reservoir constructed in 1958 on Lower Three Runs Creek, served as a recirculating

cooling reservoir for P-Reactor and R-Reactor. In March 1991, an inspection of the PAR Pond dam revealed a depression on the downstream face. The reservoir was drawn down, reducing the original volume by about two-thirds. The drawdown exposed about 1,300 acres of sediments containing both radioactive and nonradioactive contaminants. In March 1992, the exposed sediment area of the pond was declared an operable unit to be addressed under CERCLA. WSRC's Site Services Engineering and Environmental Protection departments recommended repairing and refilling the pond. Repairs were completed in August 1994; the PAR Pond Interim Action Proposed Plan was approved in November 1994; and a 30-day public review and comment period was initiated the next month. The Interim Action PAR Pond ROD, which supported refilling the pond, was issued in February 1995. The refill began that month and was completed by mid-March 1995.

Tritium Migration

The Trans-River Flow Project was initiated in 1988 to address Georgia officials' concerns about the possibility that tritium-contaminated groundwater was migrating from SRS to Georgia. U.S. Geological Survey research has confirmed that no threat exists from the tritium in question. The research is complemented by a GDNr project investigating possible tritium contamination of the Upper Three Runs aquifer, and work continued in 1995 on both of the projects, which are being funded by DOE. The progress of these efforts is detailed in chapter 12, "Special Surveys and Projects."

Environmental Program Information

To Read About . . .

Turn to Page . . .

<i>Environmental Monitoring</i>	35
<i>Dose Reconstruction Study</i>	40
<i>Pollution Prevention</i>	40
<i>Information Exchange</i>	43
<i>Public Outreach</i>	43

THIS chapter provides a general overview of environmental programs at Savannah River Site (SRS). Two goals of these programs are to measure the effects of contaminants released from site operations and to reduce the amount of these contaminants. Specific examples in this chapter will show how achievement of these goals during 1995 helped the site accomplish its mission.

The goal of environmental monitoring at SRS is to measure site releases that could affect human health and natural resources. Results of these measurements provide a technical basis for corrective actions and generate data that demonstrate compliance with applicable federal, state, and local regulations, as well as with U.S. Department of Energy (DOE) orders. Data from environmental monitoring and site operations are being evaluated independently by the Centers for Disease Control and Prevention (CDC) as part of the SRS Dose Reconstruction Project.

The goal of pollution prevention is to reduce the impact of site operations on the environment by focusing on source reduction, on recycling, and on increasing employee awareness of—and participation in—waste minimization. Other activities—such as employee awareness and training, information exchange, and public outreach—offer ways to provide job-related knowledge and skills; to share information about site operations, programs, and objectives; and to address public concerns.

Additional environmental monitoring information in this report is provided in chapters dealing specifically with

- radiological environmental surveillance (chapter 6)
- nonradiological effluent monitoring (chapter 8)
- nonradiological environmental surveillance (chapter 9)
- groundwater monitoring (chapter 10)

Environmental Monitoring

SRS environmental monitoring, which includes both onsite and offsite activities, is the responsibility of the Environmental Monitoring Section (EMS) of Westinghouse Savannah River Company's (WSRC) Environmental Protection Department (EPD). Other site operating groups—including Radiological Control Operations (RCO), Savannah River Technology Center (SRTC), Savannah River Ecology Laboratory (SREL), Savannah River Forest Station (SRFS), and Savannah River Archaeological Research Program (SRARP)—have their own environmental programs and conduct public outreach activities. Also, the Division of Environmental Research of the Academy of Natural Sciences of Philadelphia has performed biological and water quality surveys of the Savannah River since 1951.

Effluent monitoring is conducted by collecting and analyzing onsite samples of liquid and airborne effluents taken at or very near their points of discharge to the environment. In 1995, more than 4,300 samples were taken at 78 points of discharge. This activity meets regulatory requirements and provides source terms for calculating potential offsite radiation doses. More information about these calculations can be found in chapter 7, "Potential Radiation Doses."

Environmental surveillance is conducted by collecting and analyzing onsite and offsite samples

- radiological effluent monitoring (chapter 5)

Effluent Monitoring versus Environmental Surveillance

Per DOE Order 5400.5, "Radiation Protection of the Public and the Environment":

Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposure to members of the public, and demonstrating compliance with applicable standards.

Environmental surveillance is the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

Monitoring occurs at the point of discharge, such as an air stack or drainage pipe; surveillance involves looking for contaminants in the environment.

taken at various distances from points of discharge. In 1995, more than 100,000 radiological analyses were performed on approximately 25,000 samples (not including groundwater). Data from environmental surveillance are evaluated to

- determine the effects, if any, of SRS releases
- provide a way to verify dose calculations and predictions from mathematical models

Because SRS handles plutonium, tritium, and other special nuclear materials, much of the site's environmental monitoring effort is focused on collecting—and analyzing for radioactive materials in—samples of airborne and liquid effluents released during routine operations. A typical setup for airborne effluent monitoring is illustrated in figure 3-1. As shown, radioactive materials are

monitored at their points of discharge and tracked as they disperse into the surrounding environment.

Because most contaminants are released in such small amounts that they cannot be readily measured in environmental samples, SRS uses mathematical models to estimate contaminant concentrations in environmental media. The data obtained at the point of discharge (e.g., stack, pipe, or outfall)—where the concentration would be highest if a contaminant were present—is used to calculate the estimated contaminant concentration in sampled media, such as water, soil, or vegetation. More information about this modeling can be found in chapter 7.

RCO and EMS share the responsibility for radiological effluent monitoring. RCO collects and screens air and liquid samples from regulated (radiologically controlled) areas and maintains

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Figure 3-1 Typical Airborne Effluent Monitoring and Environmental Surveillance

Effluents are monitored at points of discharge; released materials of concern are tracked in the environment.

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Figure 3-2 Typical Liquid Effluent Monitoring and Environmental Surveillance

Effluents are monitored at points of discharge. Released materials of concern are tracked in the environment.

monitoring equipment on stacks and at some liquid effluent discharge points. EMS collects and analyzes most liquid effluent samples. Following validation, results of these analyses are recorded in a monthly radioactive releases report. Data from the monthly reports are summarized in an annual data publication (in 1995, *Savannah River Site Environmental Data for 1995*, WSRC-TR-96-0077).

Though much of the environmental monitoring program focuses on radioactive materials, considerable effort also is dedicated to nonradioactive materials. The primary purpose of the nonradiological monitoring program is to ensure that the physical and chemical properties of airborne and liquid releases meet federal and state standards.

Monitoring for nonradioactive contaminants in airborne effluents at SRS is designed to show compliance with permits issued by the South Carolina Department of Health and Environmental Control (SCDHEC). These permits are discussed further in chapter 2, "Environmental Compliance," and listed in appendix B, "SRS Environmental Permits." The major nonradiological airborne emissions of concern from SRS stacks include sulfur dioxide, oxides of nitrogen, total particulate matter, and toxic air pollutants, such as tetrachloroethylene (TCE), perchloroethylene (PCE), benzene, and hydrochloric acid. As part of a network associated with the federal Clean Air Act, Georgia and South Carolina

environmental agencies verify permit compliance by monitoring ambient air quality near SRS. Clean Air Act Amendments, implemented in 1990, require federal facilities, such as SRS, to comply with provisions of the act.

Nonradioactive liquid effluents generally are sampled at National Pollutant Discharge Elimination System (NPDES) outfalls (points of discharge) and reported to SCDHEC in a monthly discharge monitoring report, as required by the Clean Water Act. Monitoring requirements for liquids may vary at each outfall, depending on the type of facility and the known characteristics of the wastewater. In addition to the monitoring conducted at outfalls, surveillances are conducted through the collection and analysis of samples from site streams and the Savannah River to verify the outfall sampling data and to ensure the detection and characterization of materials that could adversely affect the environment. Adverse conditions resulting from the presence of such materials are identified and evaluated to provide a basis for corrective action. A typical setup for liquid effluent monitoring is shown in figure 3-2.

Policy

SRS policy requires an environmental monitoring program designed to

- establish effluent and ambient levels of radionuclides and other discharges

- determine trends in these releases
- provide a basis for dose assessment to humans and the environment
- provide information needed to detect and correct problems

SRS is committed to sharing this information with the public and its representatives.

Objectives

The purpose of many environmental regulations is to protect human health and the environment. In support of this purpose, the SRS environmental monitoring objectives are to

- assess actual or potential exposures of radioactive and nonradioactive materials to critical groups and populations from normal site operations or from accidents
- demonstrate compliance with authorized limits and regulatory requirements
- verify the adequacy of each facility in containing radioactivity and controlling effluents
- notify appropriate officials of unusual or unforeseen conditions and, if necessary, to activate a special environmental monitoring program
- communicate accurate and effective EMS monitoring results to DOE, to other government agencies, and to the general public
- maintain an accurate and continuous record of the effects of SRS operations on the environment
- determine concentrations of radioactive and nonradioactive contaminants in environmental media for the purpose of assessing the immediate and long-term consequences of normal and accidental releases
- distinguish between environmental contamination and effects from SRS operations and those from other sources
- evaluate and revise the environmental monitoring program in response to changing conditions in transfer pathways
- provide site-specific data for risk assessment for human populations near SRS
- conduct scientific studies on the transfer pathways of radioactive and nonradioactive contaminants in the environment
- assess the validity and effectiveness of models used to predict the concentration of pollutants in the environment

- determine the long-term buildup of—and predict environmental trends from—site-released contaminants
- establish baselines of environmental quality so that trends in the physical, chemical, and biological condition of environmental media can be characterized
- identify and quantify new or existing environmental quality problems, then assess the need for corrective actions or mitigation measures
- pinpoint exposure pathways in which contaminants are accumulated and transmitted to the public

These objectives incorporate the recommendations of the International Commission on Radiological Protection (“Principles of Monitoring for the Radiation Protection of the Public,” ICRP Publication 42), of DOE Order 5400.1 (“General Environmental Protection Program”), and of DOE/EH-0173T (“Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance”).

Rationale

Many factors are considered in the determination of monitoring activities at SRS, including good environmental stewardship. Sampling locations, sample media, sampling frequency, and types of analysis are selected on the basis of environmental regulations, exposure pathways, public concerns, and measurement capabilities. More detailed information about the site’s environmental monitoring activities program is documented in sections 1101–1111 (SRS EM Program) of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1, which was issued in June 1995. This document is reviewed annually and updated every 3 years.

Environmental Regulations

Environmental monitoring at SRS is designed to meet state and federal regulatory requirements for radiological and nonradiological programs. These requirements are stated in DOE orders 5400.1 and 5400.5 (“Radiation Protection of the Public and the Environment”); in the National Emission Standards for Hazardous Air Pollutants (NESHAP); in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA—also known as the Superfund); in the Resource Conservation and Recovery Act (RCRA); and in the Clean Water Act (i.e., NPDES). SCDHEC, the U.S. Environmental Protection Agency (EPA), and DOE conduct audits to verify that the site complies with

Figure 3-3 Potential Exposure Pathways
Airborne and liquid releases of materials from SRS operations can reach people in a variety of ways. These ways, or routes, are called exposure pathways.

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environmental regulations. Chapter 2 summarizes the site's compliance status for 1995.

Exposure Pathways

Materials released from SRS reach the environment and people in a variety of ways. The routes that materials follow to get from an SRS facility to the environment and then to people are called exposure pathways. Some potential exposure pathways are illustrated in Figure 3-3, which shows that airborne effluents can be ingested directly by inhalation or indirectly as a result of their deposition on crops, followed by ingestion of the crops. Liquid effluents can be ingested directly from drinking water or indirectly by eating aquatic food that previously has taken up the effluents.

The method used to determine exposure pathways is called a critical pathways analysis. In a limited critical pathways analysis completed in 1993, nine radionuclides released from SRS facilities each year were identified as potentially significant contributors to offsite doses; that is, they each represented more than 1 percent of the total dose [Arnett, 1993]. These radionuclides were tritium; strontium-90; iodine-129; iodine-131; cesium-137; uranium-235,238; plutonium-238; and plutonium-239.

A more complete and thorough critical contaminant/critical pathways analysis was initiated in October 1995 by SRTC's Environmental Dosimetry Group in response to a request from

DOE's Savannah River Operations Office. This analysis should be completed by October 1996. Critical pathways analysis results are used in the site's environmental monitoring activities to make decisions about sampling locations, sample media, and sampling frequency.

Results from modeling an exposure pathway can help

- verify that a sampling network performs as required
- make the best use of available resources for sampling and analysis

Public Concerns

Public concerns influence the site's environmental monitoring activities. The public wants to know about releases and their effects. One aspect of environmental monitoring that addresses a public concern is the placement of thermoluminescent dosimeters (TLDs) in offsite locations. These dosimeters provide a quick, reliable method of determining the dose from gamma-emitting radionuclides in the event of an unplanned release of radioactive material.

Measurement Capabilities

Many materials released from SRS exist in such low concentrations in the environment that they cannot be readily measured. Thus, measurement capabilities become significant factors in the rationale for monitoring certain materials. In these cases, modeling with nationally accepted computer programs is used

to predict or estimate concentration levels. More information on modeling can be found in chapter 7, more on measurement capabilities in *Savannah River Site Environmental Data for 1995*.

1995 Program Changes

The types, frequencies, and locations of environmental measurements are reviewed annually to determine how best to structure the monitoring program. If a clear rationale for a measurement no longer exists, the measurement is deleted from the program. Likewise, the program is modified as new sampling/analytical methods and needs evolve.

In January—in order to fully implement a NESHAP requirement—a correction factor was applied by EMS to calculations for airborne emissions to account for potential source-term underestimation caused by particulate deposition within sample lines (“line-loss”). A line-loss factor’s size is determined by the stack sampling system and the radionuclide emitted. For most locations, including all major sources of radioactive releases from SRS, the line-loss factor has been verified to be 1, which means no loss of sample. For some locations, where line-loss cannot be verified, the factor is conservatively set as high as 20 to account for the unknown value. This means that results reported in 1995 from these unverified locations were up to 20 times higher than what was reported in 1994, simply because the correction factor was implemented.

In July, EMS implemented a newly developed, single procedure to analyze for uranium, plutonium, americium, and curium in water and air filters. The procedure eliminates the production of mixed (radioactive/hazardous) waste by the analysis. Also, it provides nuclide-specific values for these nuclides—and replaces the old uranium/plutonium and americium/curium procedures. In addition, the new method can detect lower concentrations of these nuclides than the old procedure.

In August, SRS reduced offsite environmental surveillance of the following sample media and sampling locations: soil and vegetation; municipal drinking water; 100-mile air surveillance; 25-mile air surveillance; population TLD monitoring; and food product monitoring. The rationale discussed on page 38 was used to decide which samples to eliminate. More information about these program changes is provided in chapter 6, “Radiological Environmental Surveillance,” and chapter 9, “Nonradiological Environmental Surveillance.”

Dose Reconstruction Study

SRS has conducted environmental monitoring and evaluated the effects of radioactive materials and chemicals released to the environment since the early 1950s. An independent evaluation of what effects these materials may have had on people living near the site is being conducted by the CDC.

Phase I of the SRS Dose Reconstruction Project began in October 1992. Its purpose was to locate and review records—from SRS and other sources—that could be used in the dose reconstruction process. This phase was completed in June 1995. More than 34,000 boxes of documents were searched, with more than 260,000 pages of potentially useful documents identified.

Two reports were published to summarize the evaluation of materials released from SRS and to identify environmental monitoring and research data [CDC Task 3, 1995, and CDC Task 4, 1995]. The Task 3 report describes methods used to qualitatively characterize the historical use and potential release of chemicals and radionuclides at SRS since the beginning of site operations. The Task 4 report identifies, catalogs, and evaluates historical environmental and research information—in terms of usefulness, limitations, and quality—that could be used to support a dose reconstruction. Copies of these reports are available to the general public in the DOE Reading Room at the University of South Carolina-Aiken.

Inquiries can be made about the study—and related information provided—by writing to: Centers for Disease Control, 4770 Buford Highway NE, MS F35, Atlanta, GA 30341-3724m, or call 404-488-7040 (FAX 404-488-7044).

In Phase II of the study, which began in September, the CDC will estimate the amount of materials released (the source term) since SRS began operations in 1952 and will reconstruct—through pathways analyses and dose assessments—the doses that the public has received from these materials. This information will be used to assess the possibility of health effects, attributable to site operations, in the population around the site. Phase II is expected to be completed in 1997.

Pollution Prevention

Pollution prevention at SRS is designed to reduce the impact of site operations on the environment. Pollution prevention at the site includes

- source reduction activities
- recycling of wastes and pollutants

Disinfection Process Improvement

In 1995, chlorine was replaced with ultraviolet (UV) light in the disinfection systems of Savannah River Site's (SRS) sanitary treatment plants. Like chlorine, UV light kills pathogenic organisms.

The new systems provide two major benefits:

- ◆ they reduce the amount of waste generated at the treatment plants
- ◆ they eliminate chlorine contamination of the surrounding environment

- reduction in the use of materials, energy, water, and other resources
- protection of natural resources and human health through conservation or more efficient use
- disposal of waste in an environmentally safe manner

Pollution prevention programs permeate many activities, organizations, and implementation teams. Improvements in the coordination and communication between these program areas are ongoing, and employee awareness of—and management emphasis on—pollution prevention is increasing. The *Westinghouse Savannah River Company Waste Minimization and Pollution Prevention Plan* (WSRC-RP-95-36) provides program details. Highlights of 1995 SRS pollution prevention activities are discussed in the following paragraphs.

Solid Waste Reduction

During 1995, the solid waste reduction program was increased in scope through the reassignment of certain waste certification program personnel. SRS partnered with industry in technology exchanges that strengthened the radioactive waste reduction program. In 1995, the site achieved a 9-percent reduction in its radioactive waste generation volume, compared to 1994.

Waste Minimization

The waste minimization program at SRS continued in 1995 to reduce various wastes that require costly treatment, storage, and disposal. According to Solid Waste Management Department records, total solid radioactive waste volumes declined by about 63 percent, or more than 600,000 cubic feet, from 1991 through 1995. This is attributable to waste minimization, volume reduction, and changing site missions. In 1995, 78 Pollution Prevention

Opportunity Assessments resulted in 110 recommendations that have the potential to save more than 100,000 cubic feet of disposal space.

Solid Waste Recycling

Sanitary waste volumes have declined because of recycling initiatives. In 1995, more than 3,300 tons on nonradioactive materials were recycled at SRS, including 1,062 tons of paper and cardboard. This 8 percent increase over 1994 is attributed to greater employee participation in the recycling program.

Energy Conservation

Reducing site demand for energy in turn reduces emissions and conserves resources associated with energy production. A comprehensive energy conservation program and site mission changes helped drive down facility energy consumption in Btu per gross square foot by more than 40 percent from 1985 to 1995. In April 1995, SRS received funding for energy conservation retrofits to 50 administrative buildings through DOE's In-house Energy Management Program.

Reduction of Chemical Releases

Under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA), SRS has filed Toxic Chemical Release Inventory reports annually since 1987. The site calculates chemical releases to the environment and reports aggregate quantities for each regulated chemical that exceeds threshold amounts. Between 1987 and 1994, reportable release quantities have declined by 95 percent. More about Toxic Chemical Release Inventory reports can be found in chapter 2.

National Awards for Waste Activities

Savannah River Site (SRS) employees earned three national awards for environmental initiatives in 1995.

The awards were presented for

- ◆ the 1994 Earth Day Waste Minimization Suggestion Program
- ◆ solid waste recycling program and awareness activities
- ◆ SRS's White Paper Reduction Program, which is part of solid waste recycling.

Awards for the first two categories were presented at the U.S. Department of Energy's (DOE) Pollution Prevention Conference XI in May. The third was presented at the White House in September.

Cost-Saving Initiatives

Cost effectiveness is one of the four site imperatives that are among the factors considered when determining monitoring activities at SRS. Some of the 1995 results of the cost effectiveness imperative are described below. (Other imperatives are safety, conduct of operations, and continuous improvement.)

Affirmative Procurement of Recycled Products

Savannah River Site (SRS) contractors purchased more than \$2.13 million worth of products containing recovered or recycled material, compared to \$1.14 million worth in 1994.

Excess-Chemical Management

More than \$200,000 was saved through redistribution of excess chemicals. Contributing to this savings was the implementation of procedural controls for excess chemicals.

Disinfection Process Improvement in Site Sanitary Treatment Plants

This improvement, which is described on page 41, saved approximately \$1 million in capital costs.

Training

In September, to reduce the costs associated with offsite training, SRS granted an offsite vendor a contract to provide annual multiple instruction for 13 courses on environmental regulations.

Affirmative Procurement of Recycled Products

The SRS Affirmative Procurement Plan promotes the purchase of products in EPA-designated recycled-product categories to conserve natural resources. The plan follows federal guidance for implementing affirmative procurement requirements at DOE sites. In November 1994, SRS contractors submitted affirmative procurement reports that describe the yearly site purchases of products in the EPA-designated recycled-product categories. The reports are an annual requirement of Executive Order 12873 and RCRA Section 6002. Recycled-product purchases included paper and paper products, toner cartridges, construction materials, and other office products and supplies.

Excess-Chemical Management

The Chemical Commodity Management Center was created and staffed in 1994. The center's purpose is to ensure environmentally sound, safe, and cost-effective acquisition, distribution, and reuse of chemicals for the site.

Ozone-Depleting Substances

The Clean Air Act Amendments of 1990 require that EPA publish a number of regulations to phase out the production and consumption of ozone-depleting substances. The *Savannah River Site Refrigerant Management Plan*, issued in September 1994, provides guidance to assist SRS in meeting the requirements of these regulations. More information

about ozone-depleting-substances activities at SRS can be found in chapter 2.

Employee Awareness/Training

SRS environmental awareness and training programs help achieve environmental goals at the site. SRS is committed, as a matter of policy, to maintaining its facilities and conducting its operations in full compliance with all applicable laws and regulations for the protection of the environment and of the health and safety of its employees and the general public. The awareness program is designed to communicate SRS environmental philosophy and policy to the employees. The training program identifies training activities to teach job-specific skills that protect the environment and satisfy regulatory requirements.

Awareness

In 1988, the first Environmental Awareness Day at SRS focused on the theme "Savannah River Plant: Protecting the Future." The environmental awareness emphasis in 1994 was on employee action, with the theme "You Can Make a World of Difference." Employees were encouraged to submit their ideas on pollution prevention, waste minimization, and general environmental protection. More than 1,200 ideas were submitted and ultimately shared with site employees to increase overall environmental awareness, and many of the ideas were implemented in 1995.

The Green Building Program, piloted in November 1994, was implemented sitewide in 1995 as 18

facilities received "Green Building" status. The program includes signed contracts by the employees in specific buildings whereby the employees commit to making pollution prevention and waste minimization a daily habit and part of the SRS culture. The program incorporates such practices as recycling paper, cardboard, and aluminum; replacing plastic foam cups with paper cups or ceramic coffee mugs; encouraging double-sided copying; and outfitting the buildings for water and energy conservation.

Training

Environmental training at SRS addresses federal and state regulations. The focus is on required training and recommended education courses for employees (based on responsibility) involved with environmental oversight, hazardous materials, and waste management at the site.

Environmental training activities in 1995 included the following:

- Nearly 1,000 site workers attended Hazardous Waste Operations (HAZWOPER) courses (29 CFR 1910.120), which provide health and safety training in hazardous-waste cleanup activities and in working at RCRA treatment, storage, and disposal facilities.
- More than 16,000 site workers took the Consolidated Annual Training course to meet general training requirements, including some environmental training.
- The Water/Wastewater Continuing Education Course, which is delivered by computer-based training, won a Westinghouse Corporate Award for Service Excellence in the training category. About 350 site employees received this training in 1995.
- The SRS Central Environmental Committee Executive Committee sponsored two training sessions to teach the practical side of environmental coordination for the site's 300–400 environmental coordinators.

Information Exchange

SRS has opened several avenues of exchange with state and federal regulators, other government-owned, contractor-operated (GOCO) facilities, and scientists to improve and update its environmental monitoring and research programs.

DOE–Savannah River Operations Office (DOE–SR) representatives attend DOE Headquarters (DOE–HQ)-sponsored technical information

exchange workshops, which provide a way to enhance the exchange of technical information among DOE sites.

Environmental awareness and information exchange tours are conducted for many special-interest groups, including environmental activists and representatives of other GOCOs, of DOE–HQ, of Westinghouse Corporate, of EPA, and of SCDHEC. Tours are designed to meet the needs of a particular group. For example, EPA and SCDHEC tours might focus on regulatory issues, while visitors from other GOCOs might be interested in activities applicable to their own programs.

The Environmental Advisory Committee, which is comprised of nationally recognized consultants from the fields of biology, ecology, hydrogeology, health physics, environmental restoration, and economics, meets quarterly to review site environmental programs and make recommendations. In 1995, this group formally reviewed the *Savannah River Site Environmental Report for 1994* (WSRC–TR–075) and *Savannah River Site Environmental Data for 1995*.

The Central Savannah River Area Radiological Environmental Monitoring Program is a data exchange program involving representatives of SCDHEC, the Georgia Department of Natural Resources, Georgia Power Company, Chem-Nuclear Systems, DOE, and WSRC. This group has met semiannually since 1987 to share technical environmental program information and data. These meetings provide an open forum in which to review and possibly improve each organization's monitoring program.

Public Outreach

SRS public outreach activities—such as public meetings, the Visitors Program, the Speakers Bureau, and the Traveling Lecturers Program—provide communication channels between the site and the public. Local newspaper, television, and radio advertisements also inform the public about environmental activities. More information can be obtained by contacting the WSRC Public Relations Department at 1–800–603–0970.

When topics involve unusually complex issues, DOE may conduct workshops that give special-interest groups or citizens the chance to meet with site representatives.

Various regulations require that SRS notify the public of its environmental plans and activities. RCRA, CERCLA, NEPA, and the Clean Water Act mandate regulatory public notice requirements. SRS meets

The 5,200-square-foot Savannah River Ecology Laboratory Conference Center opened in 1995. Located on 68 wooded acres on the northern periphery of SRS, the facility is used for scientific meetings and environmental education programs for students, teachers, and the general public. It features conference rooms, offices, a kitchen suitable for large gatherings, a display area, and restroom facilities.

Steve Ashe Photo
(96-1334-3E)

these requirements by using various community involvement tools, including notices to contiguous landowners, to media, to local and state government agencies, and to any other interested stakeholders. Such notices typically are sent in a newsletter called the *Environmental Bulletin*. Appendix B of this report lists the construction and operating permits held by SRS, and chapter 2 lists 1995 SRS project NEPA documentation activities.

SRFS has community outreach programs that include Smokey Bear, Woodsy Owl, Earth Day, and the Senior Community Service Program. SRFS environmental awareness programs are shared with visitors. Also, the Natural Resources Environmental Education Program at SRFS, discussed in chapter 1, "Introduction," aims to increase student awareness of the role of science and mathematics in solving natural resource and environmental problems. The program is a cooperative effort between DOE and the University of South Carolina-Aiken. More information can be obtained by contacting SRFS at 803-725-2441.

SREL's Environmental Outreach and Education Program was shared with 45,750 people during 1995.

The program emphasizes the importance of environmental awareness in decision making regarding ecological problems. Environmental awareness is promoted through tours, lectures to students and other groups, teacher workshops, and various exhibits. A new conference center, constructed in 1994 and formally opened in 1995, is being used to accommodate program expansion. More information can be obtained by contacting SREL at 803-725-2472.

SRARP expanded its heritage education activities in 1995 with a full schedule of classroom education, public outreach, and onsite tours. Volunteer excavations at the Tinker Creek site at SRS were continued with the Augusta Archaeological Society and other avocational groups, while offsite excavations provided a variety of opportunities for field experience. Some 80 presentations, displays, and tours were provided for schools, historical societies, civic groups, and environmental and historical awareness day celebrations. Also, SRARP personnel taught four anthropology courses at area colleges. More information can be obtained by contacting SRARP at 803-725-3623.

Environmental Restoration and Waste Management

To Read About . . .

Turn to Page . . .

<i>Regulatory Compliance</i>	45
<i>Environmental Restoration</i>	46
<i>Solid Waste Management</i>	48
<i>High-Level Waste</i>	51
<i>Public Involvement</i>	52

ENVIRONMENTAL restoration and waste management programs at Savannah River Site (SRS) continued their accomplishments in 1995. This chapter presents a brief overview of the programs, describes some of their major milestones during the year, and summarizes their shift from initial concept and formulation to the achievement of results in the field in an open, responsive, and accountable manner.

The U.S. Department of Energy (DOE) uses the term "environmental restoration" to mean the assessment and cleanup of inactive waste units and groundwater (remediation). "Cleanup" means actions taken to deal with the release or potential release of hazardous substances. This may refer to complete removal of a substance, or it may mean stabilizing, containing, or otherwise treating the substance so it does not affect human health or the environment [DOE EM, 1991]. Determining the most environmentally sound method of cleaning up waste units is a major component of the environmental restoration program at SRS.

In 1995, for example, environmental restoration progress included

- an increase in the number of groundwater remediation programs, despite reduced funding
- the completion of major field work in settling/seepage basins, burning/rubble pits and piles, and the sanitary landfill
- the introduction of new environmental assessment methods at the D-Area oil seepage basin
- a quintupling by vadose zone units of the amount of solvents vacuumed from the soil

- the announcement of contract reform in environmental restoration practices
- regulator approval of new and improved technology applications, such as geosynthetic material—in place of kaolin clay—for capping

DOE uses the term "waste management" to refer to safe, effective management of various kinds of nonhazardous, hazardous, and radioactive waste generated on site. Identifying the need for appropriate waste management facilities and ensuring their availability have been major components of the SRS waste management program.

Waste management highlights during 1995 included

- the Consolidated Incineration Facility, which remained on schedule for most of the year, and the beginning of preparations for a pretrial burn
- the Low-level Radioactive Waste Disposal Facility, which underwent significant changes with the closure of the former mixed waste storage facility and of the engineered low-level trenches
- the Pollution Prevention and Waste Minimization program, which earned an award for white paper reduction (story in chapter 3, "Environmental Program Information")

Regulatory Compliance

Two major federal statutes govern the site's environmental restoration and waste management activities, which were begun in 1981: the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). RCRA addresses the management of regulated hazardous waste and requires that permits be obtained for DOE facilities that treat, store, or dispose of hazardous or

Installation of a 54-acre foundation layer of backfill soil began at the Nonradioactive Disposal Facility (Sanitary Landfill) in 1994 and was completed in 1995.

Hugh Smith Photo
(96-1131-19E)

mixed waste. It also requires that DOE facilities perform appropriate corrective action. CERCLA (also known as Superfund) addresses the uncontrolled release of hazardous substances and the cleanup of inactive waste sites. This act establishes a National Priority List of sites targeted for assessment and, if necessary, for remediation. SRS was placed on the list December 21, 1989 [Fact Sheet, 1992]. Complete information on SRS compliance activities can be found in chapter 2, "Environmental Compliance."

Environmental Restoration

The environmental restoration program at SRS was developed in 1990 to remediate more than 400 inactive waste and groundwater units on site (figure 4-1) while protecting human health and the environment. In 1995, the program achieved results through

- state-of-the-art technology
- streamlined processes
- cost savings

One of the year's most significant achievements was the startup of five vadose zone units that remove contaminants from groundwater and associated soils. This operation expanded the overall volatile organic contaminants removal capacity from 1,500 to 10,400 pounds per month, an increase of 500 percent. One hundred acres of A-Area and M-Area that have the highest concentration of contaminants are the focus of the vadose zone remediation. The units work like a vacuum, removing 5 tons of solvents per month,

compared to 1 ton per month previously. This remediation project is believed to be one of the largest of its kind in the United States [Fact Sheet, 1995].

A foundation (stabilization) layer of clean, test-compacted backfill soil was placed over the 54-acre Nonradioactive Disposal Facility (Sanitary Landfill) during 1994 and 1995. This was done to stabilize and reduce rainwater infiltration into the waste trenches prior to installation of a final, multilayer geosynthetic closure cap, which began in late 1995 is expected to be completed in 1997.

Bentonite Mat (geosynthetic clay liner) is a thinner, stronger, and more resilient covering used in the closure of waste sites. The new technology employs two geotextile materials and Bentonite (sandy) clay instead of the traditional 2-foot-thick kaolin clay for waste site caps. This design, which is being employed at the Nonradioactive Disposal Facility and at the Low-Level Radioactive Waste Disposal Facility, is less expensive than kaolin clay.

In September 1995, two environmental remediation contracts were awarded under the Environmental Restoration Remediation Services Basic Ordering Agreement. Under the first contract, the multilayer geosynthetic closure cap is being placed on the Nonradioactive Disposal Facility to prevent the spread of contamination. The second contract calls for a water treatment system, which will be installed beginning in 1996 to clean contaminated groundwater at F-Area and H-Area.

SRS Environmental Restoration Program

96X01553.01.AIL (modified)

Figure 4-1 Environmental Program Map

The SRS environmental restoration program sites map identifies closed waste sites, inactive waste units, monitored groundwater contamination, localized groundwater contamination, complete or ongoing remedial action, and decontamination and decommissioning facilities at SRS.

Expedited site characterization—a faster, more efficient, and more flexible method of sampling—was used successfully during 1995 in a remedial investigation at the D-Area oil seepage basin.

After examining data from the past 20 years, site personnel were able to use engineering tools, sample acquisition, and analytical techniques to reduce the frequency of sampling and the number of analytes. As a result, testing and sampling is concentrated where uncertainties are, thus reducing the amount of sampling and laboratory work required and cutting related costs by approximately 50 percent from 1993 to 1995.

State-of-the-art technology was tested for use under an Interim Action Record of Decision at the TNX Area. Hybrid groundwater corrective action was the remedy selected to accomplish the interim goals of addressing trichloroethylene contaminants. This method features two systems:

- an airlift recirculation well, which pushes air into groundwater and captures contaminants as they rise to the surface
- a pump-and-treat system, which consists of an air stripper connected to four recovery wells that provide containment of the plume

In February 1995, SRS's environmental restoration program gained U.S. Environmental Protection Agency (EPA) and South Carolina Department of Health and Environmental Control (SCDHEC) approval of the *Investigation-Derived Waste Management Plan*, WSRC-RP-94-1227, a document that describes the site's plan for the management of investigation-derived waste during regulatory investigations. As a result of the new plan, contaminated groundwater collected during compliance monitoring and well sampling events is loaded into port trucks called "water buffaloes" and delivered to the Effluent Treatment Facility. Ultimate disposal is at National Pollutant Discharge Elimination System (NPDES) outfall H-016, located on Upper Three Runs Creek in H-Area. Approval of this process also provides for treatment of certain hazardous wastes from other SRS sources.

Solid Waste Management

Solid waste management at SRS includes the proper handling, storage, and disposal of the various wastes generated by the site and by certain offsite operations. These include sanitary, low-level, transuranic, hazardous, and mixed wastes.

Sanitary Waste

Sanitary waste includes office waste, food, garbage, refuse, and other solid wastes that can be disposed of in landfills. SRS has privatized the collection, hauling, and disposal of its sanitary waste, which consists primarily of food and office wastes. In 1995, 5,264 tons of the site's sanitary waste were disposed of at a permitted offsite commercial facility [WCAM, 1995]. The SRS Interim Sanitary Landfill, which discontinued routine operations when disposal of sanitary waste was privatized in November 1994, opened periodically during 1995 to dispose of 5,046 tons of petroleum-contaminated soil [SWMD, 1995].

Low-Level Waste

Low-level waste is any radioactive waste not classified as high-level waste or transuranic waste. Examples of SRS low-level wastes include protective clothing, job control waste, equipment, tools, filters, rags, and papers. With a few exceptions (e.g., suspect soil, some uncertified wastes, and wastes generated at the Solid Waste Disposal Facility), SRS discontinued land disposal of solid low-level waste in engineered trenches at the Solid Waste Disposal Facility March 31, 1995. All certified low-level wastes now are stored or disposed of in the E-Area Vaults. During 1995, the Solid Waste Management Department accepted 285,905 cubic feet of low-level waste for storage or disposal in these vaults [COBRA, 1995; WITS, 1995].

Transuranic Waste

Transuranic waste is radioactive waste contaminated with isotopes that have decay rates and activities exceeding defined levels. It contains manmade elements that are heavier than uranium and that decay slowly, thus requiring thousands of years of isolation. At SRS, transuranic wastes can include equipment, protective clothing, and tools. In 1995, 5,151 cubic feet of solid transuranic waste was accepted for storage on transuranic waste pads [COBRA, 1995].

Hazardous Waste

According to RCRA, hazardous waste is any toxic, corrosive, reactive, or ignitable material that could damage the environment or negatively affect human health. Examples of SRS hazardous wastes include oils, solvents, acids, metals, and pesticides. In 1995, the Solid Waste Management Department accepted 2,538 cubic feet of hazardous waste for storage at the site's hazardous waste storage facilities [WCAM, 1995]. Of this amount, 712 cubic feet were shipped off site for commercial treatment or disposal [HWSF, 1995].

Workers at SRS's Solid Waste Disposal Facility remove rainwater from a transuranic waste drum. After the dewatering, which was completed in 1995, the drums were stored on covered transuranic storage pads.

Gary Jarrell Photo
(94-1480-20E)

Mixed Waste

Mixed waste is both radioactive and hazardous and is subject to regulations governing both waste types. In 1995, the Solid Waste Management Department accepted 373 cubic feet of mixed waste for storage at SRS's mixed waste storage buildings [WCAM, 1995].

Programs and Accomplishments

Ongoing waste management programs have been supplemented by special initiatives and innovative treatment technologies. Noteworthy results are described in the paragraphs that follow.

Waste Certification

Waste generators must characterize their waste streams to demonstrate compliance with the waste acceptance criteria of SRS's various waste management facilities. Continuing a certification program initiated in 1994, SRS certified 17 waste generators during 1995, bringing to 45 the total number of certified generators. As a followup to their original certification, four generators were reassessed in 1995. This assessment resulted in no significant issues, which indicated continued strong performance in waste certification requirements.

Waste Minimization

Waste minimization is any action that avoids or reduces the generation of waste by source reduction, by energy usage improvement, or by recycling. During 1995, SRS's waste minimization program was recognized by DOE for its sitewide recycling programs and, as indicated earlier, received an award for white office paper use reduction.

Transuranic Drum Dewatering and Transuranic Pad Aisle Spacing

In May 1995, SRS completed a nearly 2-year-long, state-approved operation to remove rainwater that had infiltrated more than 4,400 transuranic waste drums that had been stored on uncovered transuranic waste pads. The dewatered waste drums were repackaged and placed on covered transuranic pads, where they are protected from rainwater intrusion. An additional 8,700 drums of transuranic waste were inspected and aisle-spaced according to regulatory agreement.

Solvent Storage Tank Closure

In August 1995, SRS completed in-situ interim closure of six of eight solvent storage tanks, completing the first phase of an agreement with SCDHEC. Interim closure of the two remaining tanks will begin in fiscal year 1997, after which the eight tanks will be capped as part of the Low-Level Radioactive Waste Disposal Facility closure.

Shredded filter paper take-up rolls are bagged for storage at the Solid Waste Disposal Facility. The shredded rolls will be incinerated at the Consolidated Incineration Facility.

Byron Williams Photo
(95-1535-15E)

Vendor Partnership Achievements

As part of the 1994 Supplier Environmental and Waste Management Information Exchange, SRS solicited innovative treatment of various waste streams. Several noteworthy accomplishments resulted during 1995 from this partnership of the site with commercial vendors. The Suspect Soil Demonstration processed 12,000 cubic meters of soil at a rate of 80 to 100 metric tons/day. The Shredding of Filter Paper Take-Up Rolls prepared mixed waste for incineration at the Consolidated Incineration Facility by reducing the storage volume to fit inside the facility's incineration boxes. As a result of this demonstration, the shredding technology is being expanded to other waste streams. Other demonstrations successfully decontaminated cadmium-coated filter frames and radioactive lead for recycling.

Waste Management Environmental Impact Statement

The Final Waste Management Environmental Impact Statement (EIS) was issued to the public July 28, 1995, and the first of two National Environmental Protection Act (NEPA) Records of Decision was approved September 22, 1995. The second NEPA Record of Decision is expected to be finalized in 1996. The EIS

- forecasts the next 30 years of SRS waste management activities
- provides waste generation estimates for various waste streams
- describes treatment, storage, and disposal options available for managing wastes

Consolidated Incineration Facility

Construction of the Consolidated Incineration Facility was completed in 1995, and initial testing with chemical simulants was begun. The facility will incinerate both solid and liquid forms of radioactive, hazardous, and mixed wastes.

Treatment of Hazardous Wastes

In April 1995, DOE granted permission to SRS to resume shipping certain types of hazardous waste off site for treatment. This program allows hazardous waste that has been through radiological screening to leave the site for treatment at commercial facilities.

Site Treatment Plan for Mixed Wastes

The Site Treatment Plan for Mixed Wastes, which is required by the Federal Facility Compliance Act, was approved by SCDHEC October 2, 1995. The plan specifies treatment technologies or technology development schedules for all SRS mixed wastes. Provisions of the plan also allowed SRS to receive a one-time shipment (December 14) of mixed waste from the Charleston (South Carolina) Naval Shipyard, which is being closed.

RCRA Part B Permit Renewal

In October 1995, SCDHEC renewed the RCRA Part B Permit for the SRS Hazardous Waste Storage Facility. The renewed permit allows continued operation of the facility, which includes three waste storage buildings and three solid waste storage pads, into the year 2000.

High-Level Waste Management

"High-level waste" is highly radioactive waste material resulting primarily from the reprocessing of special nuclear materials. It contains both transuranic waste and fission products in concentrations requiring permanent isolation from the environment.

High-level waste from in the F-Area and H-Area canyons is segregated according to radionuclide and heat content. High-heat waste, generated primarily during the first extraction cycle in SRS's Separations canyons, contains a major portion of the radioactivity. Low-heat waste is generated primarily from the second and subsequent canyon extraction cycles.

The major waste streams into the F-Area and H-Area tank farms include transfers from the canyons, receipts from the Receiving Basin for Offsite Fuels (RBOF), and a recycle stream from the Defense Waste Processing Facility (DWPF).

SRS continues to manage approximately 34 million gallons of high-level liquid radioactive waste (about 496 million curies); this waste is currently stored in 51 massive storage tanks grouped into two "tank farms." Twenty-nine tanks are located in the H-Area Tank Farm, 22 in the F-Area Tank Farm. All SRS tanks are built of carbon steel inside reinforced concrete containment vaults.

Tank Farm Evaporator Facilities

Each tank farm has one operating evaporator system used to concentrate high-level waste received from the canyons. These evaporators reduce the waste to about 25 percent of its original volume. SRS has successfully conducted this dewatering operation in the tank farms since the early 1960s. Since the first evaporator facilities began operation in 1960, approximately 105 million gallons of space have been reclaimed.

Without these evaporator systems, SRS would have required 70 additional waste storage tanks—at \$50 million apiece—to store waste produced over the site's lifetime. A new evaporator, the replacement high level waste evaporator, is under construction to enable the tank farms to process future waste loads.

This new evaporator will have twice the processing capacity of the existing two evaporators.

Accomplishments

In 1995, SRS continued to manage both tank farms and to bring several key facilities on line to begin removing waste from tanks and preparing it for safe, long-term immobilization.

Both evaporator systems exceeded their space-gain goals for calendar year 1995; 2-F recovered 350,000 gallons of tank space in 1995, while 2-H recovered 1.2 million gallons of tank space. In the fall of 1995, SRS took the 2-H Evaporator off line in a planned outage and successfully replaced the evaporator vessel, which was approaching the end of its expected life span. This type of predictive maintenance avoids time-consuming shutdowns, and allows the site to maintain steady waste reduction operations.

In-Tank Precipitation Facility Startup

The In-Tank Precipitation Facility began radioactive operations September 2, 1995. The In-Tank Precipitation Facility is a volume reduction/pretreatment operation for DWPF. It will process the majority (about 90 percent) of the "liquid salt" waste in SRS tanks, splitting that waste into two distinct streams. The highly radioactive portion, called "precipitate," will go to DWPF for vitrification, while the remainder (about 90 percent of the salt waste) will be low-level waste, called "filtrate," that will be grouted into a solid form at the Saltstone Facility. The filtrate portion is about 90 percent of the waste's total volume, yet it will contain only .001 percent of the waste's total radioactivity.

New Waste Transfer Facility Startup

SRS successfully completed startup of the New Waste Transfer Facility November 27, 1995, almost 2 weeks ahead of schedule. An essential portion of the site's waste processing system, the New Waste Transfer Facility consists of four large pump tank cells and a large diversion box cell located inside a building outfitted with a remote crane. This new facility, which replaces an older diversion box system, will serve as the "hub" for waste transfers between F-Tank Farm, H-Tank Farm, and DWPF.

DWPF

DWPF completed its "waste qualification runs" in November 1995, filling 71 canisters with a high-quality glass form that meets all projected quality and environmental requirements to contain the site's waste. Nonradioactive chemicals were used to simulate the properties of the waste throughout this test phase.

In late December, DWPF began its final review before requesting approval to begin radioactive operations: a thorough operational readiness review by a DOE-Headquarters team. This process is similar to Nuclear Regulatory Commission review and licensing at a commercial nuclear facility. The operational readiness review process is an indepth critique of the facility and its processes, along with face-to-face interviews of personnel.

DWPF operations were suspended December 19 to address minor equipment failures and implement new procedures for operating under radioactive conditions. Completion of the operational readiness review was targeted for March 1996.

Saltstone Facility

A component of DWPF, the Saltstone Facility plays an important role in treating and disposing of high-level radioactive wastes stored at SRS.

Radioactive operations began at Saltstone in June 1990; through December 1995, the facility had processed 1.6 million gallons of low-activity waste, creating about 2.6 million gallons of "saltstone." Also, during fall 1995, Saltstone personnel received and processed their first transfer from radioactive processing at the In-Tank Precipitation Facility.

Public Involvement

One of the hallmarks of all environmental management programs, including DOE's, following the end of the Cold War is the involvement of various stakeholders in environmental management decisions and resulting activities.

Stakeholder involvement in the development of environmental management decisions and subsequent actions is required by law and encouraged by DOE and SRS even beyond the bare legal requirements. The SRS credibility-and-trust target initiative encompasses stakeholder involvement in environmental restoration and facilitates the decision-making process while responding to needs, ideas, and concerns of communities and entities impacted by the site.

During 1995, the SRS Public Involvement Program continued to support the SRS Citizens Advisory Board (CAB), an independent group of citizens who provide recommendations to DOE, EPA, and SCDHEC. Among major issues addressed by the 13 CAB recommendations from 1995 were

- increased emphasis on the use of independent scientific peer review of SRS technical decisions

Steve Ashe Photo (95-1185-10E)

Members of the SRS Citizens Advisory Board and representatives of WSRC exchange greetings at a 1995 CAB meeting.

- proposed land-use guidance for SRS, including remediation options
- development of screening criteria for the EIS on spent fuel from foreign research reactors, and comment on the EIS
- characterization of transuranic waste at SRS as an urgent problem and independent reviews of the Transuranic Waste Retrieval Program and treatment options.
- proposed study of the biological effects of tritium, by the National Institute of Occupational Safety and Health, on the DNA of SRS employees
- proposed development of a long-term strategic plan for SRS remediation initiatives by DOE, EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee), and SCDHEC
- proposed maintenance of the schedule for vitrification of high-level waste to have all such waste processed and removed by the year 2028
- proposed design of the second glass waste storage building to be more rugged and self-sufficient for long-term operation
- proposed increased emphasis on development of schedules for the shipment of vitrified high-level waste from SRS to Yucca Mountain, Nevada

The three agencies substantially concurred with all the 1995 recommendations [CAB, 1994-1995].

Public meetings became a stronger focus for stakeholder participation during 1995, as

subcommittees were established, regulatory liaisons were cultivated to partner on technical information exchanges, and results-oriented communication activities contributed to public involvement operations and programs.

Radiological Effluent Monitoring

To Read About . . .

Turn to Page . . .

<i>Airborne Emissions</i>	55
<i>Nonroutine Occurrence</i>	58
<i>Liquid Discharges</i>	58
<i>Settleable Solids</i>	63

THIS chapter describes the Savannah River Site (SRS) radiological effluent monitoring program and the 1995 effluent monitoring data results. Objectives and rationale for the SRS radiological effluent monitoring program are discussed in chapter 3, "Environmental Program Information."

Radiological effluent monitoring results are a major component in determining compliance with applicable dose standards, which can be found in chapter 7, "Potential Radiation Doses," and in appendix A, "Applicable Guidelines, Standards, and Regulations." Also, SRS management philosophy is that potential exposures to members of the public be kept as far below regulatory standards as is reasonably achievable. This philosophy is known as the "as low as reasonably achievable" (ALARA) concept.

SRS airborne and liquid effluents, which potentially contain radionuclides, are monitored at their points of discharge by a combination of direct measurement and/or sample extraction and analysis. Radiological Control Operations (RCO) and the Environmental Protection Department's Environmental Monitoring Section (EMS) share most of the radiological effluent monitoring responsibilities. RCO personnel collect and screen air and liquid samples from regulated (radiologically controlled) areas and maintain monitoring equipment on stacks and at some liquid effluent discharge points. EMS personnel collect and analyze most liquid effluent samples. Results of these analyses are compiled and reported in monthly radioactive releases reports.

Of the more than 4,300 radiological effluent samples collected and analyzed during 1995, 14 (0.3 percent) were not collected and/or analyzed because of sampling equipment failure or inadvertent loss of, or

damage to, the sample media. The radioactive releases attributed to these samples were accounted for in the annual release totals by using either historical process knowledge or less sensitive on-line monitoring results.

A complete description of the EMS sampling and analytical procedures used for radiological effluent monitoring can be found in sections 1102 and 1103 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1 (SRS EM Program), which was issued in June 1995. A summary of data results is presented in this chapter; however, more detailed data can be found in *SRS Environmental Data for 1995* (WSRC-TR-96-0077).

Airborne Emissions

Process area discharge stacks that release or have the potential to release radioactive materials are monitored continuously by applicable on-line monitoring (for tritium and noble gases) and/or sampling systems [SRS EM Program, 1995]. Filter paper samples, used to collect radioactive particles, generally are gathered daily and screened initially for radioactivity by RCO personnel. Charcoal canisters, used to collect radioiodines, are gathered weekly. RCO personnel routinely transfer the charcoal canisters and filter paper samples on a weekly basis to EMS sampling personnel for transport to, and analysis in, the EMS laboratories.

Depending on the processes involved, discharge stacks also may be monitored with "real-time" instrumentation by area operations and/or RCO personnel to determine instantaneous and cumulative atmospheric releases to the environment. Tritium is one of the radionuclides monitored with continuous real-time instrumentation.

Description of Monitoring Program

Sample Collection Systems

Sample collection systems vary from facility to facility, depending on the nature of the radionuclides being discharged. Generally, RCO personnel are responsible for ensuring that the sampling systems are maintained and for collecting the filter papers and charcoal filter samples.

The following effluent sampling and monitoring changes were made during 1995:

- In January, a correction factor was applied by EMS to calculations for atmospheric emissions to account for potential source term underestimation caused by particulate deposition within sample lines ("line loss"). A line loss factor's magnitude is determined by the stack sampling system and the radionuclide emitted. For some locations, the factor is as high as 20. This means that some results reported in 1995 were 20 times higher than those reported in 1994, simply because this correction factor was implemented. The calculated dose to persons off site was not significantly impacted.
- A new analytical method was implemented in July 1995. Called the actinide analysis method, it has greater sensitivity for specific radionuclides, such as uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, americium-241, and curium-244. This method is used to analyze samples from 11 air emission locations. The 291-F stack and the 291-H stack samples are among those being analyzed with the method.

Continuous Monitoring Systems

SRS reactor and tritium facilities use real-time instrumentation to determine instantaneous and cumulative atmospheric releases of tritium and noble gas radioisotopes. All other monitored radionuclides are sampled using filter papers, charcoal filters, or other air effluent sampling media.

Laboratory Analysis

EMS provides most of the necessary radioanalytical laboratory services required to conduct the site airborne effluent monitoring program. However, the Savannah River Technology Center (SRTC) environmental laboratory performs iodine-129 and carbon-14 analyses on certain air effluent samples because they have the sensitive instrumentation capable of detecting low levels of these radionuclides.

Al Mamatey Photo (96X02586.07)

This airborne radiological effluent release stack at SRTC is monitored by the attached isokinetic sampling system. Isokinetic sampling is conducted at major SRS operating facilities.

Effluent Flow Rates

Stack effluent flows generally are determined with hot-wire anemometers, Pitot tubes, or fan capacity calculations. Sample line flow rates usually are determined with in-line rotameters or hot-wire anemometers. Flow rates are used to determine the total quantity of radioactivity released.

Diffuse and Fugitive Sources

An estimate of radionuclide releases from unmonitored diffuse and fugitive sources also is included in the SRS radioactive release totals. These unmonitored sources include ponds, contaminated land areas, and structures without ventilation—or with ventilation but without well-defined release points. The sources were included in the overall SRS source terms for the first

time in 1991, as required by the U.S. Department of Energy (DOE).

The specific sources and methods used to estimate these emissions are described in *Calculated Release Levels from Phase III Installations*, WSRC-RP-92-542.

Monitoring Results

Data obtained from continuously monitored airborne effluent release points are used in conjunction with calculated release estimates of unmonitored radionuclides (fission product tritium and isotopes of krypton) to quantify the total amount of radioactive material released to the environment. In addition, an estimate of radionuclide releases from unmonitored diffuse and fugitive sources is included in the SRS release totals. Total SRS atmospheric releases for 1995 are shown by source in table 5-1, page 65.

The data shown in table 5-1 are a major component in the determination of offsite dose estimations from SRS operations. The calculated individual and collective doses from atmospheric releases are presented in chapter 7, as is a comparison of these offsite doses to U.S. Environmental Protection Agency (EPA) and DOE dose standards.

For dose calculation purposes, releases of unidentified beta emitters were summed with strontium-89,90 releases and accounted for 99 percent of the total strontium-89,90 reported. Likewise, unidentified alpha emitters were summed with plutonium-239 releases and accounted for nearly 65 percent of the total plutonium-239 releases reported. Strontium-90 and plutonium-239 have the highest dose factors of the common beta- and alpha-emitting radionuclides. Therefore, summing the unidentified beta and alpha emissions this way maintains conservatism of the highest dose being represented. Some of the unidentified beta and alpha activity probably originates from naturally occurring radionuclides, such as potassium-40 and radon-222 progeny. This also adds a degree of conservatism to the dose calculations.

Tritium in elemental and oxide forms accounts for more than 99 percent of the total radioactivity released to the atmosphere from SRS operations. As an isotope of hydrogen, tritium acts the same as hydrogen chemically and physically and thus is extremely difficult to remove from air effluent streams. During 1995, about 96,700 Ci ($3.6\text{E}+15$ Bq) of tritium was released from SRS, compared to about 160,000 Ci ($5.9\text{E}+15$ Bq) in 1994.

The amount of tritium (and other atmospheric radionuclides) released has been reduced throughout the history of SRS, with changes in the site's mission and improvements in facilities, processes, and operations. During the early years at SRS, large quantities of tritium were discharged to the atmosphere. The maximum yearly release of 2.4 million Ci ($8.9\text{E}+16$ Bq) of tritium occurred during 1958. From 1987 through 1992, the amount of tritium released from SRS decreased approximately 20 percent per year (figure 5-1). In 1993, an increase in tritium released was attributed to increased loading and unloading of reservoirs in the tritium facilities. The 40-percent decrease in the amount of tritium released in 1995—compared to 1994—is attributed to (1) reduced throughput in the tritium facilities, (2) reduced maintenance and layup activities in the reactor facilities, and (3) a full year of Replacement Tritium Facility (RTF) operation in 1995.

Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides

Average concentrations of radionuclides in airborne emissions are calculated by dividing the yearly release total of each radionuclide from each stack by the yearly stack flow quantities. These average concentrations then can be compared to the DOE derived concentration guides (DCGs), which are found in DOE Order 5400.5, "Radiation Protection of the Public and the Environment," for each radionuclide.

DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. Based on a 100-mrem exposure, DCGs are applicable at the point of discharge (prior to dilution or dispersion) under conditions of continuous exposure (assumed to be an average inhalation rate of 8,400 cubic meters per year). This means that the DOE DCGs are based on the highly conservative assumption that a member of the public has direct access to—and continuously breathes, or is immersed in—the actual air effluent 24 hours a day, 365 days a year. However, because of the distance between most SRS operating facilities and the site boundary, and because the wind rose at SRS shows no strong prevalence (chapter 7), this scenario is improbable.

Average annual radionuclide concentrations in SRS air effluents can be referenced to DOE DCGs as a screening method to determine if existing effluent treatment systems are proper and effective.

Most of the SRS radiological stacks/facilities release small quantities of radionuclides at concentrations below the DOE DCGs [SRS Data, 1996]. However,

Ileaf Graphic

Figure 5-1 SRS Annual Atmospheric Tritium Releases, 1987-1995

certain radionuclides—such as tritium (in the oxide form) from the heavy water rework facilities, the reactor facilities, and the tritium facilities, as well as plutonium isotopes from the F-Area and H-Area separations facilities—were emitted at concentration levels above the DCGs. Because of the extreme difficulty involved in removing tritium and because of current facility designs, site missions, and operational considerations, this situation is unavoidable. However, the dose consequences from all SRS atmospheric releases was considerably less during 1995 than the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv) (chapter 7).

Nonroutine Occurrence

An unplanned release of tritium from H-Area occurred on June 16, 1995. The release, which began at 9:30 a.m., was a puff of relatively brief duration—approximately 30 minutes. Based on process monitors, an estimated 10,700 Ci of elemental tritium (HT) was released through a 200-foot stack during the event [Kurzeja, 1995].

EMS and Environmental Technology Section sampling teams, dispatched shortly after the release, collected air, air moisture, vegetation, and standing-water samples for confirmatory accident assessment purposes [Fledderman, 1995b]. Samples were taken both on site and off site along the projected plume path.

Analytical results from the samples confirmed the initial source term estimates (type, form, and quantity

of material released) and verified dispersion model results (plume centerline, path of travel, and width). Based on the release source term and on atmospheric transport, a maximum hypothetical site boundary dose of $3.4\text{E}-06$ mrem ($3.4\text{E}-08$ mSv) was calculated for the release.

Liquid Discharges

Each process area liquid effluent discharge point that releases or has potential to release radioactive materials is sampled routinely and analyzed for radioactivity [SRS EM Program, 1995]. The radiological liquid effluent sampling locations at SRS are shown, along with the surface water surveillance sampling locations, in figure 6-4, page 77.

Site streams also are sampled upstream and downstream of seepage basins (chapter 6, “Radiological Environmental Surveillance”) to obtain data to calculate the amount of radioactivity migrating from the basins. These results are important in calculating the total amount of radioactivity released to the Savannah River as a result of SRS operations.

Description of Monitoring Program

Sample Collection Systems

Liquid effluents are sampled continuously at, or very near, their points of discharge to the receiving streams. Three primary systems are used—paddlewheel samplers, Brailsford motor pumps, and Isco samplers. EMS personnel normally collect the liquid effluent samples weekly and transport them to the EMS laboratory for analysis.

The following effluent sampling and monitoring changes were made during 1995:

- Preliminary monitoring of liquid releases at the S-004 liquid discharge point for the Defense Waste Processing Facility (DWPF) was begun in May to establish baseline data and to verify that monitoring systems were operating correctly. DWPF will start up in early 1996.
- The actinide analysis method was implemented in July. This new analytical method has greater sensitivity for specific radionuclides, such as uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, americium-241, and curium-244. This method is used to analyze samples from five liquid discharge locations. The M-Area liquid discharge point is among the sampling locations being analyzed with the method.
- Monthly monitoring of four E-Area basins began in January. The basins are monitored as "Category IV liquid effluent sources," and samples are taken when liquid is present. Analyses are conducted on the samples to confirm that concentrations of potential radioactive contaminants in the liquid (rainwater that collects in the basins) remain at relatively low levels. No flows are associated with these sampling locations; therefore, radioactive "releases" are not quantified or included in this report.

Continuous Monitoring Systems

Depending on the processes involved, liquid effluents also may be monitored by area operations and/or RCO personnel with real-time instrumentation to ensure that instantaneous releases stay within established limits. However, because of instrumentation detection capabilities, on-line monitoring systems are not used to quantify liquid radioactive releases from SRS.

Laboratory Analysis

EMS provides most of the necessary radioanalytical laboratory services required to conduct the site liquid effluent monitoring program. However, specific low-level analyses for iodine-129 and technetium-99 are performed by SRTC environmental laboratory personnel.

Flow Rate Measurements

Liquid effluent flows generally are determined by one of four methods: U.S. Geological Survey (USGS) flow stations, stream velocity measurements, Isco sampler flow meters, or pump capacity calculations. Effluent flow rates are used to determine the total radioactivity released.

Monitoring Results

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility (SWDF) migration release estimates to quantify the total radioactive material released to the Savannah River from SRS operations. SRS liquid radioactive releases for 1995 are shown by source in table 5-2, page 67.

The data shown in this table are a major component in the determination of offsite dose consequences from SRS operations. The calculated individual and collective doses from site liquid releases are presented in chapter 7, as is a comparison of these offsite doses to EPA and DOE dose standards.

For dose calculation purposes, releases of unidentified beta emitters were summed with strontium-89,90 releases and accounted for nearly 57 percent of the total strontium-89,90 reported. The combined strontium-89,90 and unidentified beta release total for 1995 ($3.98\text{E}-01$ Ci) showed a 3-percent increase over the 1994 total ($3.86\text{E}-01$ Ci); this still is about a 20-percent decrease from the 1993 total ($4.77\text{E}-01$ Ci). Also, unidentified alpha emitters were summed with plutonium-239 releases and accounted for more than 99 percent of the total plutonium-239 releases reported. The combined plutonium and unidentified alpha release total for 1995 ($1.56\text{E}-02$ Ci) showed an 8-percent increase over the 1994 total ($1.44\text{E}-02$ Ci). The release-total increases are attributed to the use of a conservative method of determining gross beta and gross alpha releases.

As with airborne releases, strontium-90 and plutonium-239 have the highest dose factors of the common beta- and alpha-emitting radionuclides found in liquid releases. Therefore, summing the unidentified beta and alpha emissions this way maintains conservatism of the highest dose being represented. In addition, some of the unidentified beta and alpha activity probably originates from naturally occurring radionuclides, such as potassium-40 and radon-222 progeny. This also adds a degree of conservatism to the dose calculations.

Tritium constitutes more than 99 percent of the radioactivity released to the Savannah River from direct, seepage basin, and SWDF migration discharges. In 1995, about 9,900 Ci ($3.7\text{E}+14$ Bq) of tritium was released in liquid discharges from SRS, based on point-of-release concentrations and flow rates, compared to about 8,800 Ci ($3.3\text{E}+14$ Bq) in 1994 [SRS Data, 1996]. SRS tritium transport data for 1960-1995 are summarized in figure 6-6

Figure 5-2 Direct Releases of Tritium to SRS Streams, 1988-1995

The 1991 total includes an accidental release in December of 5,700 Ci from K-Reactor.

(page 81) in chapter 6. For conservatism, the slightly higher SRS stream transport value (11,400 Ci) was used for dose calculations and is discussed in chapter 7.

Direct Discharges of Liquid Effluents

As discussed previously, tritium is the major radionuclide released in SRS liquid effluents. The total amount of tritium released directly from process areas (i.e., reactor, separations, heavy water rework) to site streams during 1995 was 1,340 Ci ($5.0\text{E}+13$ Bq), which was 11 percent greater than the 1994 total of 1,210 Ci ($4.5\text{E}+13$ Bq). The heavy water rework area (400-D) releases increased 67 percent, from 235 Ci in 1994 to 628 Ci in 1995. In the reactor area (P-Area, L-Area, K-Area, and C-Area), releases remained about the same (548 Ci in 1994; 542 Ci in 1995), while in the separations area, releases decreased by about 60 percent (426 Ci in 1994; 168 Ci in 1995).

Direct releases of tritium to site streams for the years 1988-1995 are shown in figure 5-2.

Comparison of Average Concentrations in Liquid Releases to DOE Derived Concentration Guides

In addition to dose standards, DOE Order 5400.5 imposes other control considerations on liquid releases. These considerations are applicable to direct discharges but not to seepage basin and SWDF migration discharges. The DOE order lists DCG values for most radionuclides. DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. These DCG values are not release limits but screening values for "best available technology" investigations and for determining whether existing effluent treatment systems are proper and effective.

According to DOE Order 5400.5, exceedance of the DCGs at any discharge point may require an investigation of "best available technology" waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from "best available technology" requirements; however, it is not excluded from other ALARA considerations. DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detectable

in the effluent is less than 1.00, based on consecutive 12-month average concentrations.

DCGs, based on a 100-mrem exposure, are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion).

They are based on the highly conservative assumption that a member of the public has continuous direct access to the actual liquid effluent and consumes 2 liters of the effluent every day, 365 days a year. However, because of security controls and the distance between most SRS operating facilities and the site boundary, this scenario is improbable.

For each site facility that releases radioactivity, EMS compares the monthly liquid effluent concentrations and 12-month average concentrations against the DOE DCGs [Releases, 1995].

The 1995 liquid effluent 12-month average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided, by discharge point, in *SRS Environmental Data for 1995*.

The U3R-2A ETF outfall at the Road C discharge point exceeded the DCG guide for 12-month average tritium concentrations during 1995. However, as noted previously, DOE Order 5400.5 specifically exempts tritium from "best available technology" waste treatment investigation requirements. This is because there is no practical technology available for removing tritium from dilute liquid waste streams. In consideration of ALARA principles for tritium discharges, SRS identified several options and alternatives to continuing with these discharges at the U3R-2A ETF outfall [Schwallie, 1992]. None of these alternatives were considered viable on a cost/benefit basis. No other discharge points exceeded the DOE DCGs in 1995.

Seepage Basin and SWDF Migration Results

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, EMS monitors and quantifies the migration of radioactivity from site seepage basins and the SWDF. During 1995, tritium, strontium-89,90, and iodine-129 were detected in migration releases [SRS Data, 1996].

Figure 5-3 is a graphical representation of releases of tritium via migration to site streams for the years 1988-1995. During 1995, the total quantity of tritium migrating from the seepage basins and SWDF was about 8,560 Ci ($3.2\text{E}+14$ Bq), compared to 7,500 Ci ($2.8\text{E}+14$ Bq) in 1994. Part of this increase is

attributed to additional tritium migration from the K-Area seepage basin.

Figure 5-4 shows 1988-1995 total combined tritium releases from direct discharges and seepage basin and SWDF migration.

Migration of Radioactivity from the K-Area Drain Field and Seepage Basin

Liquid purges from the K-Area disassembly basin were released to the K-Area seepage basin in 1959 and 1960. Since 1960, purges from the K-Area disassembly basin have been discharged to a percolation field below the K-Area retention basin. A total tritium migration of 1,650 Ci ($6.1\text{E}+13$ Bq) was calculated from weekly flow measurements and tritium concentrations measured in Indian Grave Branch (a tributary of Pen Branch) during 1995. The sample location used in 1995 to determine tritium migration from the K-Area seepage basin was changed to K-018 because stream flow is more easily measured there than at IGB-21, which has a lower flow rate. The 1995 migration total represents an 88-percent increase over the 878 Ci ($3.2\text{E}+13$ Bq) recorded in 1994.

Migration of Radioactivity from F-Area and H-Area Seepage Basins

Although seepage basins in F-Area and H-Area no longer are used, radioactivity previously deposited in them continues to migrate via the groundwater and to outcrop into Four Mile Creek.

Migration of radioactivity from F-Area and H-Area seepage basins is measured with continuous samplers and flow recorders in Four Mile Creek. Groundwater from the F-Area seepage basins enters Four Mile Creek between sampling locations FM-3A, FM-2B, and FM-A7. Four Mile Creek sampling locations are shown in figure 6-4, page 77.

Most of the outcropping from H-Area seepage basins 1, 2, and 3 occurs between FM-1C and FM-2B. Outcropping from H-Area seepage basin 4 and SWDF occurs between FM-3 and FM-3A. Radioactivity from H-Area seepage basin 4 and SWDF mixes during groundwater migration to Four Mile Creek. Therefore, radioactivity from the two sources cannot be distinguished at the outcrop point.

Measured migration of tritium from F-Area seepage basins was 2370 Ci ($8.8\text{E}+13$ Bq) in 1995. This is a nearly 18-percent decrease from the 1994 total of 2,880 Ci ($1.1\text{E}+14$ Bq). The measured migration from H-Area seepage basin 4 and SWDF was 4,010 Ci ($1.5\text{E}+14$ Bq), a 30-percent increase over the 1994 total of 3,090 Ci ($1.1\text{E}+14$ Bq). The measured migration from H-Area seepage basins 1, 2, and 3 was 528 Ci ($2.0\text{E}+13$ Bq), a nearly 29-percent decrease from the 1994 total of 739 Ci ($2.7\text{E}+13$ Bq) [SRS Data, 1996].

Past, current, and computer model-projected tritium migration releases from F-Area and H-Area seepage basins and SWDF are shown in figure 5-5. Generally, and as the data show, tritium migration from the F-Area and H-Area seepage basins, which were closed in 1988, has been declining and is projected to continue to decline. However, tritium migration from SWDF has remained relatively stable during the past 10 years. Furthermore, based on the operational history of SWDF and the geology and hydrology of the site, it is anticipated that, with no corrective actions, SWDF tritium migration to Four Mile Creek is expected to remain at about 4,500 Ci ($1.7\text{E}+13$ Bq) per year for at least the next 10 to 20 years [Looney et al, 1993].

As required by the Resource Conservation and Recovery Act (RCRA) Part B Permit, SRS is developing SWDF groundwater corrective action plans for South Carolina Department of Health and Environmental Control (SCDHEC) approval. Portions of SWDF also are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA characterization and assessment continued in 1995. Reduction of tritium migration releases is

one of the factors being considered during the development of these RCRA/CERCLA groundwater corrective action plans. Low-permeability caps, waste form stabilization, groundwater barriers, groundwater pump-treat-reinjection, and other technologies are under consideration as relevant components of SWDF remediation.

The amount of strontium-89,90 entering Four Mile Creek during 1995 was estimated to be 11 mCi ($4.1\text{E}+09$ Bq) from the F-Area seepage basins. This was a 42-percent increase over the 1994 level of 78 mCi ($2.9\text{E}+09$ Bq). In addition, 40 mCi ($1.5\text{E}+09$ Bq) of strontium-89,90 was estimated to have migrated from the H-Area seepage basins. This was a 14-percent increase over the 1994 level of 35 mCi ($1.3\text{E}+09$ Bq) [SRS Data, 1996]. Like tritium migration, strontium migration is expected to continue to decline from these closed seepage basins.

In addition, a total of 10 mCi ($3.7\text{E}+08$ Bq) of iodine-129 migrated from the F-Area and H-Area seepage basins and from SWDF; however, no cesium-137 or technetium-99 was detected in 1995. Because of the radioanalytical difficulties associated with iodine-129, this radionuclide cannot be detected—using common radioanalytical

leaf Graphic

Figure 5-3 Tritium Migration from Seepage Basins and SWDF to SRS Streams, 1988-1995

Figure 5-4 Total Tritium Releases to SRS Streams (Direct Discharges and Migration), 1988-1995

methods—in dilute streams. However, as releases of other radionuclides from SRS continue to decrease, the percentage of the maximum individual offsite dose attributed to iodine-129 (half-life of 1.57×10^7) is likely to increase in future years. The SRTC environmental laboratory, which has instrumentation sensitive enough to detect these radionuclides, analyzes for iodine-129 and technetium-99 in the F-Area and H-Area seepage basins and in SWDF migration samples.

Migration of Radioactivity from P-Area, C-Area, and L-Area Seepage Basins Liquid purges from the P-Area, L-Area, and C-Area disassembly basins have been released periodically to their respective seepage basins since 1978. Purge water is released to the seepage basins to allow a significant part of the tritium to decay before the water outcrops to surface streams and flows into the Savannah River. The delaying action of the basins reduces the dose that users of water from downriver water treatment plants receive from SRS tritium releases. The seepage basins were used for purging the disassembly basins from the 1950s until 1970, but disassembly basin purge water was released directly to SRS streams between 1970 and 1978. The earlier experience with

seepage basins indicated that the extent of radioactive decay during the holdup was sufficient to recommend that the basins be used again in P-Area, L-Area, and C-Area. However, no purges to the basins occurred during 1995.

No radionuclide migration was attributed to the C-Area seepage basin in 1995. The failure of the Twin Lakes Dam in 1991 made the determination of migration more difficult in this area. Results from a sampler installed on Steel Creek above L-Lake indicated that 355 Ci (1.3×10^{13} Bq) of tritium migrated from the P-Area seepage basin during 1995, slightly less than the 386 Ci (1.4×10^{13} Bq) of tritium in 1994 [SRS Data, 1996]. Migration of radionuclides from the L-Area seepage basin has not been detected in site streams.

Settleable Solids

Settleable solids are solids suspended in wastewater and determined to be settleable [Method 2540, 1992]. That is, settleable solids are materials settling out of suspension within a defined period.

DOE Order 5400.5 states that liquid process waste streams (liquid discharges) containing radioactive

materials in the form of settleable solids may be released to natural waterways (receiving streams) if the concentration of radioactive material in the solids present in the waste stream does not exceed 5 pCi (0.2 Bq)/g above the background level of settleable solids for alpha-emitting radionuclides, or 50 pCi (2 Bq)/g above the background level of settleable solids for beta-emitting radionuclides. The intent of this requirement is to prevent the buildup of radionuclide concentrations in sediments. DOE has stated that if either the settleable solids are not detectable or the amount of solids collected, consistent with the recommended procedure for analysis, are so small that the radionuclides cannot be reasonably detected, the requirement is satisfied. Given the limitations of analytical procedures and small quantities of settleable solids being released to receiving streams, DOE has specified that settleable solids of less than 40 parts per million would be in defacto compliance with DOE Order 5400.5.

Description of Monitoring Program

In 1995—the third year of the settleable solids

program—samples were obtained from 25 locations. Settleable solids analyses were conducted in the EMS Water Quality Laboratory, and radionuclide analyses were conducted in the EMS Radiological Laboratory.

Monitoring Results

All samples obtained under the settleable solids program contained settleable solids considerably below the limit of 40 parts per million. The maximum settleable solids value for the entire year was 14 mg/L; the average value was approximately 2 mg/L. Results data indicate that SRS is not contributing significant amounts of sediments to the environment and is satisfying DOE's ALARA requirements.

A "best available technology" investigation was begun in 1995 to determine the most efficient methods of minimizing settleable solids. However, with the DOE clarification regarding Order 5400.5 and the corresponding 40-mg/L de minimus limit for settleable solids, the investigation will be terminated in early 1996.

Illeaf Graphic

Figure 5-5 Past, Current, and Projected Tritium Migration Releases to Four Mile Creek from the F-Area and H-Area Seepage Basins and SWDF

Table 5-1
1995 Radioactive Atmospheric Releases by Source

Page 1 of 2

Radio-nuclide	Half-life	Curies ^a					Diffuse and Fugitive ^d	Total
		Reactors	Separations ^b	Reactor Materials	Heavy Water	SRTC ^c		
Notes: Blank space indicates no quantifiable activity; h = hour, d = day, y = year								
GASES AND VAPORS								
H-3 (oxide)	12.3 y	1.26E+04	4.20E+04		3.28E+02		3.32E+01	5.50E+04
H-3 (elem)	12.3 y		4.17E+04					4.17E+04
H-3 Total	12.3 y	1.26E+04	8.37E+04		3.28E+02		3.32E+01	9.67E+04
C-14	5.73E3 y						9.80E-15	9.90E-15
I-129	1.57E7 y		4.70E-03					4.70E-03
I-131	8.040 d		1.29E-05			4.07E-05	2.05E-02	2.06E-02
I-133	20.8 h					1.72E-03		1.72E-03
I-135	6.57 h					7.19E-02		7.19E-02
Xe-135	9.10 h		1.87E-02			1.49E-02		3.36E-02
PARTICULATES								
Al-26	7.3E5 y						1.50E-14	1.50E-14
S-35	87.2 d						5.26E-12	5.26E-12
Cr-51	27.70 d						1.00E-16	1.00E-16
Co-57	271.8 d						2.50E-14	2.50E-14
Co-58	77.88 d						2.60E-05	2.60E-05
Co-60	5.271 y	2.78E-05	2.84E-07			2.46E-06	2.71E-05	5.76E-05
Ni-63	100 y						2.00E-13	2.00E-13
Zn-65	243.8 d						6.24E-05	6.24E-05
Rb-86	18.65 d						2.00E-15	2.00E-15
Sr-85	64.84 d						5.20E-16	5.20E-16
Sr-89,90 ^e	29.1 y	3.29E-03	1.59E-03	1.69E-04	1.57E-04	7.31E-06	3.03E-04	5.52E-03
Y-88	106.6 d						9.10E-16	9.10E-16
Zr-95	64.02 d						4.51E-05	4.51E-05
Nb-95	34.97 d						2.67E-05	2.67E-05
Ru-103	39.27 d						3.72E-05	3.72E-05

a One curie equals 3.7 E+10 Becquerels.

b Includes separations, waste management, and tritium facilities

c Savannah River Technology Center

d Estimated releases from minor unmonitored diffuse and fugitive sources

e Includes unidentified beta-gamma emissions

Table 5-1
1995 Radioactive Atmospheric Releases by Source

Page 2 of 2

Radio-nuclide	Half-life	Curies ^a					Diffuse and Fugitive ^d	Total
		Reactors	Separations ^b	Reactor Materials	Heavy Water	SRTC ^c		
Ru-106	1.020 y		6.46E-07				1.80E-04	1.81E-04
Cd-109	462.0 d						5.21E-14	5.21E-14
Sn-113	115.1 d						3.80E-16	3.80E-16
Sb-124	60.20 d		1.81E-07					1.81E-07
Sb-125	2.758 y		9.45E-07				1.19E-04	1.20E-04
Cs-134	2.065 y		3.22E-07				2.98E-05	3.01E-05
Cs-137	30.17 y	4.68E-04	5.25E-04	3.01E-06	2.58E-06	2.94E-07	1.40E-02	1.50E-02
Ce-139	137.6 d						1.00E-16	1.00E-16
Ce-141	32.50 d						5.30E-05	5.30E-05
Ce-144	284.6 d		2.22E-07				2.32E-04	2.32E-04
Pm-147	2.623 y						7.92E-07	7.92E-07
Eu-154	8.59 y		3.02E-07					3.02E-07
Eu-155	4.71 y		7.50E-07					7.50E-07
Hg-203	46.61 d						1.00E-12	1.00E-12
U-234	2.46E5 y		1.27E-04	1.73E-06				1.29E-04
U-235	7.04E8 y		8.32E-04	2.66E-05			1.44E-15	8.59E-04
U-238	4.47E9 y		5.78E-04	1.20E-06			2.87E-09	5.79E-04
Pu-238	87.7 y		5.85E-04	4.40E-09			6.61E-06	5.92E-04
Pu-239 ^e	2.410E4 y	2.78E-04	4.04E-04	1.62E-05	2.39E-05	1.75E-06	2.21E-06	7.26E-04
Am-241	432.7 y		3.04E-05	3.61E-08			1.81E-16	3.04E-05
Am-243	7.37E3 y						2.30E-17	2.30E-17
Cm-242	162.8 d						2.03E-16	2.03E-16
Cm-243	29.1 y						4.90E-14	4.90E-14
Cm-244	18.1 y		3.39E-06	9.02E-09				3.40E-06
Cm-248	3.48E5 y						9.20E-18	9.20E-18

a One curie equals 3.7 E+10 Becquerels.

b Includes separations, waste management and tritium facilities

c Savannah River Technology Center

d Estimated releases from minor unmonitored diffuse and fugitive sources

e Includes unidentified alpha emissions

Table 5-2
1995 Radioactive Liquid Releases by Source
(Including Direct and Seepage Basin Migration Releases)

Page 1 of 1

Radio-nuclide	Half-life	Curies ^a					Total
		Reactors	Separations ^b	Reactor Materials	Heavy Water	Savannah River Technology Center/TNX	
<i>Notes: Blank space indicates no quantifiable activity; h = hour, d = day, y = year</i>							
H-3 (oxide)	12.3 y	2.97E+03	7.83E+03		6.28E+02	8.84E-01	1.14E+04
Co-60	5.271 y				2.28E-03		2.28E-03
Sr-89,90 ^c	29.1 y	1.97E-01	1.88E-01	1.04E-03	1.15E-02	1.28E-03	3.98E-01
I-129	1.6E7 y		9.49E-03				9.49E-03
Cs-137	30.2 y	1.76E-04	6.55E-02				6.57E-02 ^d
Pm-147	2.6 y		2.63E-03				2.63E-03
U-234	2.46E5 y		1.03E-05	1.17E-05	1.63E-06	1.24E-04	1.48E-04
U-235	7.04E8 y		3.46E-06	9.37E-07	1.19E-07	7.29E-06	1.18E-05
U-238	4.47E9 y		1.22E-05	1.98E-05	3.88E-06	1.33E-04	1.69E-04
Pu-238	87.7 y		2.48E-06	2.86E-05	1.63E-06	7.80E-06	4.05E-05
Pu-239 ^e	2.410E4 y	4.95E-03	9.57E-03	1.05E-05	4.98E-04	6.01E-04	1.56E-02
Am-241	432.7 y		8.60E-07	1.14E-06			2.00E-06
Cm-244	18.1 y		1.11E-07	3.52E-06			3.63E-06

a One curie equals 3.7E+10 Becquerels.

b Includes separations, waste management, and tritium facilities

c Includes unidentified beta-gamma

d For conservatism, the higher release number (2.01E-01 Ci), calculated from River Mile 120 fish concentrations, was used for dose calculations (chapter 7, "Potential Radiation Doses").

e Includes unidentified alpha

Radiological Environmental Surveillance

To Read About . . .	Turn to Page . . .
<i>Air</i>	70
<i>Rainwater</i>	72
<i>Gamma Radiation</i>	73
<i>Seepage Basins</i>	74
<i>Site Streams</i>	76
<i>Savannah River</i>	79
<i>Drinking Water</i>	82
<i>Terrestrial Food Products</i>	83
<i>Aquatic Food Products</i>	84
<i>Deer and Hogs</i>	86
<i>Turkeys</i>	87
<i>Beavers</i>	87
<i>Soil</i>	88
<i>Sediment</i>	89
<i>Terrestrial Vegetation</i>	89

THE Savannah River Site (SRS) radiological environmental surveillance program is designed to survey and quantify any effects that routine and nonroutine operations might have on the site and on the surrounding area and population. The program represented an extensive network in 1995 that covered 31,000 square miles and extended up to 100 miles from the site. In conjunction with the radiological effluent monitoring program (chapter 5, "Radiological Effluent Monitoring"), the program enables SRS to monitor ambient radiological conditions and determine site contributions of radioactive materials to the environment.

Routine Radiological surveillance activities are performed by the Environmental Protection Department's Environmental Monitoring Section (EMS) and by the Savannah River Technology Center (SRTC). The Savannah River also is monitored by other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR).

As part of the radiological surveillance program, routine surveillance of all radiation exposure

pathways (ingestion, inhalation, immersion, and submersion) is performed on all environmental media that may lead to a measurable annual dose at the site boundary. This chapter summarizes surveillance results of the atmosphere (air and rainwater), surface water (seepage basins, site streams, and the Savannah River), drinking water, food products (terrestrial and aquatic), wildlife, soil, sediment, and vegetation. Also summarized are results of extensive monitoring of ambient gamma radiation levels performed on site, at the site boundary, and in population centers (surrounding communities). A description of the surveillance program and 1995 results for groundwater can be found in chapter 10, "Groundwater."

All results discussed in this chapter are based on available samples and/or analyses. Because of sampling and/or analytical difficulties, some sample analyses may be missing. Problems may have arisen with sample collection, such as loss of power to the sampling site or inaccessibility to the sampling site (locked gates, flooding, etc.) Results for collected samples can be rejected after analysis for such reasons as insufficient sample volume, low chemical yield, or equipment failure.

The $\pm$ value reported with individual results is a counting uncertainty; the $\pm$ value reported with averages (means) is a standard deviation. Lower limits of detection (LLD) often vary because of counting times and other factors.

In 1995, more than 100,000 radiological analyses were performed on approximately 25,000 samples (not including groundwater). Details about the number of samples analyzed and the results of those analyses appear in *SRS Environmental Data for 1995* (WSRC-TR-96-0077). Information on the rationale for the radiological environmental surveillance program can be found in chapter 3, "Environmental Program Information." Data from earlier years can be found in previous SRS environmental reports and data publications. Document numbers for these can be found in appendix E, "Environmental Monitoring Reports."

A complete description of the SRS radiological environmental surveillance program can be found in section 1105 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1 (SRS EM Program). Because of budget reductions and changing site missions, a review of the radiological surveillance program was conducted in 1995. As a result, extensive changes were implemented in several parts of the program. Details about specific changes are presented in the discussions of the affected program areas.

Air

Description of Surveillance Program

EMS maintains an extensive network of sampling stations in and around SRS to monitor the

concentration of radioactive materials in the air. These locations are divided up into four subgroups: onsite, site perimeter, 25-mile-radius, and distant (100-mile radius). Figure 6-1 shows all the survey locations except the 100-mile stations.

The air surveillance program helps determine the impact (if any) of site operations on the environment and evaluates trends in airborne radionuclide concentrations. The program also is used to verify atmospheric transport models and to support emergency response activities in the event of an unplanned release of radioactive material to the atmosphere.

A technical evaluation of the radiological environmental surveillance program, conducted in 1995 because of budget and manpower reductions, resulted in extensive program changes, which were implemented in midway through the year. Monitoring was discontinued at 12 offsite locations, as indicated in table 6-1. In addition, the sampling frequency for tritium in atmospheric moisture was increased from quarterly to biweekly at Savannah.

As a result of these changes, most air surveillance is conducted at the onsite and site perimeter locations. Only limited sampling is conducted at offsite locations—primarily at major population centers.

Surveillance Results

Chapter 5 details the types and quantity of radioactive material released to the environment from SRS activities in 1995. Except for tritium, these radionuclides were not routinely detectable at the site perimeter. Both onsite and site perimeter/offsite activity concentrations were similar to levels observed in previous years.

Table 6-1
1995 Radiological Environmental Surveillance Program Changes

Subprogram	Change(s)
On site	No changes
Site perimeter	No changes
25-mile radius	Eliminate nine locations (Aiken State Park, Allendale, Langley, Lees, Olar, Perkins, South Richmond County, Springfield, and Waynesboro)
Distant (100-mile radius)	Eliminate three locations (Columbia, Greenville, and Macon); increase HTO sampling at Savannah to biweekly

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Figure 6-1 Radiological Air-Surveillance Stations

The SRS air surveillance program consists of 31 stations located within 25 miles of the site and four stations (not shown) approximately 100 miles from the site.

Gross Alpha and Gross Beta

Gross alpha and gross beta activity analyses are performed on glass fiber filter papers. Although they cannot provide concentrations of specific radionuclides, these measurements are useful in providing information for trending of the total activity in an air sample or in screening samples.

The results from 1995 are presented in table 6-2. Both the average gross alpha and average gross beta results are consistent with 1994 measured concentrations and also agree with historical results.

As observed in previous years, no significant difference was observed between the average concentrations measured on site near the operating facilities and the average concentrations observed at the site perimeter and beyond. Although a spike was observed in the 1991 gross alpha concentration, the historical data set indicates a relatively stable ambient level of gross activity in the air.

Gamma-Emitting Radionuclides

Glass fiber filters and activated charcoal canisters are collected weekly and analyzed for gamma-emitting radionuclides. The only manmade gamma emitting

Table 6-2
Average Gross Alpha and Gross Beta Measured in Air ($\mu\text{Ci/mL}$), 1990-1995

Average Gross Alpha						
Locations	1990	1991	1992	1993	1994	1995
On site	1.3E-15	2.5E-15	1.8E-15	1.9E-15	1.4E-15	1.5E-15
Site perimeter	1.1E-15	2.6E-15	1.8E-15	1.8E-15	1.4E-15	1.4E-15
25-mile radius	1.0E-15	2.5E-15	1.7E-15	1.8E-15	1.4E-15	1.4E-15
100-mile radius	1.3E-15	2.6E-15	1.7E-15	2.0E-15	1.8E-15	1.6E-15
Average Gross Beta						
Locations	1990	1991	1992	1993	1994	1995
On site	1.8E-14	1.8E-14	1.9E-14	1.8E-14	1.7E-14	1.8E-14
Site perimeter	1.8E-14	1.8E-14	1.9E-14	1.9E-14	1.8E-14	1.8E-14
25-mile radius	1.8E-14	1.8E-14	1.8E-14	1.8E-14	1.8E-14	1.8E-14
100-mile radius	1.9E-14	1.8E-14	1.7E-14	2.0E-14	1.8E-14	1.8E-14

radionuclide observed was cesium-137. Three samples showed significant quantities of cesium-137: a monthly composite from the burial ground north location, a weekly plant perimeter composite, and a weekly sample from the South Carolina Highway 21/167 location. These observations (the small number of samples with significant activity, the locations of these samples, and the low activity levels) are consistent with historic results and are a function of normal operations at SRS separations facilities and possibly at the Chem-Nuclear low level waste disposal facility, which is located adjacent to the Highway 21/167 monitoring location.

Tritium

Tritium-in-air analyses are conducted on biweekly silica gel samples. Tritium is released as part of routine SRS operations and is considered—to a lesser extent—part of the natural environment. Consistent with the source term, tritium concentrations generally decrease with increasing distance from the tritium facilities near the center of the site. In addition, the analytical results agree with the predictions of the SRS transport and dose assessment model, as detailed in Chapter 7, "Potential Radiation Doses."

Plutonium and Strontium

Glass fiber filters are composited monthly and analyzed for plutonium isotopes (plutonium-238 and plutonium-239) and total strontium (strontium-89,90). These radionuclides are released in small quantities as part of routine site operations (primarily from the separations areas). The observed concentrations of the radionuclides were similar to

historical levels. Likewise, the distribution pattern of the isotopes was similar to that observed in previous years—the concentrations of all three radionuclides are highest near the site center, as expected from source term. The concentrations then show a decrease to background levels or detection limits at the site boundary and beyond.

Rainwater

SRS maintains a network of rainwater sampling sites as part of the air surveillance program. These stations are used to measure deposition of radioactive materials.

Description of Surveillance Program

Rainwater collection pans are located at each routine air surveillance station (figure 6-1). Ion-exchange resin columns are placed at eight of these locations—H-Area, Barnwell Gate, Darkhorse, Olar, Columbia, Greenville, Macon, and Savannah. At each of these locations, rain collected in the pan passes through the column and into a collection bottle. Both the ion-exchange resin column and the collected liquid is returned to the laboratory for analysis. The column is analyzed for gamma-emitting radionuclides, gross alpha, gross beta, plutonium-238, plutonium-239, and strontium-89,90, while the rainwater is analyzed for tritium. At all other locations, the collected rainwater is returned to the laboratory and analyzed for tritium only. Sampling at the onsite, site perimeter, and 25-mile locations is performed monthly, while sampling at the four distant stations is conducted quarterly.

As discussed earlier, extensive changes to the air surveillance program were implemented in 1995. As a part of these changes, rainwater sampling and analysis was stopped at those locations where air surveillance was discontinued.

Surveillance Results

Because ion exchange resin columns at the distant (100-mile) stations are exchanged only quarterly, more activity generally is collected. Levels at these locations typically exceed those observed at the onsite, site perimeter, and 25-mile locations. To provide a standard basis of comparison, all deposition results for gross alpha and gross beta analyses are normalized to pCi/m² per year.

Gross Alpha and Gross Beta

After normalization, the gross alpha and gross beta results were consistent with those of 1994; no increasing or decreasing trend is evident. These results imply that the observed values are natural background and do not indicate any contribution directly attributable to SRS. The longer sampling interval used at the 100-mile stations resulted in higher reported values, which are indicated by the increases in maximum and minimum values observed at these locations.

Plutonium

As in 1994, no detectable levels of plutonium-238 or plutonium-239 were observed.

Strontium

As in 1994, no detectable levels of strontium-89,90 were observed.

Tritium

Tritium-in-rain values were highest at those locations near the center of the site and at D-Area. This is consistent with the H-Area and D-Area effluent release points that routinely release tritium. As with tritium in air, concentrations generally decreased as distance from the effluent release point increased (figure 6-2); this observation also is consistent with the source term and with atmospheric transport.

Gamma Radiation

Description of Surveillance Program

Ambient gamma exposure rates in and around SRS are monitored by an extensive network of dosimeters. The site uses the thermoluminescent dosimeter (TLD) to quantify integrated gamma exposure on a quarterly basis. The TLD performs this function accurately, reliably, and relatively inexpensively.

SRS has been monitoring ambient environmental gamma exposure rates with TLDs since 1965. The

Figure 6-2 Average Concentration of Tritium in Rainwater

Tritium concentrations in rainwater (shown here in pCi/mL), generally decrease as the distance from the site increases.

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Table 6-3
1995 Gamma Radiation Surveillance Program Changes

Subprogram	Change(s)
Site operating areas	No changes
Site perimeter stations	No changes
Population centers	Eliminate 53 locations (figure 6-3)
Air surveillance stations	Eliminate 12 locations: Aiken State Park, Allendale, Columbia, Greenville, Langley, Lees, Macon, Olar, Perkins, South Richmond County, Springfield, and Waynesboro (figure 6-1)

information provided by this program is used primarily to determine the impact (if any) of site operations on the gamma exposure environment and to evaluate trends in environmental exposure levels. Other potential uses include

- support of routine and emergency response dose calculation models
- assistance in determining protective action recommendations in the event of an unplanned release of gamma-emitting radionuclides
- confirmatory accident assessment

The SRS ambient gamma radiation monitoring program is divided into five subprograms, as follows: onsite operating areas, site perimeter stations, population centers, air surveillance stations, and NRC/Vogtle (stations co-located with Nuclear Regulatory Commission and Georgia Power Company locations that monitor potential exposures from Georgia Power's Vogtle Electric Generating Plant). All TLDs are exchanged quarterly.

A technical evaluation of the radiological environmental surveillance program, conducted in 1995 because of budget and manpower reductions, resulted in extensive changes to the gamma radiation surveillance program. Most of the changes were implemented in midyear, as 65 of 394 monitoring stations were eliminated (table 6-3).

As a result of these modifications, most gamma exposure monitoring is conducted on site and at the site perimeter. Monitoring continues to be conducted in population centers within approximately 9 miles (15 km) of the site boundary (figure 6-3), but only limited monitoring is conducted beyond this distance and at the 25- and 100-mile air surveillance stations.

Surveillance Results

In general, 1995 gamma radiation surveillance program results indicate gamma exposure rates consistent with exposure rates observed in 1994. As expected, results from site perimeter and offsite locations (assumed to be unaffected by SRS activities) show some variation based on normal site-to-site and year-to-year differences in the components of natural background gamma exposure rates. However, the results agree with previously published historical results. Table 6-4 summarizes the 1995 surveillance results.

As in previous years, most onsite measurements were no greater than levels measured at the site perimeter or off site. However, several areas on site did indicate clearly elevated exposure levels (over 200 mrem per year). The location showing the highest annual exposure was Location 5 in N-Area, near facilities where work is performed on reactor steam generators.

Seepage Basins

During previous years of operation, SRS discharged liquid effluent to seepage basins to allow for the decay and natural removal of radioactivity in the water before it reached onsite streams. The practice of discharging water to the seepage basins was discontinued in 1988, but water accumulating in the basins from other sources continues to be monitored by EMS because of potential contamination from the basin soil.

Description of Surveillance Program

In 1995, aqueous samples were scheduled to be collected monthly from the Solid Waste Disposal Facility (SWDF) and TNX seepage basins and quarterly from the C-Area, L-Area, and P-Area seepage basins. Because of dry conditions, not all scheduled samples were collected from the A-Area

THERMOLUMINESCENT DOSIMETERS (TLDs) are used at SRS to quantify ambient gamma exposure rates. The TLD badges (above) are packaged to protect them from adverse environmental conditions. Sets of badges are exchanged in the field on a quarterly basis by EMS technicians (left), who use bar code readers to record TLD placement information, such as badge number and location. After each exchange, the placement information is loaded into a computer file. Old badges are removed from the packaging and placed on trays, which in turn are loaded into an automatic reader for processing (below). During processing, each TLD is heated, and its stored energy is released as light; the amount of light released is proportional to the total gamma exposure. Information from the TLD reader is transferred to a computer file, and a program matches reader data with bar code information to determine exposure at a given location.

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Figure 6-3 Offsite TLD Surveillance Locations

Ambient gamma exposure rates are monitored in cities and towns within a 50-mile radius of SRS.

and P-Area seepage basins in 1995. As part of the E-Area expansion plan, EMS also monitors two basins, E-Basin North and E-Basin South. Seepage basin surveillance locations are shown in figure 6-4.

Seepage basin water is analyzed for gross alpha, gross beta, and tritium content. Analyses for specific radionuclides are determined by the makeup of previous releases to the basins.

Surveillance Results

Sampling results from 1995 for seepage basin water were similar to those from 1994, largely because liquid effluents no longer introduce new activity to the basins. Tritium results were slightly lower in 1995 than in 1994 for all but one location, SWDF Basin South (E-001), which was slightly higher than in 1994. The C-Area basin contained the highest beta activity, the majority of which was identified as cesium-137. Analysis of uranium/plutonium activities by alpha spectroscopy began in July 1995, allowing

results to be reported for individual isotopes of uranium and plutonium.

Site Streams

Continuous surveillance is used on several SRS streams, including Tims Branch, Upper Three Runs Creek, Four Mile Creek (also known as Fourmile Branch), Pen Branch, Steel Creek, and Lower Three Runs Creek. Stream water sampling locations that monitor below process areas serve to detect and quantify levels of radioactivity in liquid effluents that are being transported to the Savannah River. In 1995, 23 samplers on SRS streams served as environmental surveillance points. Stream surveillance locations are shown in figure 6-4.

Description of Surveillance Program

Stream samples are collected every week and analyzed as either weekly, biweekly, or monthly composites. Frequency and types of analyses

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Figure 6-4 Radiological Surface-Water Sampling Locations

Surveillance and effluent sampling points are located on SRS seepage basins and streams and on the Savannah River.

performed on each sample are based on the potential quantity and type of radionuclides likely to be present in the water at the surveillance station. Generally, tritium determinations, gamma spectroscopy, and

gross alpha and gross beta screening are performed on stream water. Monthly composites also are analyzed for strontium-89,90, another likely byproduct of SRS operations. Analytical schemes for

Table 6-4
TLD Surveillance Results Summary for 1995

Monitoring Subprogram	Mean Exposure (mrem per year)	Maximum Exposure (mrem per year)	Maximum-Exposure Location
On site	98.69	275.04	N-Area #5
Site perimeter	73.45	106.28	Perimeter #49
Air surveillance	81.72	124.75	BG North
Population centers	81.94	100.16	Girard, GA
NRC/Vogtle	65.83	89.76	NRC #5

particular stream locations are documented in the SRS EM Program.

Surveillance Results

The average gross alpha, gross beta, and tritium concentrations at downstream locations near the creek mouths are presented in table 6-5. A graph showing the average concentration over an 8-year period is presented in figure 6-5. The locations of these stations, well below all points at which radioactivity is introduced into the respective streams, ensure that adequate mixing has taken place and that a representative sample is being analyzed.

Concentrations at surveillance station U3R-1A (above process effluents and runoff locations on Upper Three Runs Creek) and at an Edisto River surveillance station in the Aiken State Park above SRS are listed for comparison purposes in table 6-5. The following sections contain discussions of surveillance results from each of the major SRS creeks.

Tims Branch

A tributary of Upper Three Runs Creek, Tims Branch receives effluents from M-Area and SRTC. A surveillance point on Tims Branch, TB-5, is located downstream of all release points and before entry into Upper Three Runs Creek. Tritium was below the lower limit of detection in Tims Branch in 1995, and gross alpha and beta measurements, while above the detection limits, are comparable to levels seen above SRS at the U3R-1A and the Edisto sampling locations.

Upper Three Runs Creek

Upper Three Runs Creek receives discharges from the Effluent Treatment Facility (ETF), flow from Tims Branch, effluent from the Naval Fuels Facility, and stormwater runoff from F-Area and H-Area.

Tritium, the predominant radionuclide detected in Upper Three Runs Creek, is discharged primarily from the ETF. The average concentration of tritium in 1995 at U3R-4, located on SRS Road A, was $(2.21 \pm 1.57)E-06$ $\mu\text{Ci/mL}$, which was 11 percent of the $2.00E-05$ $\mu\text{Ci/mL}$ EPA drinking water standard for tritium—down from 18 percent in 1994. Gross alpha concentrations in Upper Three Runs Creek were slightly above those observed at the Edisto River station. The highest concentrations are believed to be caused by naturally occurring radium, thorium, and/or uranium from heavy mineral deposits common to waters in these sampling areas.

Four Mile Creek

Four Mile Creek receives effluents from F-Area, H-Area, and C-Area, as well as from water that has migrated from seepage basins and is outcropping into the stream. Four Mile Creek transported the majority of radioactivity present in SRS streams in 1995, mostly in the form of gross beta-gamma activity and tritium. The gross beta-gamma is made up of strontium-89,90 (outcropping from retired seepage basins) and cesium-137 (from direct releases and resuspension of activity deposited in the streambed). The amount of tritium transported in Four Mile Creek was approximately 69 percent of the total amount reaching the Savannah River in 1995. Because the highest tritium concentrations are present at surveillance points along Four Mile Creek, and not at the stations monitoring direct releases, most of the tritium transport is due to outcropping activity from retired seepage basins and from the SWDF. This activity is expected to decrease as a result of the closure of the F-Area and H-Area seepage basins in 1988.

Pen Branch

Pen Branch receives discharges from K-Area and flow from a tributary, Indian Grave Branch. Because

K-Reactor did not operate in 1995, tritium detected in Pen Branch was due to water entering from Indian Grave Branch, which carries tritium outcropping from the K-Area percolation field and seepage basins. The average tritium concentration at PB-3 was $(6.89 \pm 1.33)\text{E-05 } \mu\text{Ci/mL}$ in 1995, slightly higher than the level observed in 1994. EMS is planning to begin an investigation in 1996 to determine the cause of this increase in tritium.

Steel Creek

Steel Creek receives releases from L-Area effluents and tritium migration from P-Area seepage basins. When P-Area diverts water away from PAR Pond to Steel Creek, the area's discharges are transported to the stream. All releases enter L-Lake, water from which overflows into Steel Creek and is monitored at SC-4. Gross alpha concentrations at SC-4 were below detection limits in 1995. Gross beta concentrations were slightly above detection limits, at $(1.62 \pm 0.78)\text{E-09 } \mu\text{Ci/mL}$, with tritium being detected at an average concentration of $(6.97 \pm 0.93)\text{E-06 } \mu\text{Ci/mL}$. Because the highest tritium concentration, $(1.14 \pm 0.05)\text{E-05 } \mu\text{Ci/mL}$, was measured at the surveillance station at SC-2A, and not at the direct-release monitoring stations in L-Area and P-Area, activity

being transported in Steel Creek is attributed to outcropping from the P-Area seepage basins.

Lower Three Runs Creek

Lower Three Runs Creek receives overflow from PAR Pond, a manmade pond that receives discharges from P-Area. Gross beta concentrations in PAR Pond and Lower Three Runs Creek are above detection limits; this is attributable to low concentrations of cesium-137 from previous releases during P-Area and R-Area operations. Average gross alpha and tritium concentrations are below detection limits.

Savannah River

Continuous surveillance is performed along the Savannah River at points above and below SRS and below the point at which Plant Vogtle liquid discharges enter the Savannah River. In 1995, five locations along the river served as environmental surveillance points. River sampling locations are shown in figure 6-4.

Description of Surveillance Program

The Savannah River, which provides SRS its western boundary for a 35-mile stretch, is analyzed to determine what effect the site's effluents have on the

Table 6-5
Average 1995 Concentration of Radioactivity in SRS and Surveillance Station Waters ($\mu\text{Ci/mL}$)

Location ^a	Gross Alpha	Gross Beta	Tritium
Lower Limits of Detection	6.23E-10	1.55E-09	1.30E-06 ^b
<i>Onsite Downstream Locations</i>			
Tims Branch (TB-5)	$(1.47 \pm 0.59)\text{E-09}$	$(2.39 \pm 0.99)\text{E-09}$	$(9.66 \pm 3.41)\text{E-07}$
Upper Three Runs (U3R-4)	$(1.30 \pm 0.56)\text{E-09}$	$(1.27 \pm 0.59)\text{E-09}$	$(2.21 \pm 1.57)\text{E-06}$
Four Mile Creek (FMC-6)	$(2.81 \pm 3.01)\text{E-10}$	$(1.03 \pm 0.26)\text{E-08}$	$(2.28 \pm 0.33)\text{E-04}$
Pen Branch (PB-3)	$(1.07 \pm 2.38)\text{E-10}$	$(1.25 \pm 0.64)\text{E-09}$	$(6.89 \pm 1.33)\text{E-05}$
Steel Creek (SC-4)	$(0.84 \pm 1.95)\text{E-10}$	$(1.62 \pm 0.78)\text{E-09}$	$(6.97 \pm 0.93)\text{E-06}$
Lower Three Runs (L3R-2)	$(3.25 \pm 3.08)\text{E-10}$	$(1.84 \pm 0.71)\text{E-09}$	$(9.88 \pm 3.47)\text{E-07}$
<i>Onsite Surveillance Station (for comparison purposes)</i>			
Upper Three Runs (U3R-1A)	$(2.12 \pm 0.85)\text{E-09}$	$(1.59 \pm 0.72)\text{E-09}$	$(5.08 \pm 3.45)\text{E-07}$
Lower Limit of Detection			4.07E-07 ^c
<i>Offsite Surveillance Station (for comparison purposes)</i>			
Edisto River	$(7.67 \pm 4.29)\text{E-10}$	$(1.58 \pm 0.67)\text{E-09}$	$(2.22 \pm 1.65)\text{E-07}$

a Site surveillance locations are near mouths of streams.

b Lower limit of detection for tritium by short count

c Lower limit of detection for tritium by long count

Figure 6-5 Average Tritium Concentration in SRS Streams, 1988–1995

Stream water analysis shows a fairly steady decrease in the concentration of tritium in SRS streams.

river water. Gross screening for alpha and beta emitters, along with determinations of specific radionuclides, such as tritium and gamma emitters, is performed on weekly, biweekly, and monthly composites. The collection of strontium-89,90 samples on the Savannah River was inadvertently omitted in 1995.

Surveillance Results

Gross Alpha, Gross Beta, and Tritium

The average concentrations of gross alpha, gross beta, and tritium at river locations are presented in table

6-6. The order of the locations begins at RM-160, above the site, and ends at RM-120, after all site streams enter the Savannah River. Samplers situated between RM-160 and RM-120 are located at regular intervals along the SRS boundary and where Plant Vogtle discharges feed into the river.

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The highest average concentration in 1995, $(1.74 \pm 1.00)E-06$ $\mu\text{Ci/mL}$, was measured at RM-150. The average concentration above SRS, measured at RM-160, was $(2.09 \pm 1.86)E-07$ $\mu\text{Ci/mL}$. The average concentration at RM-120, located

Table 6-6

Average 1995 Concentration of Radioactivity in the Savannah River ($\mu\text{Ci/mL}$)

Location	Gross Alpha	Gross Beta	Tritium
Lower Limits of Detection	$6.23E-10$	$1.55E-09$	$4.07E-07$
RM-120	$(0.82 \pm 2.40)E-10$	$(1.98 \pm 0.59)E-09$	$(1.28 \pm 0.45)E-06$
RM-140	$(1.96 \pm 3.44)E-10$	$(2.33 \pm 0.96)E-09$	$(1.54 \pm 0.63)E-06$
RM-150	$(1.42 \pm 3.17)E-10$	$(1.98 \pm 0.62)E-09$	$(1.74 \pm 1.00)E-06$
Vogtle discharge	$(1.73 \pm 2.60)E-10$	$(1.94 \pm 0.74)E-09$	$(0.79 \pm 1.01)E-06$
RM-160	$(0.83 \pm 2.71)E-10$	$(2.19 \pm 1.52)E-09$	$(2.09 \pm 1.86)E-07$

on U.S. Highway 301 below SRS, was $(1.28 \pm 0.45) \times 10^{-6}$ $\mu\text{Ci/mL}$. The RM-120 concentration was 6 percent of the 2.00×10^{-5} $\mu\text{Ci/mL}$ drinking water standard set by EPA for tritium in drinking water.

Tritium Transport in Streams and River

Tritium is introduced into SRS streams and the Savannah River via production areas on site. Because of the mobility of tritium in water and the quantity of the radionuclide released during the years of SRS operations, a tritium balance has been performed annually since 1960. The balance is evaluated among the following alternative methods of calculation:

- tritium releases from effluent release points and calculated seepage basin migration (direct releases)

- tritium transport in SRS streams and the last sampling point before entry into the Savannah River (stream transport)
- tritium transport in the Savannah River downriver of SRS after subtraction of any measured contribution above the site (river transport)

Figure 6-6 shows graphic and numeric summaries of the last 36 years of direct releases, stream transport, and river transport determined by EMS.

In 1995, tritium transport remained at levels consistent with those of 1994. Stream transport showed a slight increase—probably because of increased migration from site seepage basins.

General agreement between the three calculational methods of annual tritium transport—measurements at the source, stream transport, and river transport—serves to validate SRS sampling schemes and counting results. Differences between the various methods can be attributed to uncertainties arising in the collection and analytical processes, including

Ileaf Graphic

Figure 6-6 SRS Tritium Transport Summary, 1960-1995

SRS has maintained a tritium balance of direct releases, stream transport, and river transport since 1960 in an effort to account for and trend tritium releases in liquid effluents from the site. The general downward slope over time indicates that tritium transport has decreased as production has slowed and effluent controls have been developed.

Figure 6-7 Radio-logical Offsite Drinking-Water Sampling Locations

SRS collected drinking water samples during 1995 from 16 offsite locations within a 30-mile radius and from three water treatment plants, one of which is shown on the map. The 16 offsite locations were discontinued midway through 1995.

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determinations of water flows and varying transport times. Because of the close agreement, and because it can be independently verified by offsite agencies, the river transport value has been chosen for use in annual environmental dose calculations.

Drinking Water

EMS collects drinking water samples from locations at SRS, in surrounding towns and communities, and at water treatment facilities that use Savannah River water. Potable water from surrounding communities is analyzed to ensure that SRS operations are not adversely affecting the water supply and to provide voluntary assurance that drinking water is below EPA drinking water standards for radionuclides.

Description of Surveillance Program

Sampling on site consists of monthly grab samples at production areas and quarterly grab samples at nonproduction and perimeter stations. Semiannual collections at towns within a 30-mile radius of the site was discontinued in July 1995 because of budget/program reductions. Collected monthly are samples from

- two water treatment plants downriver of SRS that supply treated Savannah River water to Beaufort and Jasper counties in South Carolina and to Port Wentworth, Georgia
- the North Augusta (South Carolina) Water Treatment Plant
- the D-Area treatment facility on site

At all these facilities, raw and finished water samples are collected daily and composited for analysis by EMS. All drinking water samples are screened for alpha and beta emitters and analyzed specifically for tritium. Drinking water samples also are analyzed at least once a year for strontium-89,90. Offsite drinking water sampling locations are shown in figure 6-7.

Surveillance Results

Gross Alpha and Gross Beta

All drinking water samples collected by EMS are screened for gross alpha and gross beta concentrations to determine if activity levels warrant further analysis. No samples collected in 1995 exceeded EPA's $1.50\text{E}-08\text{-}\mu\text{Ci/mL}$ alpha activity limits or $5.00\text{E}-08\text{-}\mu\text{Ci/mL}$ beta activity limits. As in 1994, the highest average alpha concentra-

tion— $(6.18 \pm 5.12)E-09$ $\mu\text{Ci/mL}$ at the 701-5G Aiken Barricade (Talatha Gate)—has been characterized for specific alpha activity, with at least a partial source of activity due to radium-226. No sample's average exceeded $8.00E-09$ $\mu\text{Ci/mL}$ of beta activity. This concentration is the EPA limit for strontium-90, which is the most restrictive beta-emitting radionuclide.

Strontium

No drinking water samples collected and analyzed by EMS for strontium-89,90 exceeded the $1.90E-09$ - $\mu\text{Ci/mL}$ detection limit of the EMS laboratories. This limit is approximately 25 percent of the EPA drinking water standard for strontium-90.

Tritium

No drinking water samples collected and analyzed by EMS exceeded the $2.00E-05$ - $\mu\text{Ci/mL}$ EPA tritium limit. Detectable levels of tritium were present in the drinking water samples collected monthly from the Beaufort-Jasper and Port Wentworth water treatment facilities. These levels reflect the introduction of tritium from SRS operations into the Savannah River. The average tritium concentration in finished water at Beaufort-Jasper in 1995, $(8.25 \pm 2.26)E-07$ $\mu\text{Ci/mL}$, was 4 percent of the EPA drinking water limit. The average tritium concentration at Port Wentworth, $(1.02 \pm 0.19)E-06$ $\mu\text{Ci/mL}$, was 5 percent of the EPA drinking water limit.

Terrestrial Food Products

The terrestrial food products surveillance program consists of radiological analyses of food product samples typically found in the Central Savannah River Area (CSRA). Because radioactive materials can be transported to man through the consumption of milk and other food products containing radioactivity, food product samples are analyzed to determine what effects, if any, SRS operations have on them. Data from the food product surveillance program are not used to show direct compliance with any dose standard; however, the data can be used as required to verify dose models and determine environmental trends.

Description of Surveillance Program

Beef, Fruit, Grains, and Greens

Budget reductions led to changes in the food products surveillance program during 1995, as the numbers of locations and of samples collected were reduced. Results from the 1995 sample analyses thus reflect a combination of the old and new programs; for

example, grains and fruit were collected under the old program (during the first half of the year), green vegetables and beef under the new one.

The new program divides the area that surrounds the site, approximately 9 miles (15 km) beyond its perimeter, into four quadrants—northeast, southeast, southwest, and northwest. Samples of food—including beef, fruit, green vegetables (collards), and milk—are collected from one location within each of the quadrants and from a control location within an extended (to 25 miles beyond the perimeter) southeast quadrant. All food samples are collected annually except milk, which is collected monthly for analysis of tritium and gamma-emitting radionuclides and quarterly for analysis of strontium-90.

Under the old program, which had been expanded in 1993, samples were collected from four 50-mile-radius quadrant locations.

Food samples are analyzed for gamma-emitting radionuclides, tritium, strontium-89,90, uranium and plutonium (nonspecific), plutonium-238, and plutonium-239.

Milk

During 1995, EMS collected milk samples at five dairies within a 25-mile radius of SRS, at four dairies within a 50-mile radius, and from locally produced inventories of a major distributor. Budget reductions also led to changes in the milk program, as the four 50-mile-radius locations were eliminated in August. The new program, under which samples continue to be collected monthly, consists of the five local dairies and the major distributor.

Milk samples are analyzed for tritium and gamma-emitting radionuclides, primarily cesium-137 and iodine-131. Additional milk samples are collected quarterly and analyzed for strontium-90. Collection of two of the quarterly samples for strontium-90 was inadvertently omitted in 1995.

Surveillance Results

Gamma-Emitting Radionuclides

The only manmade gamma-emitting radionuclide detected in food products, excluding milk, was cesium-137. The maximum concentration, $(1.48 \pm 0.44)E-02$ pCi/g, was measured in grain from the Hilda area. Cesium-137 concentrations at the control location were below detection limits. Generally, concentrations of cesium-137 in indicator samples were similar to those measured at the control location, although some locations showed detectable activity. These concentrations were similar to those observed in previous years.

Cesium-137 was the only manmade gamma-emitting radionuclide detected in milk samples during 1995. Measured average concentrations ranged from a high of $(5.64 \pm 1.34)E-03$ pCi/mL to a low of $(3.16 \pm 0.95)E-03$ pCi/mL. The mean concentrations measured in 1995 were similar to those measured in 1994.

Iodine-131 was not detected in any 1995 milk samples. Because of its short physical half-life (8 days), iodine-131 generally is not detected, except shortly after tests of nuclear weapons or in the wake of events such as the Chernobyl incident. There were no announced nuclear weapons tests or other major nuclear incidents in 1995.

Tritium

Tritium concentrations ranged from below detection limit in several samples to a high of $(1.44 \pm 0.32)E-01$ pCi/g, measured in collards from the 15-km southeast quadrant. Tritium concentrations were similar to those measured in 1994.

Tritium in milk and other samples is attributed to releases from SRS. Milk from most dairies showed detectable concentrations of tritium at some point during 1995. The maximum concentration, $(1.08 \pm 0.14)E+00$ pCi/mL, was measured at a Jackson, South Carolina, location. The minimum concentration from other local sampling locations was below detection limits. Tritium concentrations measured in milk in 1995 were similar to those in 1994 and generally reflect atmospheric releases from the site.

The maximum tritium concentration detected in milk from the 50-mile-radius locations, $(5.68 \pm 1.36)E-01$ pCi/mL, was measured in a sample from the northeast quadrant. The minimum tritium concentration at the 50-mile radius also was below detection limits. As expected, the concentrations of tritium in milk measured at the 50-mile locations were slightly lower than those observed at the perimeter and 25-mile locations.

Strontium

All strontium-89,90 concentrations in food products, excluding milk, were below the detection limit of $1.0 E-01$ pCi/g and generally were within the ranges observed during past years.

Strontium-90 analysis was performed on milk from the perimeter and 25-mile sample locations. Measured concentrations ranged from a high of $(7.47 \pm 4.43)E-03$ pCi/mL in the Girard, Georgia, area to a low below detection limits. The mean concentrations

measured in 1995 were similar to those measured in 1994.

Uranium/Plutonium

Most concentrations of total uranium and plutonium (nonspecific) in food products, excluding milk, were not detectable. The highest concentration, $(8.15 \pm 2.37)E-02$ pCi/g, was measured in grain collected from the Springfield, South Carolina, vicinity. This concentration was slightly higher than the 1994 maximum concentration of $(4.58 \pm 1.15)E-02$ pCi/g, which was measured in greens from the northwest quadrant.

Concentrations of plutonium-238 in food products, excluding milk, during 1995 ranged from below detection limits to a high of $(4.61 \pm 1.09)E-04$ pCi/g, measured in fruit collected below Barricade No. 5. Plutonium-239 concentrations in food products, excluding milk, ranged from below detection limits to a high of $(7.49 \pm 2.36)E-05$ pCi/g in green vegetables from the 15-km southwest quadrant. Plutonium-238 and plutonium-239 concentrations measured in food products, excluding milk, during 1995 were similar to the 1994 concentrations.

Aquatic Food Products

Description of Surveillance Program

The aquatic food product surveillance program consists of both fish (freshwater and marine) and shellfish. To determine the potential dose and risk to the public from consumption of these fish, both are sampled.

Nine surveillance points for the collection of fish are located on the Savannah River. These include

- the Augusta Lock and Dam area, above the site
- five areas where site streams enter the Savannah River
- the U.S. Highway 301 bridge, below the site
- Stokes Bluff Landing, below the site
- the U.S. Highway 17A bridge area, below the site

Nine surveillance points for fish collection also are located within the SRS boundary. These points include PAR Pond, L-Lake, Pond B, Lower Three Runs Creek, Upper Three Runs Creek, Beaver Dam Creek, Pen Branch, Steel Creek, and Four Mile Creek. In 1995, not enough fish could be collected for composite samples (five from the same category per location) from Stokes Bluff, Upper Three Runs Creek, Four Mile Creek, Pen Branch, or Lower Three Runs Creek at Patterson Mill.

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Figure 6-8 Fish Sampling Points on the Savannah River

SRS collects fish from the Savannah River above, adjacent to, and below the site, as well as at Stokes Bluff Landing and near Savannah.

Freshwater fish are grouped into one of three categories: predatory fish, panfish, or bottom-dwelling fish. Largemouth bass were placed in the predatory group; bluegill, redbreast (both bream), and crappie in the panfish group; and catfish in the bottom-dwelling group. Marine (saltwater) fish, collected from the U.S. Highway 17A bridge area, also are grouped into one of three categories: predatory fish, filter feeder, or bottom-dwelling fish. Speckled sea trout and spot tail bass were placed in

the predatory group; mullet in the filter feeder group; and catfish and flounder in the bottom-dwelling group. The fish are grouped in this manner because they are the most sought-after fish in the Savannah River, according to the latest creel survey conducted by the Fisheries Management Section of the Georgia Department of Natural Resources Wildlife Resources Division.

All fish are analyzed for gross alpha and gross beta. Fish collected from Augusta Lock and Dam downstream through the U.S. Highway 301 bridge also are analyzed for strontium-89,90; plutonium-238 and plutonium-239; and tritium.

In the shellfish surveillance program, samples of oysters and crabs are collected on the coast near Savannah, Georgia. The shellfish are analyzed for gross alpha, gross beta, and strontium-89,90.

Calculations of risk from the consumption of fish from the Savannah River can be found in chapter 7.

Surveillance Results

In the following surveillance results discussion, uncertainty values are provided because most measurements were at or near the LLD.

Freshwater Fish

Savannah River Fifty edible composites (25 onsite and 25 offsite) and 24 nonedible (offsite) composites of fish from the Savannah River were analyzed in 1995 for gross alpha and gross beta. Each composite consisted of samples of five fish from one of the following categories:

- Panfish (bream, crappie)
- Bottom dwellers (catfish)
- Predators (bass)

Gross alpha activities in the offsite edible composites ranged from a high of $(1.87 \pm 1.80)\text{E-01}$ pCi/g in a bream from the mouth of Steel Creek to a low of $(-7.77 \pm 6.34)\text{E-02}$ pCi/g in a catfish from Lower Three Runs Creek. The maximum gross alpha activity— $(8.32 \pm 6.02)\text{E-01}$ pCi/g, in a nonedible composite—was measured in a crappie from Augusta Lock and Dam (control location).

The maximum edible gross beta activity from the Savannah River, $(5.09 \pm 0.58)\text{E+00}$ pCi/g, was measured in a catfish composite from the mouth of Steel Creek. This concentration was slightly lower than the maximum nonedible gross beta activity, $5.86 \pm 1.28\text{E+00}$ pCi/g, measured in a bream at the Augusta Lock and Dam.

In 1995, composites of fish from the Savannah River were analyzed for gamma-emitting radionuclides. Figure 6-8 shows surveillance locations on the Savannah River and the control location at the Augusta Lock and Dam. Cesium-137 was the only manmade, gamma-emitting radionuclide detected. The maximum cesium-137 activity in edible fish from the Savannah River, $(1.21 \pm 0.04)\text{E+00}$ pCi/g,

was measured in a bass composite from the mouth of Steel Creek. The maximum cesium-137 concentration in nonedible fish from off site was $(7.30 \pm 0.35)\text{E-01}$ pCi/g, measured in a bass composite from the mouth of Steel Creek.

In 1995, both edible and nonedible composite portions were analyzed for strontium-89,90. The maximum strontium-89,90 concentration was $(1.54 \pm 0.28)\text{E+00}$ pCi/g in a bream sample from the Augusta Lock and Dam.

The maximum tritium concentration at the control location (Augusta Lock and Dam, upstream of SRS) was $(9.91 \pm 4.15)\text{E-02}$ pCi/g, measured in a bream composite. The maximum tritium concentration downstream and/or adjacent to the site, $(2.70 \pm 0.05)\text{E+00}$ pCi/g, was found in a bream composite at Steel Creek Mouth.

Onsite Streams and Ponds Gross alpha and gross beta analyses were performed on edible fish composites collected from SRS streams and ponds. Maximum gross alpha and gross beta concentrations— $(2.76 \pm 1.66)\text{E-01}$ pCi/g and $(8.72 \pm 0.18)\text{E+01}$ pCi/g, respectively—were measured in bass composites from L-Lake and Pond B, respectively. Minimum gross alpha and gross beta concentrations— $(-9.99 \pm 8.01)\text{E-01}$ pCi/g and $1.78 \pm 0.37\text{E+00}$ pCi/g, respectively—were measured in bream composites from PAR Pond and L-Lake, respectively.

Cesium-137 was the only manmade, gamma-emitting radionuclide detected in fish from onsite streams and ponds. The maximum cesium-137 concentration in an onsite edible composite, $(3.39 \pm 0.03)\text{E+01}$ pCi/g, came from a Pond B bream composite.

Marine Fish

One sample of mullet was collected in 1995 from the U.S. Highway 17A bridge area. The gross alpha concentration was $(0.33 \pm 1.36)\text{E-01}$ pCi/g; the gross beta concentration was $(2.60 \pm 0.04)\text{E+00}$ pCi/g.

Shellfish

Only one sample of shellfish—oysters, from near the mouth of the Savannah River—was collected in 1995. Analytical results showed that no manmade radioisotopes above the detection limit were present in the sample.

Deer and Hogs

Description of Surveillance Program

Annual hunts, open to members of the general public, are conducted at SRS to control the site's deer and

feral hog populations and to reduce animal-vehicle accidents. Before any animal is released to a hunter, EMS uses portable sodium iodide detectors to perform field analysis for cesium-137. The resulting dose from consumption is calculated for each animal, and each hunter's cumulative total is tracked. Media samples (muscle and/or bone) are collected periodically for laboratory analysis based on a set frequency, on cesium-137 levels, and/or on exposure limit considerations.

Surveillance Results

During 1995, 1,152 deer and 47 feral hogs were taken from the site as part of the controlled hunt program. This compares to 1,591 deer and 147 feral hogs taken during the 1994 site hunts. The number of hunts was reduced from 14 to 12 in 1995 as part of the site's ongoing wildlife management program.

Gamma-Emitting Radionuclides

In 1995, the maximum field measurement of cesium-137 in deer muscle was approximately 40 pCi/g, while the mean cesium-137 concentration was approximately 5 pCi/g. In feral hogs, the maximum field measurement of cesium-137 in muscle was approximately 7 pCi/g, while the mean concentration was approximately 2 pCi/g.

Each animal is monitored prior to release, and the field measurements are supplemented by laboratory analyses. Samples are collected from approximately 10 percent of the animals processed, including every 10th animal monitored and any animal that results in a hunter's dose exceeding 25 mrem—either alone or in combination with previous animals killed by the hunter. In 1995, 127 samples from 116 animals were collected and analyzed for gamma-emitting radionuclides; tables in *SRS Environmental Data for 1995* include measurements only from these animals.

As observed during previous hunts, cesium-137 was the only manmade gamma-emitting radionuclide detected during laboratory analysis. The cesium-137 concentrations measured by the field and lab methods were comparable. Field measurements ranged from approximately 1 pCi/g to 40 pCi/g, while lab measurements ranged from approximately 1 pCi/g to 45 pCi/g.

Strontium

Strontium levels are determined in some of the animals tested for cesium-137. Typically, muscle and bone samples are collected for analysis from the same

animals checked for cesium-137, and the samples are analyzed for strontium-89,90.

In 1995, 28 muscle samples from 17 animals were collected for strontium analysis. Only one sample showed strontium-89,90 above the detection limit; this sample showed approximately 0.02 pCi/g. These results are consistent with those observed during previous hunts—most animals do not have detectable strontium-89,90, with only low levels present in the remainder.

Twelve bone samples were collected from 12 animals for strontium analysis in 1995. The analytical results indicated a wide range of strontium-89,90 concentrations, from approximately 1 pCi/g to approximately 9 pCi/g. These levels are consistent with the bone sample concentrations observed during previous years. Strontium, whether stable or radioactive, is chemically similar to calcium. In animals, these elements tend to concentrate in bone; therefore, higher strontium-89,90 levels are observed in bone than in muscle tissue.

Turkeys

Description of Surveillance Program

Wild turkeys are trapped on site by the South Carolina Wildlife and Marine Resources Department and used to repopulate South Carolina game areas. All turkeys are monitored for cesium-137 with portable sodium iodide detectors before leaving SRS. No turkey above 25 pCi/g is released off site.

Surveillance Results

EMS monitored 16 turkeys in 1995. Concentrations of cesium-137 generally were similar to those measured in the past, with all results 1.0 pCi/g or less. This compares to a maximum concentration in 1994 of 10.0 pCi/g and minimum of 1 pCi/g.

Beavers

Description of Surveillance Program

The U.S. Forest Service administers a contract for the trapping of beavers in selected areas within the SRS perimeter. The purpose of trapping is to reduce the beaver population in specific areas of the site and thereby minimize dam-building activities that can result in flood damage to timber stands, primary and secondary roads, and railroad beds. All beavers are monitored for cesium-137 with a portable sodium iodide detector and disposed of in the SRS sanitary landfill.

Figure 6-9 Radiological Soil Sampling Locations
SRS collected soil samples from 22 onsite locations (four perimeter locations not shown) and two offsite locations in 1995.

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Surveillance Results

EMS monitored 123 beavers in 1995. The maximum cesium-137 concentration was 10.5 pCi/g, measured in an animal trapped on Four Mile Creek near C-Area. The minimum concentration was 1.0 pCi/g. This compares with a 1994 maximum of 22 pCi/g and minimum of 1 pCi/g. The maximum and minimum in 1993 were 47 pCi/g and 1 pCi/g, respectively.

Soil

The SRS soil monitoring program provides

- data for long-term trending of radioactivity deposited from the atmosphere (both wet and dry)
- information on the concentrations of radioactive materials in the environment

Routine and nonroutine SRS atmospheric releases, as well as worldwide fallout, are monitored in this program. The concentrations of radionuclides in soil vary greatly among locations because of differences in rainfall patterns and in the mechanics of retention and transport in different types of soils. Because of

this program's design, a direct comparison of data from year to year is not appropriate.

Description of Surveillance Program

Soil samples were collected in 1995 from 18 uncultivated and undisturbed locations in F-Area, H-Area, S-Area, Z-Area, and E-Area and from four locations on the site perimeter. (figure 6-9). Two locations approximately 100 miles from SRS—Savannah, Georgia, and Clinton, South Carolina—also were sampled. The Clinton location was discontinued after the 1995 collection as part of the radiological surveillance budget/program reduction.

Hand augers or other similar devices are used in sample collection. The samples are analyzed for gamma-emitting radioisotopes, strontium-89,90, plutonium-238, and plutonium-239. The rationale for each sampling site is explained in the SRS EM Program.

Surveillance Results

Gamma-Emitting Radionuclides

Cesium-137 was observed at levels above the LLD ($2.4\text{E}-02$ pCi/g) at 17 of the 24 locations. The highest

concentration detected on site, $(1.01 \pm 0.03)E+00$ pCi/g, was in a sample taken near H-Area, and the lowest was below the LLD. Concentrations ranged from 0.25 pCi/g to 0.42 pCi/g at the site perimeter and from 0.29 pCi/g to 0.35 pCi/g at the 100-mile-radius locations.

Plutonium

Plutonium-238 was observed above the LLD ($7.3E-04$ pCi/g) at 11 onsite, three site perimeter, and no offsite locations. The highest perimeter concentration was $(1.90 \pm 0.72)E-03$ pCi/g, in the southwest quadrant. Plutonium-239, the analysis results of which continued a recent trend of relatively lower concentrations, was observed above the LLD ($5.9E-04$ pCi/g) at 14 onsite, four perimeter, and two off site locations. The highest perimeter concentration was $(1.49 \pm 0.12)E-02$, in the northwest quadrant; the highest offsite concentration was $(6.81 \pm 0.44)E-03$ pCi/g, at Clinton.

Strontium

Soil samples from all locations were analyzed for strontium-89,90, and all were below the LLD ($1.20E-01$ pCi/g).

Sediment

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in stream beds and in the Savannah River bed. Because of the continuous deposition and remobilization occurring in the stream and river beds, significant year-to-year differences may be evident, but the data obtained can be used to observe long-term environmental trends.

Description of Surveillance Program

Sediment samples are collected annually at 15 locations: six in the Savannah River and nine in site streams (figure 6-10). Samples are obtained from the top 8 cm of sediment in areas where fine sediment accumulates and most radionuclides concentrate. Sediments are analyzed for gamma-emitting fission and activation products, strontium-89,90, plutonium-238, and plutonium-239.

Surveillance Results

Concentrations of radionuclides in river sediment during 1995 were similar to those detected upriver in the control sample from Demiere's Landing. Maximum activities were observed in samples obtained from Steel Creek and Pen Branch.

Gamma-Emitting Radionuclides

Cesium-137 was the only manmade gamma-emitting radionuclide observed in river sediment. The highest level in 1995 was detected in sediment taken from below Little Hell Landing. Also, the Lower Three Runs Creek Mouth location has shown higher than typical concentrations for the past 3 years; it is possible that this increase is caused by the changes in PAR Pond (chapter 12, "Special Surveys and Projects").

Cesium-137 concentrations were slightly higher in stream sediments than in river sediments. This is to be expected because the streams receive radioisotope-containing liquid effluents from the site. Most radionuclides settle out and deposit on the stream bed before reaching the river.

Cobalt-60 was detected in sediment from Steel Creek.

Plutonium

Maximum concentrations of plutonium-238 occurred at the Steel Creek Swamp Discharge location, while maximum concentrations of plutonium-239 occurred at the Pen Branch Swamp Discharge point. As expected, concentrations of these isotopes in streams generally were higher than concentrations in the river. Changes observed when these data are compared to previous years probably are due to the effects of resuspension and deposition, which occur constantly in sediment media.

Strontium

The maximum strontium-89,90 concentration, which again occurred at Four Mile Creek A-7A, is lower than the result reported in 1994. The change in magnitude probably is due to the year-to-year variations cited earlier.

Terrestrial Vegetation

The radiological program for terrestrial vegetation is designed to collect and analyze samples from onsite and offsite locations to determine radionuclide concentrations. Vegetation samples are obtained to complement the soil and sediment samples in order to determine the environmental accumulation of radionuclides and help confirm the dose models used by SRS. Furthermore, the program provides information that can be used to determine the effect, if any, of various radioactive material operations on the surrounding vegetation.

Typically, grasses are collected for vegetation because of their year-round availability. Bermuda grass is preferred because of its importance as a pasture grass for dairy herds.

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Figure 6-10 Radiological Sediment Sampling Locations

Sediment samples were collected in 1995 at six Savannah River locations—upriver of, adjacent to, and downriver of the site—and nine site stream locations.

Description of Surveillance Program

The onsite samples, collected on a seasonal or quarterly basis, are obtained from

- locations containing soil radionuclide concentrations that are expected to be higher than normal background levels

- locations receiving water that may have been contaminated

These onsite collection locations are inside and around the many seepage and retention basins, F-Area, H-Area, Z-Area, S-Area, seepage and retention basins, and SWDF (burial ground).

Until mid-1995, the offsite samples generally were collected near the environmental air monitoring stations at 25- and 100-mile-radius locations, which are designated as "614" buildings. Because of budget/program reductions, however, all four 25-mile-radius and three (of four) 100-mile-radius stations were retired in midyear.

Vegetation samples are analyzed for gross alpha and gross beta, gamma-emitting radionuclides, strontium-89,90, and tritium. Terrestrial vegetation can be contaminated externally by the deposition of airborne radioactive contaminants (i.e., from fallout) and internally by uptake, from soil or water, by the roots. While the program makes no attempt to differentiate between contributions of the external and internal contaminations, the contributions can be approximated when naturally occurring radionuclide concentrations in local soils are known.

Surveillance Results

The vegetation surveillance program is divided into three broad areas: quarterly surveillance samples, annual seepage basin and retention basin samples, and quarterly and annual SWDF (burial ground) samples. All results are based on dry weight [SRS Data, 1996].

Quarterly Surveillance Samples

No changes were made in the 18 onsite and 14 site perimeter quarterly surveillance sampling locations for vegetation during 1995. However, as indicated earlier, four 25-mile-radius and three 100-mile-radius stations were retired in midyear; therefore, data provided in this report from the retired locations are for January through August 1995 only. The onsite locations are shown in figure 6-11. Analytical results are summarized in table 6-7.

The F-Area and H-Area locations are about 2,000 feet from the areas' atmospheric discharge stacks. This distance was chosen to avoid production and construction activities within the areas. Also, the distance places most of the sampling locations outside high-security areas so they can be accessed and maintained more easily. Sampling around S-Area

Figure 6-11 Vegetation Sampling (Except Inside SWDF)

Samples are collected for radiological analysis from 18 onsite-quarterly and 13 outside-SWDF locations.

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Table 6-7
Maximum Radionuclide Concentrations in Vegetation from Quarterly Surveillance Samples (pCi/g)

Surveillance Ring	Maximum	Location
Gross Alpha		
Onsite	$(2.41 \pm 1.24)E+00$	643-26E-1
Site Perimeter	$(1.52 \pm 1.44)E+00$	Patterson Mill Road
25-Mile-Radius	$(8.12 \pm 7.65)E-01$	Allendale, SC
100-Mile Radius	$(1.66 \pm 0.77)E+00$	Macon, GA
Gross Beta		
Onsite	$(2.83 \pm 0.20)E+01$	643-26E-2
Site Perimeter	$(5.31 \pm 0.38)E+01$	Highway 125 @ Road A-14
25-Mile-Radius	$(1.75 \pm 0.18)E+01$	Langley, SC
100-Mile Radius	$(2.30 \pm 0.20)E+01$	Columbia, SC
Cesium-137		
Onsite	$(4.23 \pm 0.38)E-01$	F-Area
Site Perimeter	$(9.33 \pm 0.73)E-01$	Barnwell Gate
25-Mile-Radius	$(9.18 \pm 0.63)E-01$	Langley, SC
100-Mile-Radius	$(1.04 \pm 0.13)E-01$	(Composite)
Strontium		
Onsite	$((7.91 \pm 0.87)E-01$	F-Area
Site Perimeter	$(8.39 \pm 0.49)E-01$	(Composite)
25-Mile-Radius	$(3.63 \pm 0.79)E-01$	(Composite)
100-Mile-Radius	$(1.97 \pm 0.44)E-01$	(Composite)
Tritium		
Onsite	$(1.87 \pm 0.02)E+01$	643-26E-1
Site Perimeter	$(1.13 \pm 0.03)E+00$	D-Area
25-Mile-Radius	$(1.13 \pm 0.45)E-01$	Waynesboro, GA
100-Mile-Radius	$(8.63 \pm 2.51)E-02$	Savannah, GA

and Z-Area was initiated in 1989 to obtain baseline information prior to the start of radioactive operations at these waste processing facilities. The locations continue to be sampled to determine if the operations have any effect on the surrounding vegetation.

The site perimeter locations circle SRS to permit sampling within each 30-degree sector around the site.

The 25-mile-radius locations were used to accumulate trending data, while the 100-mile-radius locations served as control locations and provided historical baseline information. SRS continues to collect quarterly samples at the 100-mile-radius location in Savannah, Georgia.

Quarterly samples taken outside the SWDF are discussed on page 94.

Gross Alpha and Gross Beta The 1995 gross alpha levels detected in onsite, site perimeter, 25-mile-radius, and 100-mile-radius samples generally are comparable to 1994 gross alpha levels. These data again indicate that the gross alpha levels for the F-Area and H-Area samples generally are comparable to those for the 100-mile-radius samples. This may be somewhat unexpected because the facilities in F-Area and H-Area are involved with the production/isolation of materials that are alpha emitters. However, these facilities did not operate during much of 1995. An examination of the gross beta values revealed no significant difference between the onsite surveillance locations and the offsite locations.

Many of the gross alpha results (from both onsite and offsite samples) were at or below the EMS LLD, as

indicated by the relatively large analytical uncertainties and negative concentrations. Even though many of the gross alpha concentrations are present at the LLD, it is appropriate to state that the data are comparable to those of previous years because the methods for collection, preparation, and analysis have not changed since 1992. Variations in worldwide fallout patterns and in concentrations of naturally occurring radionuclides in the soil contribute to the differences in the gross beta concentrations.

Gamma-Emitting Radionuclides Most vegetation samples are composited for analysis of gamma-emitting radionuclides. Samples are composited by area (F-Area, H-Area) and by radius (perimeter, 25-mile, and 100-mile). S-Area and Z-Area samples are not composited but are analyzed individually.

An abundance of naturally occurring radionuclides, such as potassium-40, were detected in vegetation samples, which is to be expected. Cesium-137, the only manmade gamma-emitting radionuclide detected in the 1995 vegetation samples, was detected in samples from most locations, but most of the results were only slightly above the typical cesium-137 LLD of 0.1 pCi/g.

Strontium The relatively low levels of strontium-89,90 detected in 1995 are similar to the levels detected in 1993 and 1994. The differences in the results from year to year can be attributed to the variable strontium distribution in the surrounding soils.

As was the case with the gross alpha results, some of the strontium-89,90 levels were at or below the EMS LLD, as indicated by the large analytical uncertainty or negative concentrations.

Tritium Onsite and site perimeter tritium concentrations generally were higher than the concentrations in vegetation samples collected from the 25- and 100-mile-radius locations. These higher concentrations on site and at the site perimeter are attributed to atmospheric tritium releases from SRS.

Seepage and Retention Basin Samples

Vegetation samples also are collected in the areas of seepage and retention basins. Vegetation is collected annually, and all samples from a specific operating area are composited for analysis of gross alpha, gross beta, gamma-emitting radionuclides, and strontium-89,90 [SRS Data, 1996]. Maximum concentrations are presented in table 6-8.

Gross Alpha and Gross Beta Gross alpha activity levels in vegetation samples taken at basin locations were at or below minimum detectable concentrations. Generally, the levels were consistent with the background levels observed off site and on the site perimeter.

Gross beta activity was detected in all vegetation samples analyzed. In general, the gross beta activity detected was at or near background levels observed off site and on the site perimeter.

Gamma-Emitting Radionuclides As in 1994, cesium-137 was the only manmade gamma-emitting radionuclide detected; it was present in a majority of the seepage and retention basin vegetation samples. Generally, the concentrations were present at levels comparable to those detected at the site perimeter, but slightly greater than the offsite levels.

Strontium Strontium-89,90 was detected in most samples; concentrations in the basin vegetation generally were greater than in the site perimeter and offsite vegetation. However, most values were near or slightly lower than last year's values. In 1994, the greatest concentration, $(6.71 \pm 0.06)E+01$ pCi/g, was

Table 6-8
Maximum Radionuclide Concentrations in Vegetation from Seepage and Retention Basins (pCi/g)

	Maximum	Location
Gross Alpha	$(8.68 \pm 8.98)E-01$	P-Area seepage
Gross Beta	$4.40 \pm 0.26)E+01$	H-Area Retention
Cesium-137	$(5.02 \pm 0.16)E+00$	H-Area Retention
Strontium	$(8.46 \pm 0.22)E+00$	H-Area Retention

Figure 6-12 Vegetation Sampling – Inside SWDF

Vegetation samples are collected inside the SWDF to determine whether uptake of radioactivity by vegetation has occurred.

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detected at the P-Area seepage basin. A resample result, $(2.51 \pm 0.13)E+00$ pCi/g, confirmed the higher value. The 1995 concentration of strontium-89,90— $(3.81 \pm 0.65)E-01$ pCi/g—was comparable to the 1993 value of $(3.36 \pm 0.88)E-01$ pCi/g.

The year-to-year variability of the results probably is attributable to the variable strontium distribution in the surrounding soils and the fact that the vegetation could have been collected from a slightly different location within the immediate area.

Solid Waste Disposal Facility Samples

When available, vegetation samples are collected

annually inside and quarterly outside the SWDF to determine if there is a significant uptake of radioactivity emanating from the buried waste. During 1995, samples were collected from 39 of the 51 inside locations (figure 6-12) and 10 of the 13 locations immediately outside the SWDF fence (figure 6-11). SWDF samples are analyzed for gross alpha, gross beta, and gamma-emitting radionuclides. Maximum concentrations are presented in table 6-9. Generally, sample results were comparable to or slightly lower than 1993 and 1994 results, and all activity was at or near levels detected at the site perimeter. These results indicate no significant uptake of radioactivity from the buried waste.

Table 6-9
Maximum Radionuclide Concentrations in Vegetation from Inside and Outside the Solid Waste Disposal Facility (pCi/g)

	Maximum	Location
Gross Alpha	$(1.59 \pm 0.80)E+00$	OBG-8
Gross Beta	$(6.34 \pm 0.18)E+01$	IBG-17
Cesium-137	$(1.94 \pm 0.09)E+00$	IBG-4A

Potential Radiation Doses

To Read About . . .**Turn to Page . . .**

<i>Calculating Dose</i>	96
<i>Dose Calculation Results</i>	99
<i>Potential Risk from Consumption of SRS Creek Mouth Fish</i>	107
<i>Radiological Assessment Program</i>	110

THIS chapter presents the potential doses to offsite individuals and the surrounding population from 1995 Savannah River Site (SRS) atmospheric and liquid radioactive releases. Also described are the methods used to calculate these doses. Additionally, potential doses from special-case exposure scenarios—such as deer meat, fish, and goat milk consumption and crops irrigated with Savannah River water—are documented.

Unless otherwise noted, the generic term “dose” used in this report includes both the committed effective dose equivalent (50-year committed dose) from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body. The effective dose equivalent, a risk-equivalent value, is used to express dose in terms of the potential health impact. Use of the effective dose equivalent allows doses from different types of radiation and to different parts of the body to be expressed on the same relative basis.

Many parameters—such as radioactive release quantities, population distribution, meteorological conditions, radionuclide dose factors, human consumption rates of food and water, and environmental dispersion—are considered in the dose models used to estimate offsite doses at SRS. Descriptions of the effluent monitoring and environmental surveillance programs discussed in this chapter can be found in chapter 5, “Radiological Effluent Monitoring,” and chapter 6, “Radiological Environmental Surveillance.” A complete description of how potential doses are calculated can be found in section 1108 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1 (SRS EM Program). Tables containing all potential dose calculation results are presented in *SRS Environmental Data for 1995* (WSRC-TR-96-0077).

Applicable dose regulations can be found in Appendix A, “Applicable Guidelines, Standards, and Regulations,” of this document.

Dose to the Maximally Exposed Individual

When calculating radiation doses to the public, SRS uses the concept of the maximally exposed individual; however, because of the conservative lifestyle assumptions used in the dose models, no such person is known to exist. The parameters used for the dose calculations are

For airborne releases: Someone who lives at the SRS boundary 365 days per year and consumes large amounts of milk, meat, and vegetables produced at that location

For liquid releases: Someone who lives downriver of SRS (near River Mile 120) 365 days per year, drinks 2 liters of water per day from the Savannah River, consumes a large amount of Savannah River fish, and spends the majority of time on or near the river

To demonstrate compliance with the DOE Order 5400.5 all-pathway dose standard of 100 mrem per year, 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.

Calculating Dose

Potential offsite doses from SRS effluent releases of radioactive materials (atmospheric and liquid) are calculated for the following scenarios:

- maximally exposed individual
- 80-kilometer (50-mile) population

Because the U.S. Department of Energy (DOE) has adopted dose factors only for adults, SRS calculates maximally exposed individual and collective doses as if the entire 80-kilometer population consisted of adults [DOE, 1988].

The International Commission on Radiological Protection (ICRP), in its Publications #56 and #67, has established age-specific dose factors for six age groups, ranging from 3-month-old infants to adults. However, dose factors for only a select group of radioisotopes were published, and these are applicable to only the ingestion pathway. In general, for most radioisotopes, the dose to an infant is higher than to an adult. For the radioisotopes that constitute most of SRS's radioactive releases (i.e., tritium and cesium-137), the dose to infants would be approximately two to three times higher than to adults. The dose to older children becomes progressively closer to the adult dose.

When the ICRP completes age-specific dose factors for all radioisotopes and develops an age-specific lung model for inhalation, and when DOE adopts these factors and models, doses will be calculated for the various age groups.

SRS also uses adult consumption rates for food and drinking water and adult usage parameters to estimate intakes of radionuclides [SRS Data, 1996]. These intake values and parameters were developed specifically for SRS based on an intensive regional survey [Hamby, 1991]. The survey includes data on agricultural production, consumption rates for food products, and use of the Savannah River for drinking water and recreational purposes.

Dose Calculation Models

To calculate annual offsite doses, SRS uses radiation transport and dose models developed for the commercial nuclear industry [NRC, 1977]. The models are implemented at SRS in the following computer programs [SRS EM Program, 1995]:

- MAXIGASP: calculates maximum and average doses to offsite individuals from atmospheric releases.
- POPGASP: calculates collective doses from atmospheric releases.
- LADTAPII: calculates maximum and average doses to offsite individuals and the population from liquid releases.
- CAP88: calculates doses to offsite individuals from atmospheric releases to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) under the Clean Air Act.

The CAP88 computer code is required under the Clean Air Act to calculate offsite doses from atmospheric releases from existing and proposed facilities. SRS uses the CAP88 dose estimates to show NESHAP compliance, but not for routine dose calculations. Both the CAP88 and the MAXIGASP codes use modeling based on U.S. Nuclear Regulatory Commission Regulatory Guide 1.109.

Meteorological Database

Meteorological data are used as input for the atmospheric transport and dose models.

For 1995, all potential offsite doses from releases of radioactivity to the atmosphere were calculated with a quality-assured meteorological database for H-Area (located near the center of the site), which was determined for the period 1987–1991 [SRS Data, 1996]. A 5-year average database is used instead of the actual annual data because of the difficulty of compiling, inputting, and validating all the data in time to be used for the current-year dose calculations, and because there is little year-to-year variation in the meteorology at SRS.

The wind rose developed from the 1987–1991 database is shown in figure 7–1. As can be seen, there is no prevailing wind at SRS, which is typical for the lower midlands of South Carolina. The maximum frequency that the wind blew in any one direction was 9.1 percent of the time, which occurred from the northeast blowing towards the southwest sector.

The meteorological measurements include all dispersion conditions observed during the 5-year period, ranging from unstable (considerable turbulence, which leads to rapid dispersion) to very stable (very little turbulence, which produces a narrow, undispersed plume). The data for 1987–1991 indicate that the SRS area experiences stable conditions (atmospheric stability classes E, F, G) about 21 percent of the time.

Hugh Smith Photo (95-1358-7E)

The wind tunnel used by the Environmental Transport Group of SRTC produces controlled air flow conditions ranging from less than 0.2 meter per second to about 25 meters per second. Meteorological instrumentation is calibrated and tested in the wind tunnel with the aid of a PC-based data acquisition system. Accurate meteorological data are critical factors in dose calculations. The wind tunnel also plays an important role in determining the baseline performance of the meteorological sensors developed during current cooperative research agreements.

Population Database and Distribution

Collective, or population, doses from atmospheric releases are calculated for the population within a 80-kilometer (50-mile) radius of SRS.

For 1995 dose calculations, the 1990 population database prepared by the University of South Carolina was used. This database distributes the population into a grid of cells one-second latitude by one-second longitude. This database is transformed by the POPGASP Code into polar coordinates of 16 compass sectors and varying radial distances out to 80 kilometers. The POPGASP Code can prepare a polar coordinate database for any release point put into the code in polar coordinates. A separate, fixed-polar-coordinate database was prepared for use with the CAP88 Code, which does not have the capability of transforming the grid into polar coordinates. The population database generated by

the POPGASP Code is centered on the geographical center of SRS [SRS Data, 1996].

Within the 80-kilometer radius, the total population for 1990 was 620,100, compared to 555,200 for 1980, a 12-percent population growth in 10 years.

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 (formerly Cherokee Hill Water Treatment Plant), near Port Wentworth, Georgia (15,000 persons), and by the Beaufort-Jasper Water Treatment Plant, near Beaufort, South Carolina (50,000 persons).

River Flow Rate Data

Offsite dose from liquid effluents varies each year with the amount of radioactivity released and the amount of dilution (flow rate) in the Savannah River. Although flow rates are recorded at U.S. Geological Survey (USGS) gauging stations at the SRS boat

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Figure 7-1 Wind Rose for SRS, 1987-1991

The wind rose plot shows the percent of occurrence frequencies of wind direction and speed at SRS. The plot is based on a composite of hourly averaged wind data from the SRS meteorological tower network for the five-year period 1987-1991. Measurements were taken 200 feet above the ground. Directions indicated are *from* which the wind blows.

dock and near River Mile 120 (U.S. Highway 301 bridge), these data are not used directly in dose calculations. This is because weekly river flow rates fluctuate widely (i.e., short-term dilution varies from week to week). Used instead are "effective" flow rates, which are based on measured concentrations of tritium in Savannah River water and measured concentrations in water used at the downstream water treatment plants. However, the USGS-measured flow rates are used for comparison to these calculated values.

For 1995, the River Mile 120 calculated (effective) flow rate of 9,973 cubic feet per second was used in determining doses to maximally exposed individuals, population doses from recreation and fish consumption, and potential doses from crops irrigated with river water. This flow rate was about 4 percent more than the 1994 effective flow rate of 9,611 cubic feet per second. For comparison, during 1995 the USGS-measured flow rate at River Mile 120 was 12,750 cubic feet per second. Therefore, the calculated value is more conservative because it accounts for less dilution.

The 1995 calculated (effective) flow rates determined for the Beaufort-Jasper (15,474 cubic feet per second) and Port Wentworth (13,000 cubic feet per second) water treatment facilities were used in determining drinking water doses.

The 1995 calculated Savannah River estuary flow rate (14,059 cubic feet per second) was used only for calculation of dose from consumption of salt water invertebrates.

Uncertainty in Dose Calculations

Radiation doses are calculated using the best available data. If adequate data are unavailable, then site-specific parameters are selected that would result in a conservative estimate of the maximum dose.

All radiation data and input parameters have an uncertainty associated with them, which causes uncertainty in the dose determinations. For example, there is uncertainty in the assumption that an individual eats 81 kg (179 pounds) of meat each year. Obviously, a few people will eat more than 81 kg, but most probably will eat less. Uncertainties can be combined mathematically to create a distribution of doses rather than a single number. While the concept is simple, the calculation is quite difficult. A detailed technical discussion of the method of estimating uncertainty at SRS was published in the July 1993 issue of *Health Physics* (Volume 65, Number 1).

Dose Calculation Results

Liquid and air pathway doses are calculated for the maximally exposed individual and for the surrounding population. In addition, a sportsman dose is calculated separately for consumption of fish, deer, and feral hogs, which are nontypical exposure pathways. Finally, a dose is calculated for the aquatic biota found in SRS streams.

Liquid Pathway

This section contains information on liquid release quantities used as source terms in SRS dose calculations, including a discussion about radionuclide concentrations in Savannah River fish. The calculated dose to the maximally exposed individual, the calculated collective (population) dose, and the potential dose from agricultural irrigation are presented.

Liquid Release Source Terms

The 1995 radioactive liquid release quantities used as source terms in SRS dose calculations are presented in chapter 5 and summarized by radionuclide in table 7-1. In order to maintain conservatism, the stream transport tritium release total of 11,400 Ci (4.2E+14 Bq), which was the highest value of the three alternative tritium release calculation methods employed at SRS (chapter 6), was used in the dose calculations.

As discussed in chapter 5, for dose calculations, releases of unidentified beta-gamma emitters were summed with strontium-89,90 releases, and unidentified alpha emitters were summed with releases of plutonium-239.

For use in dose determinations and model comparisons, concentrations of radionuclides in Savannah River water and fish were measured at several locations along the river. The measured concentrations of tritium oxide and cesium-137 in the Savannah River near River Mile 120 and of tritium oxide at the Beaufort-Jasper and Port Wentworth water treatment facilities are shown in table 7-1, as are the LADTAPII computer code-determined concentrations for the other released radionuclides.

The 12-month average tritium oxide concentrations measured in the Savannah River at the U.S. Highway 301 bridge (1,280 pCi/L), and at the Beaufort-Jasper (825 pCi/L) and Port Wentworth (982 pCi/L) water treatment plants, remained below the U.S. Environmental Protection Agency (EPA) and DOE concentration standards of 20,000 pCi/L and 80,000 pCi/L, respectively.

Table 7-1
1995 Radioactive Liquid Release Source Terms and Downriver Radionuclide Concentrations
(Calculated Concentrations Based on Effective River Flow Rates)

Nuclide	Curies Released	Concentration (pCi/L)		
		Below SRS ^a	Beaufort-Jasper ^b	Port Wentworth ^c
H-3	1.1E+04 ^d	1.3E+03 ^e	8.3E+02 ^e	9.8E+02 ^e
Co-60	2.3E-03	2.6E-04	1.5E-04	2.0E-04
Sr-89,90 ^f	4.0E-01	4.5E-02	2.6E-02	3.4E-02
I-129	9.5E-03	1.1E-03	6.3E-04	8.2E-04
Cs-137	2.0E-01 ^d	2.3E-02 ^e	1.3E-02	1.7E-02
Pm-147	2.6E-03	3.0E-04	1.8E-04	2.3E-04
U-234	1.5E-04	1.7E-05	9.9E-06	1.3E-05
U-235	1.2E-05	1.3E-06	7.9E-07	1.0E-06
U-238	1.7E-04	1.9E-05	1.1E-05	1.5E-05
Pu-238	4.1E-05	4.6E-06	2.7E-06	3.5E-06
Pu-239 ^g	1.6E-02	1.8E-03	1.0E-03	1.3E-03
Am-241	2.0E-06	2.3E-07	1.3E-07	1.7E-07
Cm-244	3.6E-06	4.1E-07	2.4E-07	3.1E-07

a Savannah River Mile 120, just downriver of SRS at the U.S. Highway 301 bridge

b Beaufort-Jasper, South Carolina, drinking water

c Port Wentworth, Georgia, drinking water

d Amount of tritium released based on measured stream transport values. Amount of cesium-137 released based on measured values from River Mile 120 fish.

e Measured concentrations; all other concentrations calculated using models verified with tritium measurements. H-3 concentration is from EMS [SRS Data, 1996]; Cs-137 concentration is from SRTC [Beals, 1995]

f Includes unidentified beta releases

g Includes unidentified alpha releases

These concentrations are approximately the same as the corresponding 1994 concentrations, even though the amount of tritium oxide released from SRS during 1995 was about 5 percent more than the amount released during 1994 (11,400 Ci in 1994 versus 10,900 Ci in 1993). This is because the Savannah River flow rate was about 4 percent higher in 1995 than in 1994, causing more dilution to occur. Additional information about the river's flow rates can be found in the River Flow Rate Data section of this chapter (page 97).

Radionuclide Concentrations in River Fish A major dose pathway for the maximally exposed individual is from the consumption of fish.

Fish exhibit a high degree of bioaccumulation for certain contaminants. For the element cesium (including radioactive isotopes of cesium), the bioaccumulation factor for Savannah River fish is approximately 3,000. That is, the concentration of cesium found in fish flesh is about 3,000 times greater than the concentration of cesium found in the water in which the fish live.

Because of this high bioaccumulation factor, cesium-137 is more easily detected in fish flesh than in river water. Therefore, the fish pathway dose from cesium-137 is based directly on the radioanalysis of the fish collected near Savannah River Mile 120, which is the assumed location of the hypothetical maximally exposed individual [SRS Data, 1996]. The fish pathway dose from all other radionuclides is based on the calculated concentrations determined by the LADTAPII code. A consumption rate of 19 kg (42 pounds) of fish per year is used in the maximally exposed individual dose calculation [Hamby, 1991]. Some fraction of this estimated dose is due to cesium-137 from worldwide fallout and from neighboring Vogtle Electric Generating Plant; however, that amount is difficult to determine and is not subtracted from the total.

The dose determinations are accomplished in the LADTAPII code by substituting a cesium-137 release value that would result in the measured concentration in river fish, assuming the site-specific bioaccumulation factor of 3,000. A weighted average concentration (based on the number of fish in each

composite analyzed) of cesium-137 in River Mile 120 fish was used for maximally exposed individual and population dose determinations. Using the above factors, the cesium-137 release value used for LADTAPII input was 0.20 Ci (7.4 E+09 Bq).

Dose to the Maximally Exposed Individual

The potential liquid pathway dose to the hypothetical maximally exposed individual living downriver of SRS, near River Mile 120, was determined based on intake parameters discussed earlier in this chapter.

As shown in table 7-2, the highest potential dose to the maximally exposed individual from liquid releases in 1995 was estimated at 0.14 mrem (0.0014 mSv). This dose is 0.14 percent of DOE's 100-mrem all-pathway dose standard for annual exposure.

The 1995 potential maximally exposed individual dose was the same as the 1994 dose of 0.14 mrem (0.0014 mSv). The potential dose remained the same even though the amount of tritium oxide released from SRS during 1995 was about 5 percent more than during 1994. This was because of increased dilution in the Savannah River due to the 4 percent increase in river flow during 1995.

Approximately 47 percent of the dose to the maximally exposed individual at the site perimeter resulted from the ingestion of cesium-137, mainly from the consumption of fish, and about 43 percent resulted from the ingestion (via drinking water) of tritium oxide [SRS Data, 1996].

Drinking Water Pathway Persons downriver of SRS may receive a radiation dose by consuming drinking water that contains radioactivity as a result of liquid releases from the site. In 1995, tritium oxide in downriver drinking water represented the majority of the dose (about 85 percent) received by persons at downriver water treatment plants.

The calculated doses to maximally exposed individuals whose entire daily intake of water is supplied by the Beaufort-Jasper and Port Wentworth water treatment facilities, located downriver of SRS, were determined for maximum (2 liters per day for a year) water consumption rates [SRS Data, 1996].

At the Beaufort-Jasper Water Treatment Plant, the potential dose for maximum water consumption rates was 0.04 mrem (0.0004 mSv). At the City of Savannah Industrial and Domestic Water Supply Plant, the potential dose was 0.05 mrem (0.0005 mSv).

As shown in table 7-2, the maximum dose of 0.05 mrem (0.0005 mSv) is 1.25 percent of the DOE and EPA standard of 4 mrem per year from public water supplies. The 1995 maximum potential drinking water dose was slightly lower than the 1994 maximum dose of 0.06 mrem (0.0006 mSv). This decrease in dose is attributed to the increase in effective Savannah River flow during 1995.

Collective (Population) Dose

The collective drinking water consumption dose is calculated for the discrete population groups at Beaufort-Jasper and Port Wentworth. The collective dose from other pathways is calculated for a diffuse

Table 7-2
Potential Dose to the Maximally Exposed Individual from SRS Liquid Releases in 1995

	Committed Dose	Applicable Standard	Percent of Standard
Maximally Exposed Individual			
At Site Boundary (untreated river water)	0.14 mrem	100 mrem ^a	0.14
At Port Wentworth (public water supply only)	0.05 mrem	4 mrem ^b	1.25
At Beaufort-Jasper (public water supply only)	0.04 mrem	4 mrem ^b	1.00

a All-pathway dose standard: 100 mrem per year (DOE Order 5400.5)

b Drinking water pathway standard: 4 mrem per year (DOE Order 5400.5 and EPA, 1975)

population that makes use of the Savannah River. However, it cannot be described as being in a specific geographical location.

Potential collective doses were calculated, by pathway and radionuclide, using the LADTAPII computer code [SRS Data, 1996]. In 1995, the collective dose from SRS liquid releases was estimated at 1.7 person-rem (0.017 person-Sv). This was about the same as the 1994 collective dose.

Potential Dose from Agricultural Irrigation

The 1990 update of land- and water-use parameters [Hamby, 1991] revealed that there is no known use of river water downstream of SRS for agricultural irrigation purposes. However, in response to public concerns, potential doses from this pathway are calculated for information purposes only and are not included in calculations of the official maximally exposed individual or collective doses. A potential offsite dose of 0.09 mrem (0.0009 mSv) to the maximally exposed individual and a collective dose of 6.5 person-rem (0.065 person-Sv) were estimated for this exposure pathway. As in previous years, collective doses from agricultural irrigation were calculated for 1,000 acres of land devoted to each of four major food types—vegetation, leafy vegetation, milk, and meat [SRS Data, 1996].

Air Pathway

This section describes the atmospheric source terms and concentrations used for dose determinations and presents the calculated dose to the maximally exposed individual, as well as the calculated collective (population) dose. Also included is a discussion about how SRS demonstrates NESHAP compliance.

Atmospheric Source Terms

The 1995 radioactive atmospheric release quantities used as source terms in SRS dose calculations are presented in chapter 5. For dose calculation purposes, releases of unidentified beta emitters were summed with strontium-89,90 releases and releases of unidentified alpha emitters were summed with plutonium-239 releases [SRS Data, 1996].

Estimates of unmonitored diffuse and fugitive source terms again were considered, as required for demonstrating compliance with NESHAP regulations. Most of the estimated diffuse and fugitive releases occurred at the separations areas, the reactor areas, and the Solid Waste Disposal Facility.

Atmospheric source terms are grouped by major release points for dose calculations. For the

MAXIGASP code, five release locations with specific release heights were used [SRS Data, 1996].

The CAP88 code can calculate doses from collocated release heights but cannot combine calculations for releases at different geographical locations.

Therefore, for CAP88 calculations, source terms were grouped for elevated releases (61 meters) and ground-level releases (0 meters), and the geographical center of the site was used as the release location for both [SRS Data, 1996].

Atmospheric Concentrations

The MAXIGASP and CAP88 codes calculate average and maximum concentrations of all released radionuclides at the site perimeter. These calculated concentrations are used for dose determinations instead of measured concentrations. This is because most radionuclides released from SRS cannot be measured, using standard methods, in the air samples collected at the site perimeter and offsite locations. However, the concentrations of tritium oxide at the site perimeter locations usually can be measured and are compared with calculated concentrations as a verification of the dose models.

The average tritium oxide concentration in air measured at the 14 site perimeter locations during 1995 was 16 pCi/m³ (0.59 Bq/m³), which is a 30 percent decrease from the 1994 measured value of 23 pCi/m³ (0.9 Bq/m³). The 1995 measured value compares favorably with the MAXIGASP and CAP88 computer code values of 16 pCi/m³ (0.59 Bq/m³) and 14 pCi/m³ (0.52 Bq/m³), respectively.

The maximum tritium oxide concentration measured in air at the site perimeter was 32 pCi/m³ (1.2 Bq/m³), which occurred at the D-Area location. This value is higher than, but compares favorably with, the MAXIGASP computer code value of 27 pCi/m³ (1.0 Bq/m³). Because of logistics, the D-Area air monitoring station is located near the entrance to D-Area, about 2.4 kilometers (1.5 miles) from the site perimeter. The measured values may be higher than the modeled values because the D-Area station is 2.4 kilometers closer to the center of the site than the MAXIGASP-modeled location. Also, because of the large (49 percent) decrease in 1995 tritium oxide releases from the separations and reactor areas, the local effects of D-Area tritium oxide releases may cause the measured concentrations at the D-Area air monitoring station to be higher than the modeled concentrations.

The CAP88 code calculated a maximum site perimeter concentration of 21 pCi/m³ (0.78 Bq/m³). This value is lower than the MAXIGASP code value be-

Table 7-3
Ten-Year History of SRS Atmospheric Tritium and Tritium Oxide Releases and Average Measured Tritium Oxide Concentrations in Air Compared to Calculated Concentrations in Air

Year	Total Tritium Released (Ci)	Tritium Oxide Released ^a (Ci)	Average Tritium Oxide Concentrations in Air		
			Center of Site (measured at 4 locations) (pCi/m ³)	Site Perimeter (measured at 14 locations) (pCi/m ³)	Site Perimeter (calculated by dose model) (pCi/m ³)
1986	425,000	285,000	1,520	79	88
1987	595,000	270,000	1,230	81	81
1988	462,000	288,000	1,030	54	87
1989	309,000	218,000	790	37	65
1990	253,000	175,000	530	32	53
1991	200,000	137,000	310	21	42
1992 ^b	156,000	100,000	420	27	30
1993	191,000	133,000	450	30	37
1994 ^c	160,000	107,000	350	23	30
1995	97,000	55,000	300	16	16

a Tritium oxide releases are included with elemental tritium releases in the "Total Tritium Released" column.

b During May 1992, the method for determining tritium oxide concentrations in air was changed to the use of measured humidity values instead of a single generic value. The listed concentrations are for May to December 1992.

c During 1994, because of problems with measuring location-specific humidity values, a single generic value of 11.4 g/m³ was used for absolute humidity.

cause the CAP88 code assumes that all releases occurred from only one point, which is located at the center of the site.

In table 7-3, the average 1986-1995 tritium oxide concentrations in air—measured at four locations near the center of the site (F-Area, H-Area, SWDF North, and SWDF South) and at 14 locations along the site perimeter—are compared to the average concentrations calculated for the site perimeter, using the MAXIGASP code. These data show that the calculated site-perimeter tritium oxide concentrations are conservative in that they are higher than or equal to the measured site-perimeter concentrations. However, they consistently and reasonably approximate the measured values and therefore are appropriate for use in dose determinations.

Also shown in table 7-3 are the total tritium and tritium oxide releases from SRS for the same years. As can be seen, there is a correlation between the quantity of tritium oxide released and the measured concentration of tritium oxide in air at the monitoring locations. The 49-percent decrease in tritium oxide releases during 1995 is attributed mainly to improvements in operations brought about by the

state-of-the-art Replacement Tritium Facility and to decreases in tritium processing activities.

Dose to the Maximally Exposed Individual

The potential air pathway dose to a hypothetical maximally exposed individual located at the site perimeter was determined using the MAXIGASP computer code [SRS Data, 1996]. The parameters used for the calculations were discussed earlier in this chapter.

In 1995, the estimated dose to the maximally exposed individual was 0.06 mrem (0.0006 mSv), which is about 0.6 percent of the DOE Order 5400.5 ("Radiation Protection of the Public and the Environment") standard of 10 mrem per year. This dose was approximately 33 percent lower than the 1994 dose of 0.09 mrem (0.0009 mSv) because of the 49-percent decrease in tritium oxide releases from 1994 to 1995 (chapter 5). Tritium oxide releases accounted for about 78 percent of the dose to the maximally exposed individual. Table 7-4 compares the maximally exposed individual's dose with the DOE standard.

For 1995, the MAXIGASP code determined that the west-southwest sector of the site was the location of the maximally exposed individual. Figure 7-2 shows

Table 7-4
Potential Dose to the Maximally Exposed Individual from SRS Atmospheric Releases in 1995

	MAXIGASP	CAP88 (NESHAP)
Calculated dose	0.06 mrem	0.08 mrem
Applicable standard	10 mrem ^a	10 mrem ^b
Percent of standard	0.6%	0.8%

a DOE: DOE Order 5400.5, February 8, 1990

b EPA: (NESHAP) 40 CFR 61 Subpart H, December 15, 1989

the potential dose to the maximally exposed individual residing at the site boundary for each of the 16 compass point directions around SRS.

The major pathways contributing to the dose to the maximally exposed individual from atmospheric releases were from inhalation (44 percent) and from consumption of vegetation (37 percent), cow milk (11 percent), and meat (5 percent).

Additional calculations of the dose to the maximally exposed individual were performed substituting a goat milk pathway for the customary cow milk

pathway. The maximum potential dose using the goat milk pathway was estimated at 0.06 mrem (0.0006 mSv), which is about the same as the cow milk pathway dose.

Collective (Population) Dose

Potential doses also were calculated, by pathway and radionuclide, using the POPGASP computer code for the population (620,100 people) residing within 80 kilometers of the center of SRS [SRS Data, 1996]. In 1995, the collective dose was estimated at 3.5 person-rem (0.035 person-Sv), which is less than 0.01 percent of the collective dose received from

Figure 7-2 Sector-Specific Adult Maximally Exposed Individual Doses (mrem) for 1995

Maximally exposed individual site boundary doses from airborne releases are shown for each of the 16 compass point directions surrounding SRS. As indicated by the dose totals for 1995, the west-southwest sector was the location of the highest maximally exposed individual dose.

EPD/GIS Map

Figure 7-3 SRS Maximum Potential All-Pathway Doses to the Maximally Exposed Individual (Airborne plus Liquid Pathways) Since 1986

natural sources of radiation (about 195,000 person-rem). The 1995 collective dose was approximately 44 percent lower than the 1994 collective dose of 6.3 person-rem (0.063 person-Sv)—again, because of the 49-percent decrease in tritium oxide releases from 1994 to 1995. Tritium oxide releases accounted for about 83 percent of the 1995 collective dose.

NESHAP Compliance

To demonstrate compliance with NESHAP (Clean Air Act, 40 CFR 61, Subpart H) regulations, maximally exposed individual and collective doses were calculated, and a percentage of dose contribution from each radionuclide was determined using the CAP88 computer code [SRS Data, 1996].

The dose to the maximally exposed individual, calculated with CAP88, was estimated at 0.08 mrem (0.0008 mSv), which is 0.8 percent of the 10-mrem-per-year EPA standard, as shown in table 7-4. Tritium oxide releases accounted for almost 96 percent of this dose.

The CAP88 collective dose was estimated at 8.4 person-rem (0.084 person-Sv). Tritium oxide releases accounted for about 96 percent of this dose.

As the data show, the CAP88 code estimates a higher dose than do the MAXIGASP and POPGASP codes. Most of the differences occur in the tritium dose estimated from food consumption. The major cause of this difference is the CAP88 code's use of

100-percent equilibrium between tritium in air moisture and tritium in food moisture, whereas the MAXIGASP and POPGASP codes use 50-percent equilibrium values, as recommended by the Nuclear Regulatory Commission [NRC, 1977]. A recent publication indicates that the 50-percent value is correct for the atmospheric conditions at SRS [Hamby and Bauer, 1994].

All-Pathway Dose

To demonstrate compliance with the DOE Order 5400.5 all-pathway dose standard of 100 mrem per year (1.0 mSv per year), SRS conservatively combines the maximally exposed individual airborne pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations.

Figure 7-3 shows a 10-year history of SRS's all-pathway doses (airborne pathway plus liquid pathway doses to the maximally exposed individual).

For 1995, the potential maximally exposed individual all-pathway dose was 0.20 mrem (0.0020 mSv)—0.06 mrem from airborne pathway plus 0.14 mrem from liquid pathway. This dose is about 13 percent lower than the 1994 all-pathway dose of 0.23 mrem (0.0023 mSv), primarily because of the decrease in atmospheric tritium oxide releases during 1995.

Figure 7-4 shows that the 1995 maximum potential all-pathway dose attributable to SRS operations

(0.20 mrem) contributed less than 0.1 percent of the average annual radiation dose received by a typical Central Savannah River Area (CSRA) resident.

As shown in table 7-5, the 1995 potential all-pathway dose of 0.20 mrem (0.0020 mSv) is 0.20 percent of the 100-mrem-per-year DOE dose standard.

Sportsman Dose

DOE Order 5400.5 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem per year, which applies to all members of the public, includes doses a person receives from routine DOE operations through all exposure pathways. Nontypical exposure pathways, not included in the standard calculations of the doses to the maximally exposed individual, are considered and quantified separately. This is because they apply to low-probability scenarios, such as consumption of fish caught exclusively from the mouths of SRS streams, or to unique scenarios, such as volunteer deer hunters.

Deer and Hog Consumption Pathway

For approximately 6 weeks each year, controlled hunts of deer and feral hogs are conducted at SRS. Hunt participants are volunteers. Before any harvested animal is released to a hunter, SRS personnel perform a field analysis for cesium-137 on the deer and hogs at the hunt site, using portable sodium iodide detectors. Like fish, deer and hogs have a high bioaccumulation factor for cesium.

The estimated dose from consumption of the harvested deer or hog meat is determined for each hunter. During 1995, the maximum potential dose that could have been received by a hunter was estimated at 30 mrem (0.30 mSv), or 30 percent of DOE's 100-mrem all-pathway dose standard (table 7-5). This dose was determined for a hunter who had harvested three animals during the 1995 hunts. The hunter-dose calculation is based on the conservative assumption that the hunter individually consumed the entire edible portion—approximately 71 kg (156 pounds)—of the animals he harvested from SRS.

An additional deer meat consumption pathway considered during 1995 was for a hypothetical offsite individual whose entire intake of meat during the

leaf Graphic

Figure 7-4 Contributions to the Average Individual Dose

The major contributor to the annual average individual dose in the United States, including residents of the CSRA, is naturally occurring radiation (about 300 mrem) [NCRP, 1987]. During 1995, SRS operations potentially contributed a maximum individual dose of 0.20 mrem, which is less than 0.1 percent of the 360-mrem total annual average dose (natural plus manmade sources of radiation).

Table 7-5
1995 All-Pathway and Sportsman Doses Compared to the DOE All-Pathway Dose Standard

	Committed Dose	Applicable Standard	Percent of Standard
Maximally Exposed Individual Dose			
All-Pathway (Liquid Plus Airborne Pathway)	0.2 mrem	100 mrem ^a	0.2
Sportsman Doses			
Creek Mouth Fisherman	1.2 mrem	100 mrem ^a	1.2
Onsite Hunter	30 mrem	100 mrem ^a	30
Offsite Hunter	15 mrem	100 mrem ^a	15

^a All-pathway dose standard: 100 mrem per year (DOE Order 5400.5)

year was deer meat. It was assumed that this individual harvested deer that had resided on SRS, but then moved off site. The estimated dose was based on the maximum annual meat consumption rate for an adult of 81 kg per year [Hamby, 1991].

Based on these low-probability assumptions and on the average concentration of cesium-137 (4.6 pCi/g) in deer harvested from SRS during 1995, the potential maximum dose from this pathway was estimated at 15 mrem (0.15 mSv). As shown in table 7-5, this potential dose is 15 percent of DOE's 100-mrem all-pathway dose standard. This dose was about 25 percent lower in 1995 than it was in 1994, primarily because of the 23-percent decrease in the average concentration of cesium-137 in the deer harvested during 1995.

Fish Consumption Pathway

For 1995, analyses were conducted of fish taken from the mouths of the six SRS streams, and the subsequent estimated doses from the maximum consumption of 19 kg per year [Hamby, 1991] of these fish were determined [SRS Data, 1996]. Fish flesh was composited by species for each location and analyzed for tritium, strontium-90, cesium-137, plutonium-238, and plutonium-239.

As shown in table 7-5, the maximum potential dose from this pathway was estimated at 1.2 mrem (0.012 mSv) from the consumption of bass collected at the mouth of Steel Creek. This hypothetical dose is based on the low-probability scenario that, during 1995, a fisherman consumed 19 kg of bass caught exclusively from the mouth of Steel Creek. More than

98 percent of this potential dose was from cesium-137. Again, some fraction of this cesium-137 is from worldwide fallout and from neighboring Vogtle Electric Generating Plant; however, that amount is difficult to determine and is not subtracted from the total.

Because access to SRS streams and ponds is restricted, the fish consumption pathway dose does not include fish caught within the SRS boundary.

Potential Risk from Consumption of SRS Creek Mouth Fish

During 1991 and 1992, in response to a U.S. House of Representative Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed—in conjunction with the Georgia Department of Natural Resources (GDNr), the South Carolina Department of Health and Environmental Control (SCDHEC), and EPA—and implemented the WSRC/EMS Fish Monitoring Plan [SRS EM Program, 1995]. Part of the reporting requirements of this plan are to perform an assessment of radiological risk from the consumption of Savannah River fish, and to summarize the results in the annual *SRS Environmental Report*. The following sections discuss the potential radiological risks from the consumption of Savannah River fish, using SRS-published data from 1993, 1994, and 1995. Potential radiological risks are determined using both the ICRP-60 [ICRP, 1990] and the EPA [EPA, 1991] methods.

Exposure Scenario In EPA's risk assessment guidance document [EPA, 1991], two fish consumption pathways are considered—the recreational fisherman

scenario and the subsistence fisherman scenario. Because there are no known permanent residences adjacent to, or immediately downriver of, SRS, the recreational fisherman scenario—as opposed to the subsistence fisherman scenario—is considered the more reasonable exposure scenario and is used in this assessment.

It is assumed that a recreational fisherman fishes for a single species of fish (either panfish, predators, or bottom dwellers) from the mouth of a single worst-case SRS stream. Access to upstream portions of SRS streams is prohibited by postings, fencing (where possible), and periodic patrols.

Per EPA guidance [EPA, 1991], the maximum consumption rate that should be used for determining risk to the recreational fisherman is 19 kilograms (42 pounds) per year. This is the same as the consumption rate used by SRS for demonstrating dose compliance [Hamby, 1991].

The EPA guidance document requires that critical subpopulations and fish species be considered in risk assessments. Currently, there are no known sensitive subpopulations (e.g., Native Americans) in the immediate SRS region who are known to regularly consume whole fish (edible and nonedible portions) as part of their typical diet. Also, there are no known species of fish, such as smelt, in the SRS region of the Savannah River that are commonly eaten whole. Therefore, it is reasonably assumed that the recreational fisherman consumes only the edible (fillet only) portion of the fish caught.

Risk Factors For the EPA method, estimates of potential risk are calculated directly by multiplying the amount of each radionuclide ingested by the appropriate risk (slope) factors provided in EPA's *Health Effects Assessment Summary Tables* (HEAST) [EPA, 1995]. The HEAST ingestion slope factors are best estimates of potential, age-averaged, lifetime excess cancer incidence (fatal and nonfatal) risk per unit of activity ingested.

For the ICRP-60 method, estimates of potential risk are determined first by calculating a radiation dose attributable to the amount of radionuclides ingested and then multiplying that dose by the ICRP-60 coefficient of risk of severe detriment of $7.3\text{E-}07$ per mrem [ICRP, 1990]. Stated another way, if a group of 10,000,000 people each received a radiation dose of 1 mrem, during their collective lifetimes there would theoretically be 7.3 additional severe detrimental incidences (fatal/nonfatal cancer or severe hereditary effects), which is small compared to the 2,000,000 or more expected fatal cancer incidences from other causes during their lifetimes [BEIR V, 1990].

The ICRP-60 risk coefficient includes factors for

- fatal cancers ($5.0\text{E-}07$ per mrem)
- nonfatal cancers ($1.0\text{E-}07$ per mrem)
- hereditary effects ($1.3\text{E-}07$ per mrem)

Exposure Duration According to guidance provided by EPA, the upper bound value of 30 years can be used for exposure duration when calculating reasonable maximum residential exposures. However, the guidance states that other site-specific exposure durations may be used at the discretion of the risk assessor. This assessment compares the potential risks of exposure durations of 1 year, 30 years, and 50 years. The 30-year and 50-year exposure duration risks are simply 30 times and 50 times the 1-year exposure duration risk, respectively.

Risk Comparisons The maximum potential lifetime risks from the consumption of SRS creek mouth fish for 1-year, 30-year, and 50-year exposure durations are shown in table 7-6. Also shown are the potential radiation doses. For each year, the maximum recreational fisherman dose was caused by the consumption of bass collected at the mouth of Steel Creek. More than 98 percent of the doses are attributable to cesium-137.

Table 7-6 includes a comparison of radiation risks associated with the DOE Order 5400.5 all-pathway dose standard of 100 mrem (1.0 mSv) per year.

Though not directly applicable to the fish consumption pathway, the radiation risks associated with the DOE and EPA drinking water dose standard of 4 mrem (0.04 mSv) per year and airborne pathway dose standard of 10 mrem (0.10 mSv) per year are included in table 7-6. The associated EPA-method risks were determined using the slope factors for cesium-137.

As indicated in table 7-6, the 50-year maximum potential lifetime risks from consumption of SRS creek mouth fish range between $3.7\text{E-}05$ and $4.7\text{E-}05$, which are below the 50-year risks associated with the dose standards.

According to EPA practice, if a potential risk is calculated to be less than $1.0\text{E-}06$ (i.e., one additional case of cancer over what would be expected in a group of 1,000,000 people), then the risk is considered minimal and the corresponding contaminant concentrations are considered negligible. If a calculated risk is greater than $1.0\text{E-}04$ (one additional case of cancer in a population of 10,000), then some form of corrective action or remediation usually is required. However, if a calculated risk falls between $1.0\text{E-}04$ and $1.0\text{E-}06$, which is the case with

Table 7-6
Potential Lifetime Risks from the Consumption of Savannah River Fish for 1993, 1994, and 1995
Compared to Dose Standards

	Committed Dose	ICRP-60 Risk Method	EPA/CERCLA Risk Method
1993 Savannah River Fish			
1-Year Exposure	1.26 mrem	9.20E-07	7.94E-07
30-Year Exposure	37.8 mrem	2.76E-05	2.38E-05
50-Year Exposure	63.0 mrem	4.60E-05	3.97E-05
1994 Savannah River Fish			
1-Year Exposure	1.29 mrem	9.42E-07	8.17E-07
30-Year Exposure	38.7 mrem	2.83E-05	2.45E-05
50-Year Exposure	64.5 mrem	4.71E-05	4.08E-05
1995 Savannah River Fish			
1-Year Exposure	1.17 mrem	8.54E-07	7.44E-07
30-Year Exposure	35.1 mrem	2.56E-05	2.23E-05
50-Year Exposure	58.5 mrem	4.27E-05	3.72E-05
Dose Standards			
100-mrem/year All Pathway			
1-Year Exposure	100 mrem	7.30E-05	6.33E-05
30-Year Exposure	3,000 mrem	2.19E-03	1.90E-03
50-Year Exposure	5,000 mrem	3.65E-03	3.17E-03
10-mrem/year Airborne Pathway			
1-Year Exposure	10 mrem	7.30E-06	6.00E-06
30-Year Exposure	300 mrem	2.19E-04	1.80E-04
50-Year Exposure	500 mrem	3.65E-05	3.00E-04
4-mrem/year Drinking Water Pathway			
1-Year Exposure	4 mrem	2.92E-06	2.57E-06
30-Year Exposure	120 mrem	8.76E-05	7.70E-05
50-Year Exposure	200 mrem	1.46E-04	1.28E-04

the the 30-year and 50-year maximum potential lifetime risks from the consumption of Savannah River fish, then the risks are considered acceptable if they are kept as low as reasonably achievable (ALARA).

At SRS, the following programs are in place to ensure that the potential risk from site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) are kept ALARA:

- radiological liquid effluent monitoring program (chapter 5)
- radiological environmental surveillance program (chapter 6)

- environmental ALARA program [SRS EM Program, 1995]

Dose to Aquatic Animal Organisms

DOE Order 5400.5 establishes an interim dose standard for protection of native aquatic animal organisms. The absorbed dose limit to these organisms is 1 rad per day (0.01 Gy per day) from exposure to radioactive material in liquid effluents released to natural waterways.

Hypothetical doses to aquatic biota in SRS streams are calculated annually to demonstrate compliance with this 1-rad-per-day (0.01-Gy-per-day) dose standard. Upper-limit doses are calculated with measured radioactivity transport and minimum flow

rates for each surface stream. Flow rates are chosen to maximize the biota dose. Source terms (stream transport) are provided by the site's Environmental Monitoring Section (EMS) [SRS Data, 1996].

The CRITR computer code [Soldat et al., 1974], incorporated as part of the LADTAPII code, calculates internal and external doses to aquatic biota and to higher trophic levels that depend on aquatic biota for food. The CRITR Code is one of the three aquatic biota dose codes recommended by DOE [DOE, 1991]. External doses are calculated with the same external dose factors used for man [DOE, 1988]. Internal doses are based on the physical size of the biota (effective radius) and on effective energies provided for each radionuclide for each radius. The maximum dose to biota was estimated at 0.011 rad per day (0.00011 Gy per day), which occurred in ducks in Four Mile Creek. This is 1.1 percent of the 1-rad-per-day (0.01-mGy-per-day) DOE dose limit.

Radiological Assessment Program

The preparation of documents describing the effects of SRS operations on the environment began in 1988. The format chosen was a separate document for each major radionuclide or group of similar radionuclides. The documents describe the operating history of the site with respect to the production, storage, and release of each radionuclide. The transport of the

radionuclide in air, surface water, and groundwater is explained, and a calculation of the dose estimate to individuals and the population surrounding SRS is presented. As of December 31, 1995, the following documents had been published^a:

- *Assessment of Tritium in the Savannah River Site Environment*, WSRC-TR-93-214
- *Cesium in the Savannah River Site Environment*, WSRC-RP-92-250
- *Uranium in the Savannah River Site Environment*, WSRC-RP-92-315
- *Radioiodine in the Savannah River Site Environment*, WSRC-RP-90-424-2
- *Assessment of Radiocarbon in the Savannah River Site Environment*, WSRC-TR-93-215
- *Assessment of Technetium in the Savannah River Site Environment*, WSRC-TR-93-217
- *Assessment of Strontium in the Savannah River Site Environment*, WSRC-RP-92-984
- *Plutonium in the Savannah River Site Environment*, WSRC-RP-92-879, Rev. 1
- *Assessment of Mercury in the Savannah River Site Environment*, WSRC-TR-94-0218ET
- *Assessment of Noble Gases in the Savannah River Site Environment*, WSRC-TR-95-0219

A document for activation products is scheduled for publication in 1996.

^a Copies of these documents can be obtained from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

Nonradiological Effluent Monitoring

To Read About . . .

Turn to Page . . .

<i>Airborne Emissions</i>	111
<i>Liquid Discharges</i>	114
<i>History of NPDES Exceedances</i>	116
<i>1995 NPDES Exceedances</i>	117

NONRADIOACTIVE air emissions originating at Savannah River Site (SRS) facilities are monitored at their points of discharge by direct measurement, sample extraction and measurement, or process knowledge. Air monitoring verifies that all emissions and ambient concentrations are within applicable regulatory standards.

Nonradiological liquid effluent monitoring encompasses sampling and analysis and is performed by the Environmental Protection Department's Environmental Monitoring Section (EMS) and the Savannah River Technology Center (SRTC).

A complete description of EMS sampling and analytical procedures used for nonradiological monitoring can be found in sections 1101–1111 (SRS EM Program) of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1, which was issued in June 1995. A summary of data results is presented in this chapter; more complete data can be found in *SRS Environmental Data for 1995* (WSRC-TR-96-0077).

Airborne Emissions

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates nonradioactive air emissions—both criteria pollutants and toxic air pollutants—from SRS sources. Each source is permitted by SCDHEC, with specific limitations identified, as outlined in various South Carolina air pollution control regulations and standards. Many of the applicable standards are source dependent, i.e., Emissions from Fuel Burning Operations, Waste Combustion and Reduction, Emissions from Process Industries, etc. However, the primary standards that govern all sources for criteria air pollutants and ambient air quality are identified in

SCDHEC Air Pollution Control Regulation 61–62.5, Standard No. 2, and Regulation 61–62.5, Standard No. 8, for toxic air pollutants. Standard No. 2 lists eight criteria air pollutants commonly used as indices of air quality (e.g., sulfur dioxide, nitrogen dioxide, and lead) and provides an allowable site boundary concentration for each pollutant. Standard No. 8 identifies 257 toxic air pollutants and their respective allowable site boundary concentrations. Specific permits for operating facilities are listed in appendix B, “SRS Environmental Permits.”

Airborne emission standards for each SRS permitted source may differ, based on size and type of facility, type and amount of expected emissions, and the year the facility was placed into operation. For example, for powerhouse boilers constructed before February 11, 1971, the particulate emission limit is 0.6 pounds per million BTU (British thermal unit) of boiler fuel heat input. Boilers constructed after 1971 must meet more stringent standards, identified in 40 CFR 60, “New Source Performance Standards,” in addition to the SCDHEC requirements. For process and diesel engine stacks in existence prior to January 1, 1986, and powerhouse stacks built before February 11, 1971, the opacity standard is 40 percent. For new sources placed into operation after these dates, the opacity standard typically is 20 percent. Table 8–1 shows typical standards for criteria pollutants from SRS coal-fired boilers.

At SRS, there are 194 permitted nonradiological air emission sources, 156 of which were in operation in some capacity during 1995. The remaining 38 sources either were being maintained in a “cold standby” status or were under construction.

Description of Monitoring Program

Major nonradiological emissions of concern from stacks at SRS facilities include sulfur dioxide, carbon

Table 8-1
Nonradiological Airborne Emissions Standards
for SRS Coal-Fired Boilers

Sulfur dioxide	3.5 lb/10 ⁶ BTU ^a
Total suspended particulates	0.6 lb/10 ⁶ BTU
Opacity	40%

a British thermal unit

monoxide, oxides of nitrogen, particulate matter smaller than 10 microns, volatile organic compounds, and toxic air pollutants. Stacks that have such emissions at SRS include those associated with diesel engine-powered equipment, package steam generators, powerhouse boilers, the Defense Waste Processing Facility (DWPF), the in-tank precipitation process, groundwater air strippers, and various other process facilities. Emissions from these sources are determined during an annual emissions inventory from calculations using fuel oil consumption rates, total hours of operation, and the emission factors provided in EPA's "Compilation of Air Pollution Emission Factors," AP-42. The calculation for boiler sulfur dioxide emissions also uses the average sulfur content of the coal and assumes 100 percent liberation of sulfur and 100 percent conversion to sulfur dioxide. Most of the processes at SRS are nonstandard-type sources requiring complex calculations that use process chemical or material throughputs, hours of operation, chemical properties, etc., to determine actual emissions. In addition to the annual emissions inventory, compliance with various standards is determined in several ways, as follows:

At the SRS powerhouses, stack compliance tests are performed every 2 years for each boiler by airborne emission specialists under contract to SRS. The tests include

- sampling of the boiler exhaust gases to determine particulate emission rates and carbon dioxide and oxygen concentrations
- laboratory analysis of coal for sulfur content, ash content, moisture content, and BTU output

Sulfur content and BTU output are used to calculate sulfur dioxide emissions. SCDHEC also conducts visible-emissions observations during the tests to verify compliance with opacity standards. The day-to-day control of particulate matter smaller than 10 microns is demonstrated by opacity meters in all SRS powerhouse stacks.

For the package steam generating boilers in K-Area and P-Area, compliance with sulfur dioxide standards

is determined by analysis of the fuel oil purchased from the offsite vendor. The percent of sulfur in the fuel oil must be below 0.5 and is reported to SCDHEC each quarter. Compliance with particulate emission standards is demonstrated by mass-balance calculations rather than stack emission tests.

Compliance by SRS diesel engines and other process stacks is determined during annual compliance inspections by the local SCDHEC district air manager. These inspections include a review of operating parameters, an examination of continuous-emission monitors (where required for process or boiler stacks), and a visible-emissions observation for opacity.

Compliance by all toxic air pollutant and criteria pollutant sources also is determined by using U.S. Environmental Protection Agency (EPA)-approved air dispersion models. Air dispersion modeling is extremely conservative unless refined models are used. The Industrial Source Complex Version No. 2 model was used to predict maximum ground-level concentrations occurring at or beyond the site boundary for new sources permitted during 1995. Some site sources of toxic air pollutants also are required to be stack tested every 2 years.

Monitoring Results

As noted earlier, emissions are calculated each year as part of an annual emissions inventory. In 1995, operating data were compiled and emissions were calculated for 1994 operations for all site air emission sources. Because this process, which begins in January, requires up to 6 months to complete, this report will provide a more comprehensive examination of total 1994 emissions, with only limited discussion of available 1995 monitoring results. Actual emissions for 1995 will be compiled and reported in depth in the *SRS Environmental Report for 1996*.

Three coal-fired power plants with nine boilers operate at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 8-2. The four D-Area boilers use pulverized coal as their primary fuel; they use propane, No. 2

Table 8-2
SRS Power Plant Boiler Capacities

Location	Number of Boilers	Capacity (BTU/hr)
A-Area	2	71.7E+06
D-Area	4	39.6E+07
H-Area	3	71.1E+06

Table 8-3
Boiler Stack Test Results (D-Area, A-Area)

Boiler	Pollutant	Emission Rates	
		lbs/mmBTU	lbs/hr
D #4	Particulates	0.20	85.63
	Sulfur dioxide	1.41	NC ^a
A #1	Particulates	0.33	25.8
	Sulfur dioxide	1.83	NC ^a

a Not calculated

fuel oil, and used oil as secondary fuels. The other boilers are overfeed stoker fed and use coal as their only fuel. Effective October 1, 1995, the U.S. Department of Energy (DOE) leased the D-Area powerhouse and supporting facilities to the South Carolina Electric and Gas Company (SCE&G), thereby transferring all regulatory compliance responsibilities to SCE&G. Prior to the effective date of the lease, one of the D-Area boilers was stack tested by Westinghouse Savannah River Company (WSRC) for compliance, as discussed above. The A-Area No. 1 boiler also was stack tested in 1995. The results are shown in table 8-3.

SRS also has four package steam generating boilers fired by No. 2 fuel oil. These boilers are used primarily to heat buildings during cold weather. If necessary, they are used during process facility operation. The location, number of boilers, and capacity of each boiler are shown in table 8-4. During 1995 only the 76.8- and 38.0-mmBTU/hr boilers were operated. The percent of sulfur in the fuel oil burned during the year was certified by the vendor to meet the requirements of the permit.

At SRS, 120 permitted sources, both portable and stationary, are powered by internal combustion diesel engines. These sources include portable air compressors, diesel generators, emergency cooling water pumps, and fire water pumps ranging in size

Table 8-4
SRS Package Steam Boiler Capacities

Location	Number of Boilers	Capacity (BTU/hr)
K-Area	1	76.8E+06
K-Area	1	38.0E+06
K-Area	1	17.0E+06
P-Area	1	17.0E+06

from 150 to 2050 kilowatts for generators and 200 to 520 horsepower for air compressor and pump engines. Total fuel oil consumption for the sources operated in 1995 will be included in the report for calendar year 1996.

Another significant source of criteria pollutant emissions at SRS is the burning of forestry areas across the site. The Savannah River Forest Station (SRFS), a unit of the U.S. Department of Agriculture Forest Service, periodically conducts controlled burning of vegetation and undergrowth as a means of preventing uncontrolled forest fires. During 1995, the SRFS burned a total of 18,082 acres across the site. Emissions from these burns are not yet available for publication; however, emissions from the controlled burns conducted in 1994 are included in table 8-5.

Other sources of criteria pollutants, such as sulfur dioxide, oxides of nitrogen, carbon monoxide, particulate matter, and volatile organic compounds, at SRS are too numerous to discuss here by type. Table 8-5 provides the 1994 atmospheric emissions results for all permitted SRS sources, as determined by the air emissions inventory conducted in 1995. All calculated emissions were within applicable SCDHEC standards and permit limitations during 1994.

Of the SRS permitted sources, 26 are permitted for toxic air pollutants and were operated in 1995. Of the operable toxic air pollutant sources, only six are required to be stack tested. During 1995, four soil vapor extraction/catalytic oxidation units were stack tested to determine compliance with their respective permitted emission rates. Table 8-6 shows the test results and the permitted emission rates.

Total toxic air pollutant emissions at SRS are determined annually in tons per year for each pollutant [SRS Data, 1996].

As a result of a Notice of Violation (NOV), SRS was required to conduct additional analyses for sulfur

Table 8-5
1994 Criteria Pollutant Air Emissions

Pollutant Name	Actual Tons/Year
Sulfur dioxide	8.86E+03
Total suspended particulates	2.58E+00
PM10 (particulate matter <10 microns)	2.45E+03
Carbon monoxide	3.92E+03
Ozone (volatile organic compounds)	3.64E+02
Gaseous fluorides (as hydrogen fluoride)	6.74E-02
Nitrogen dioxide (NOX)	3.91E+03
Lead	1.46E-01

Table 8-6
Soil Vapor Extraction Unit (SVEU)/Catalytic Oxidation Stack Test Results

SVEU	Pollutant	Result lb/hr	Limit lb/hr
782-3M	HCL	0.0900	4.0
	PCE	0.0766	0.239
	TCE	0.0060	0.239
782-4M	HCL	0.2300	4.0
	PCE	0.1406	0.239
	TCE	0.0312	0.239
782-5M	HCL	0.1100	4.0
	PCE	0.0799	0.239
	TCE	0.0540	0.239
782-6M	HCL	0.2300	4.0
	PCE	0.1406	0.239
	TCE	0.0312	0.239-

content in the coal being burned in the D-Area boilers during 1995. Results of the additional analyses have shown that the boilers were in compliance with applicable regulations and permit conditions.

Finally, SRS was issued an NOV for failure to properly maintain required continuous opacity emissions monitors and to submit a complete quarterly continuous opacity emissions monitor report for the D-Area monitors. Corrective actions were taken in accordance with the NOV and no fines were levied for the violation.

Ambient Air Quality

SRS does not conduct onsite monitoring for ambient air quality; however, as a result of regulatory requirements, the site is required to show compliance with various air quality standards. To accomplish this, air dispersion modeling was conducted during 1995 for new emission sources as part of the sources' construction permitting process. The modeling analysis showed that SRS air emission sources were in compliance with applicable regulations.

The Environmental Transport Group, a component of the Environmental Technology Section at SRTC, is responsible for all regulatory nonradiological air quality modeling required by SCDHEC. In 1994, the Environmental Transport Group conducted air dispersion modeling for various new sources using EPA's Industrial Source Complex short-term and long-term models for criteria and toxic air pollutants. These models simulate the dispersion of emissions over extensive areas for time scales ranging from an hour to a year. For realism, a year (1991) of hourly site meteorological data were used as one of the inputs to the model. Other inputs included source

information and air emissions rate data from the SRS Air Inventory Reporting System database.

South Carolina and Georgia continue to monitor ambient air quality near SRS as part of the network associated with the Clean Air Act.

Liquid Discharges

Description of Monitoring Program

In 1995, SRS discharged water into site streams and the Savannah River under four NPDES permits: two for industrial wastewater (SC0000175 and SC0044903) and two for stormwater runoff—SCR000000 (industrial discharge) and SCR100000 (construction discharge). A fifth NPDES permit—a no-discharge permit (ND0072125)—was issued to cover land application of sludge generated at onsite sanitary waste treatment plants. Industrial permit SC0000175 expired in 1988 and industrial permit SC0044903 expired November 30, 1995, but because SRS has applied for a new permit, discharges can continue under the expired permits until the new one is issued. SCDHEC sent SRS a preliminary draft permit in May 1994, and SRS has sent its comments to SCDHEC for consideration. When the new permit is issued, it will include the discharge points covered under permits SC0000175 and SC0044903. Until then, the site is discharging industrial wastewater under these two permits.

The D-Area Powerhouse was leased to SCE&G October 1, 1995. This resulted in the transfer of ownership of six outfalls (D-001, D-001B, D-001C, D-003, D-005, and D-006) from WSRC to SCE&G, which has assumed responsibility for all sampling, analysis, and reporting for these outfalls.

The Central Sanitary Waste Treatment Facility (CSWTF) was placed into operation May 21, 1995, and discharges from eight sanitary facility outfalls (A-015, C-004A, F-003A, F-008A, H-013, S-011, DW-003, and T-007) have been rerouted to the CSWTF. All of the discharge from CSWTF is monitored at outfall G-010.

Stormwater industrial permit SCR000000 covers 48 discharge locations sorted into 11 groups. A representative site from each group was sampled, as required by the permit. Construction permit SCR100000 does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site. SCDHEC did not request any such sampling in 1995.

NPDES discharge points are sampled according to applicable permit requirements. The samples are preserved in the field according to 40 CFR 136, the

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An EMS sampling technician collects water, for laboratory analysis, from one of SRS's 83 permitted NPDES outfalls. The samples are analyzed to determine their biological and chemical properties and to demonstrate compliance with the NPDES program, which is designed to prevent deterioration of water quality.

federal document that lists specific sample collection, preservation, and analytical methods acceptable for the type of pollutant to be analyzed. Chain-of-custody procedures are followed after collection and during transport to the analytical laboratory. The samples then are accepted by the laboratory and analyzed according to procedures listed in 40 CFR 136 for the parameters required by the permit.

The effectiveness of the NPDES monitoring program is documented by a surveillance program involving chemical and biological evaluation of the waters to which effluents have been discharged. More monitoring information can be found in chapters 9, "Nonradiological Environmental Surveillance," and 12, "Special Surveys and Projects."

Monitoring Results

SRS reports analytical results to SCDHEC through a

monthly discharge monitoring report, which includes a list of exceedances or locations at which analyses showed the discharge did not meet permit requirements.

In 1995, 68 of the 83 permitted outfalls discharged; 11 did not discharge; and 4 were not in service. Results from 19 of the 7,515 discharge-sample analyses performed during 1995 exceeded permit limits because of process upsets—such as extended equipment down time—that caused erosion of galvanized pipes (which in turn elevated the zinc concentration at Outfall M-004). With these exceedances, the site had a 99.8-percent compliance rate—higher than the 98-percent compliance rate mandated by DOE. A list of the 1995 exceedances appears in table 8-7, beginning on page 117. Figure 8-1 shows the NPDES exceedances at SRS from 1986 through 1995. SCDHEC has not mandated permit limits for stormwater outfalls.

Number of Exceedances

Number of Analyses

6,240	6,560	6,250	6,859	6,810	8,329	7,729	8,000	7,568	7,515
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Compliance Rate

99.4%	99.7%	99.8%	99.9%	99.8%	99.9%	99.9%	99.9%	99.9%	99.8%
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Ileaf Graphic

Figure 8-1 History of NPDES Exceedances, 1986-1995

To determine the compliance rate, the number of analyses not exceeding limits for a given year is divided by the total number of analyses. For example, 6,810 analyses were performed in 1990, with 16 exceedances. To calculate the compliance rate for that year, divide 6,794 (6,810 minus 16) by 6,810 for a quotient of .9976, or 99.8, percent.

Table 8-7
1995 NPDES Exceedances

Page 1 of 2

Department	Outfall	Date	Analysis	Result	Possible Cause	Corrective Action
Reactor Materials	M-04	Jan. 26	Zinc	.375 mg/L (avg)	Corrosion of galvanized pipes	Process sampling prior to discharge
SSD/LOD/TNX	X-14	Jan. 31	Benzene	5.49 µg/L (max)	Unknown	Administrative review
Power	D-01	Feb. 27	pH	5.3 su (min)	Coal pile basin discharge; storm event	Close basin discharge valve when storm event expected
Reactor Engineering	C-01	March 8	pH	5.6 su (min)	Groundwater process discharge; natural causes	Obtain lower pH limit or delete outfall from permit
DWPF	DW-04	April 10	BOD	>66 mg/L (avg and max)	Acid sump dike	Monitor facility
DWPF	DW-04	June 12	BOD	>66 mg/L (avg and max)	Acid sump dike	Monitor facility
High-Level Waste	H-07	July 11	pH	4.2 su (min)	Well 905-88H flush water	Restrict well flushing time
Site Services Division	A-05	July 19	Fecal coliform	1,600 col/100mL (avg and max)	Animal holding facility	Eliminate animal holding pen discharge to environment
Site Services Division	A-05	July 26	Fecal coliform	16,000 col/100mL (avg and max)	Animal holding facility	Eliminate animal holding pen discharge to environment
Environmental Restoration	A-01A	Aug. 31	TCE	6 µg/L (max)	Unknown	Ensure stripper operating correctly
WMET-ESS	A-001	Sept. 20	BOD	181 mg/L (avg and max)	Unknown	None (no source identified)
SSD/SUD	P-014	Oct. 10	Fecal coliform	7,500 col/100mL (avg and max)	Scale on UV tube	Modify cleaning procedure
SSD/SUD	P-014	Oct. 11	Fecal coliform	900 col/100mL (avg and max)	Scale on UV tube	Modify cleaning procedure

Table 8-7
1995 NPDES Exceedances

Page 2 of 2

Department	Outfall	Date	Analysis	Result	Possible Cause	Corrective Action
Environmental Restoration	A-1A	Oct. 17	PCE	13.3 µg/L (max)	Unknown	None (no cause determined)
Environmental Restoration	M-05	Oct. 17	PCE	11.8 µg/L (max)	Unknown	None (no cause determined)
Environmental Restoration	A-1A	Oct. 23	PCE	12.0 µg/L (max)	Unknown	None (no cause determined)
SSD/SUD	G-010	Nov. 15	TSS	65 mg/L (max)	Unknown	Under investigation
Reactor Engineering	C-01	Dec. 4	pH	5.9 su (min)	Groundwater process discharge; natural causes	Obtain lower pH limit or delete outfall from permit
Reactor Engineering	K-018	Dec. 15	pH	5.8 su (min)	Natural occurrence due to low pH in river water	Not applicable

Key: BOD – Biochemical Oxygen Demand
 TCE – Trichloroethylene
 PCE – Tetrachloroethylene
 TSS – Total Suspended Solids

Nonradiological Environmental Surveillance

To Read About . . .**Turn to Page . . .**

<i>Site Streams</i>	119
<i>Savannah River</i>	120
<i>Drinking Water</i>	120
<i>Sediment</i>	122
<i>Fish</i>	122

NONRADIOACTIVE environmental surveillance at the Savannah River Site (SRS) involves the sampling and analysis of surface waters (six onsite streams and the Savannah River), drinking water, sediment, groundwater, and fish. A description of the surveillance program and 1995 results for groundwater can be found in chapter 10, "Groundwater."

The Environmental Protection Department's Environmental Monitoring Section (EMS) and the Savannah River Technology Center (SRTC) perform nonradiological surveillance activities. The Savannah River also is monitored by other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR). In addition, the Academy of Natural Sciences of Philadelphia conducts special environmental surveys on the Savannah River through a program that began in 1951. Results of Academy studies for 1995 are discussed in chapter 12, "Special Surveys and Projects."

A complete description of the EMS sample collection and analytical procedures used for nonradiological surveillance can be found in section 1105 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1 (SRS EM Program), which was issued in June 1995. A summary of data results is presented in this chapter; however, more complete data can be found in *SRS Data for 1995* (WSRC-TR-96-0077). Information on the rationale for the nonradiological environmental surveillance program can be found in chapter 3, "Environmental Program Information."

In 1995, approximately 15,800 nonradiological analyses for specific chemicals and metals were performed on about 3,900 samples, not including groundwater.

SRS currently does not conduct onsite surveillance for ambient air quality. However, to ensure compliance with SCDHEC air quality regulations and standards, SRTC conducted air dispersion modeling for all site sources of criteria and toxic air pollutants in 1993. This modeling indicated that all the SRS sources were in compliance with the air quality regulations and standards. Since that time, additional modeling conducted for new sources of criteria and toxic air pollutants has demonstrated continued compliance by the site with these regulations and standards. The states of South Carolina and Georgia continue to monitor ambient air quality near the site as part of a network associated with the federal Clean Air Act.

Site Streams

SRS streams are classified as "Freshwaters" by SCDHEC. Freshwaters are defined as surface water suitable for

- primary- and secondary-contact recreation and as a drinking water source after conventional treatment in accordance with SCDHEC requirements
- fishing and survival and propagation of a balanced indigenous aquatic community of fauna and flora
- industrial and agricultural uses

Appendix A, "Applicable Guidelines, Standards, and Regulations," provides some of the specific guides used in water quality surveillance, but because some

of these guides are not quantifiable, they are not tracked in response form (i.e., amount of garbage found).

Description of Surveillance Program

EMS samples site streams monthly for chemicals, metals, and physical and biological properties to ensure that water quality criteria are met [SRS EM Program, 1995]. Stream nonradiological surveillance is conducted for any evident degradation that could be attributed to the water discharges regulated by site National Pollutant Discharge Elimination System (NPDES) permits. This also helps detect materials that may be released inadvertently from sources other than routine release points.

Each SRS stream receives varying amounts of treated wastewater and rainwater runoff from site facilities. Stream locations are sampled for water quality at weekly and monthly frequencies by the conventional grab-collection technique. Each grab sample shows the water quality at the time of sampling only. An overview of sampling locations is shown in figure 9-1.

Pesticides and herbicides have been monitored at SRS since 1976 to assess their concentrations in surface waters from site streams and the Savannah River. Water samples from six of seven stream (one was inadvertently omitted) and two river locations were analyzed for 21 pesticides and herbicides during 1995 (figure 9-1).

Also, EMS samples from four SCDHEC stream locations were analyzed monthly for the same pesticides and herbicides and for three volatile organic compounds.

Surface water analyses for pesticides and herbicides and for pesticides, herbicides, and volatile organic compounds are listed in two tables in *SRS Environmental Data for 1995*.

Surveillance Results

The 1995 stream water quality data showed normal fluctuations expected for surface water. Comparison of the 1995 data with published historical data for site surface water monitoring did not indicate any abnormal deviations from past monitoring data. Analysis for pesticides, herbicides, and volatile organic compounds in SRS streams yielded positive results for pesticides at two locations (Steel Creek-4 and Tims Branch-5); for herbicides at one location (Upper Three Runs-4); and for volatile organic compounds at two locations (Upper Three Runs-4 and Tims Branch-5) [SRS Data, 1996]. Coliform

analysis results exceeded recommended standards 36 times in 1995.

Savannah River

Description of Surveillance Program

The Savannah River is sampled monthly at three locations for organic and inorganic contaminants [SRS EM Program, 1995]. Sampling locations on the river are shown in figure 9-1. These sampling sites are located upriver of, adjacent to, and downriver of the site to compare the SRS contribution of pollutants with background levels of chemicals from natural sources and from contaminants produced by municipal sewage plants, medical facilities, and other upriver industrial facilities. Nonradiological surveillance of the river also checks for any degradation that could be attributed to the water discharges regulated by site NPDES permits.

Field measurements for conductivity, dissolved oxygen, pH, and temperature also are taken monthly in the Savannah River to monitor the water quality and to ensure that water quality criteria are met.

Laboratory analyses are conducted for other water quality parameters, such as metals, chemicals, and physical and biological properties.

Surveillance Results

A comparison of Savannah River water quality analyses upriver (River Mile 160) and downriver (River Mile 120) of SRS showed no significant differences [SRS Data, 1996].

A comparison with historical data shows that the coliform data are within normal fluctuations for river water in this area. However, river locations did have an increase in the number of sample analyses (from nine in 1994 to 13 in 1995) in which coliforms did not achieve recommended standards. The monitoring data for the river locations generally met the Freshwaters standard guides (some of which appear in appendix A), and comparison of the 1995 data with published historical analytical results and measurements for river samples did not show any abnormal deviations [SRS Data, 1996].

Drinking Water

Description of Surveillance Program

All 27 drinking water systems at SRS utilize well water pumped from the McBean, Congaree, Black Creek, and Middendorf formations. Most of the well water supplies require treatment to meet SCDHEC

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Figure 9-1 SRS Streams and Savannah River Water Quality Sampling Locations

Surface water samples are collected from four Savannah River and 15 SRS stream locations for analysis of nonradiological contaminants, including pesticides, herbicides, and/or inorganic contaminants. Steel Creek-4 (SC-4), Tims Branch-5 (TB-5), Four Mile Creek at Road A7 (FM-A7), and Upper Three Runs-4 (U3R-4) are both EMS and SCDHEC sampling locations, from which samples are also analyzed for volatile organic compounds.

drinking water quality standards. Sodium hydroxide or soda ash is added for pH control, sodium hypochlorite for bacteriological control, and phosphates for corrosion control.

The following testing is performed to ensure compliance with SCDHEC water quality standards:

- The concentrations of chemicals added are monitored daily.
- All systems are monitored either monthly or quarterly for total coliform bacteria. The sampling frequency depends on the population served.
- All systems are monitored semiannually for chlorocarbon concentrations.
- The 13 larger systems are monitored for lead and copper concentrations. The sampling frequency varies from twice per year to once every 3 years, depending on SCDHEC requirements.
- SCDHEC periodically collects samples from the 13 larger systems to determine compliance with chemical, synthetic organic, and volatile organic water quality limits.

Surveillance Results

All SRS drinking water systems complied with SCDHEC chemical, bacteriological, synthetic organic, and volatile organic water quality standards in 1995.

Sediment

EMS's nonradiological sediment surveillance program provides a method of determining the deposition, movement, and accumulation of nonradiological contaminants in stream systems.

Description of Surveillance Program

The surveillance of pesticides and herbicides and of inorganic contaminants, such as metals, make up the two major activities of the nonradiological sediment surveillance program.

Pesticides and herbicides were used at the location of SRS before 1950, when the U.S. Government obtained the land. Pesticides and herbicides also have been used since then as part of the site's forestry management program and for ongoing landscape and roadside maintenance. A pesticide and herbicide surveillance program was established in 1976 to ensure that there is no buildup of these materials in the sediments of site streams or the Savannah River. Sediment samples from two Savannah River and six of seven site stream locations (one was inadvertently omitted) were

analyzed for pesticides and herbicides during 1995 [SRS Data, 1996]. Sediment sampling locations are shown in figure 9-2.

The inorganics area of the program was designed in 1993 to document the buildup, if any, of inorganic contaminants over time. Sampling locations were chosen at six site streams, two Savannah River locations, and three background locations (two stream locations and one river location). Sampling of the inorganics was accidentally omitted in 1995, but the program will resume in 1996.

Surveillance Results

No pesticides or herbicides were found to be above the practical quantitation limits in 1995 in Savannah River sediment samples. All the river sample results were below the detection limits of the U.S.

Environmental Protection Agency (EPA) analytical procedures used. However, samples from two onsite streams showed detectable pesticides. The pesticides 4,4-DDE and endrin aldehyde were detected in sediment from Lower Three Runs Creek, and 4,4-DDD and 4,4-DDE were detected in sediment from Upper Three Runs Creek [SRS Data, 1996].

Mercury in Fish

Mercury is a naturally occurring metal that cycles between land, water, and air. The major sources of atmospheric mercury are as follows:

- **Natural** – Degassing of the earth's crust generates 2,700 to 6,000 tons of mercury a year (WHO, 1990).
- **Manmade** – Burning of fossil fuels releases an estimated 5,000 tons of mercury per year [Klaassen et al., 1986]; industrial and other discharges account for an undetermined amount.

Perspective on Mercury

Mercury in the environment can come from natural sources, such as volcanoes and venting of the earth's crust, and from manmade sources and processes, such as fungicides and fossil fuel combustion byproducts and the manufacture of chlorine, sodium hydroxide, plastics, and electrical apparatus.

An important source in the SRS region may be in releases upriver of the site. Much of the mercury detected in SRS fish has been attributed to offsite sources, such as Savannah River water [Davis et al., 1989]. Savannah River water is pumped onto the site for use as cooling water and subsequently is released into site streams and lakes.

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Figure 9-2 SRS Stream and Savannah River Nonradiological Sediment Sampling Locations

Sediment is sampled at three Savannah River and 10 SRS stream locations for nonradiological contaminants, including pesticides, herbicides, and inorganic contaminants. In 1995, however, sampling of the inorganic contaminants was inadvertently omitted.

An EMS sampling technician weighs a catfish from Stokes Bluff Landing prior to delivery to the laboratories for analysis. More than 100 fish from SRS streams and ponds were collected and analyzed for mercury during 1995 as part of the site's nonradiological environmental surveillance program.

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(96X02586.12)

As mercury enters streams and rivers through rainfall, runoff, and discharges, it is converted to the chemical compound methylmercury by bacterial and other processes. As part of the natural cycling, some mercury is absorbed by plants and animals into their tissues. Fish absorb methylmercury from food they ingest and from water as it passes over their gills; the methylmercury then is bound in their tissues.

Consumption, by people, of fish containing methylmercury completes the food cycle to man. The amount of fish that can be safely eaten varies with (1) the level of methylmercury found in the fish, (2) the amount of methylmercury consumed at any given sitting, and (3) the frequency of consumption of fish containing methylmercury during a given period of time. These three (primary) factors, and others, are the basis of calculations performed during "risk analysis," which is a method used to determine how much fish can be consumed

safely. State and federal regulatory agencies calculate the health risk associated with the consumption of fish and other organisms, then recommend consumption guidelines based on that risk. Adherence to these guidelines can effectively control one's exposure to methylmercury. A list of fish advisories and/or recommended consumption limits can be obtained from state environmental agencies.

Description of Surveillance Program

EMS analyzes the flesh of fish caught from onsite streams and ponds and from the Savannah River to determine concentrations of mercury in the fish [SRS EM Program, 1995]. The fish analyzed represent the most common edible species of fish in the Central Savannah River Area (CSRA), an 18-county area in Georgia and South Carolina that surrounds Augusta, Georgia, and includes SRS.

Surveillance Results

In 1995, 112 fish from SRS streams and ponds and the Savannah River were collected and analyzed for mercury [SRS Data, 1996].

The mercury concentrations in fish analyzed from onsite waters ranged from a high of 1.70 µg Hg/g in

an L-Lake bass to lows below the lower limit of detection (0.17) at several locations.

Mercury concentrations in offsite fish ranged from a high of 0.83 µg Hg/g in a bass from the mouth of Beaver Dam Creek to lows below the lower limit of detection (0.17) at several locations.

Chapter 10

Groundwater

To Read About . . .

Turn to Page . . .

<i>Groundwater Hydrology</i>	127
<i>Geological and Hydrogeological Setting at SRS</i>	131
<i>Description of Groundwater Monitoring Program</i>	133
<i>Groundwater Monitoring Program Changes During 1995</i>	135
<i>Groundwater Monitoring Results</i>	137

GROUNDWATER beneath an estimated 5 to 10 percent of the Savannah River Site (SRS) has been contaminated by industrial solvents, tritium, metals, or other constituents used or generated by operations at SRS. There is no evidence that groundwater contaminated with these constituents has migrated off site. Groundwater in areas indicated on figure 10-1 (page 128) contains one or more of these constituents at or above the levels of Safe Drinking Water Act primary drinking water standards (DWS) of the U.S. Environmental Protection Agency (EPA).

This chapter describes the groundwater monitoring results for approximately 1,600 wells in 94 locations (figure 10-1) within designated areas at SRS. Only summaries of the results exceeding the standards discussed on page 136 will be found in this report. Detailed results may be found in the following public documents: *The Savannah River Site's Groundwater Monitoring Program, First Quarter 1995* (ESH-EMS-950393); *The Savannah River Site's Groundwater Monitoring Program, Second Quarter 1995* (ESH-EMS-950394); *The Savannah River Site's Groundwater Monitoring Program, Third Quarter 1995* (ESH-EMS-950395); *The Savannah River Site's Groundwater Monitoring Program, Fourth Quarter 1995* (ESH-EMS-950396). Full results for each well sampled during a quarter are presented alphabetically in the quarterly reports.

Another public document, the *Environmental Protection Department's Well Inventory* (ESH-EMS-950419), contains detailed maps of the wells at each monitored location.

During 1995, most analytical results were similar to those of recent years. Wells at the F-Area tank farm were resampled for trichlorofluoromethane (Freon 11) because elevated levels were reported in 1994,

when the wells were first sampled for specific volatile organic compounds. Elevated levels again were reported in two wells.

Strontium-89, with a half-life of 50 days, again was reported at elevated levels in F-Area and H-Area seepage basins and in F-Area canyon wells. Based on the last operations date for processes that produce strontium-89, Westinghouse Savannah River Company (WSRC) considers positive results for strontium-89 to originate from errors in the laboratory.

Groundwater Hydrology

Groundwater aquifers are pathways by which potentially hazardous substances at SRS may enter nearby streams and eventually the Savannah River. Substances in the soil may dissolve in rainwater, which moves them downward through the unsaturated zone to the water table. The water then flows downgradient toward a discharge point.

To identify the extent of contamination in groundwater and to predict the possible fate of the contaminants, scientists must determine the location and movement of groundwater. To make this determination, an understanding is required about how groundwater moves, in general, and how that movement will be influenced by the specific geologic setting at SRS.

When rain falls, part of the rainwater soaks into the ground, infiltrating soil and rock. The accumulation of groundwater in pore spaces of sediments creates sources of useable water. Groundwater eventually reappears at the surface in springs, swamps, streambeds, riverbeds, or wells. Thus, groundwater is a reservoir whose primary input is rainwater

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Figure 10-1 Facilities Monitored by the SRS Monitoring Well Network, Including Areas Having Constituents Exceeding Drinking Water Standards in 1995

Key for Figure 10-1

Acid/Caustic Basins

1. F-Area Acid/Caustic Basin
2. H-Area Acid/Caustic Basin
3. K-Area Acid/Caustic Basin
4. P-Area Acid/Caustic Basin
5. R-Area Acid/Caustic Basin

Burning/Rubble, Rubble, and Metals Burning Pits

6. A-Area Burning/Rubble Pits and A-Area Ash Pile
7. A-Area Metals Burning Pit
8. Burma Road Rubble Pit
9. C-Area Burning/Rubble Pit
10. D-Area Burning/Rubble Pits
11. F-Area Burning/Rubble Pits
12. K-Area Burning/Rubble Pit
13. L-Area Burning/Rubble Pit
14. N-Area (formerly Central Shops) Burning/Rubble Pits
15. N-Area Burning/Rubble Pit South
16. P-Area Burning/Rubble Pit
17. R-Area Burning/Rubble Pits

Coal Pile Runoff Containment Basins, Ash Basins, and Coal Piles

18. A-Area Coal Pile Runoff Containment Basin
19. C-Area Coal Pile Runoff Containment Basin
20. D-Area Coal Pile Runoff Containment Basin and Ash Basins
21. F-Area Ash Basin
22. F-Area Coal Pile Runoff Containment Basin
23. H-Area Coal Pile Runoff Containment Basin
24. K-Area Ash Basin
25. K-Area Coal Pile Runoff Containment Basin
26. P-Area Coal Pile Runoff Containment Basin
27. R-Area Coal Pile

Disassembly Basins

28. C-Area Disassembly Basin
29. K-Area Disassembly Basin
30. L-Area Disassembly Basin
31. P-Area Disassembly Basin
32. R-Area Disassembly Basin

Seepage and Retention Basins

33. C-Area Reactor Seepage Basins
34. F-Area Seepage Basins and Inactive Process Sewer Line
35. Ford Building Seepage Basin
36. H-Area Retention Basins
37. H-Area Seepage Basins and Inactive Process Sewer Line
38. K-Area Reactor Seepage Basin
39. K-Area Retention Basin
40. L-Area Reactor Seepage Basin
41. M-Area Hazardous Waste Management Facility
42. Metallurgical Laboratory Seepage Basin
43. New TNX Seepage Basin
44. Old F-Area Seepage Basin
45. Old TNX Seepage Basin
46. P-Area Reactor Seepage Basins
47. R-Area Reactor Seepage Basins
48. Savannah River Laboratory Seepage Basins

Operating Buildings and Facilities

49. F-Area Canyon Building and A-Line Uranium Recovery Facility
50. F-Area Effluent Treatment Cooling Water Basin
51. H-Area Auxiliary Pump Pit
52. H-Area Canyon Building
53. H-Area Effluent Treatment Cooling Water Basin
54. K-Area Tritium Sump
55. N-Area Hazardous Waste Storage Facility
56. S-Area Facilities
57. S-Area Low-Point Pump Pit
58. S-Area Vittrification Building
59. Z-Area Low-Point Drain Tank
60. Z-Area Saltstone Manufacturing and Disposal Facility

Plume Monitoring

61. A-Area and M-Area
62. Separations and Waste Management Areas
63. T-Area (TNX)

Radioactive Waste Storage and Disposal Facilities

64. Burial Ground Expansion (E-Area Vaults)
65. Hazardous Waste/Mixed Waste Disposal Facility
66. Old Burial Ground
67. Radioactive Waste Burial Ground
68. F-Area Tank Farm
69. H-Area Tank Farm

Sanitary Landfill

70. Sanitary Landfill and Interim Sanitary Landfill

Sludge Application Sites

71. F-Area Sanitary Sludge Land Application Site
72. H-Area Sanitary Sludge Land Application Site
73. K-Area Sludge Land Application Site
74. PAR Pond Sludge Land Application Site
75. Second PAR Pond Borrow Pit Sewage Sludge Application Site

Other Sites

76. B-Area Gas Station
77. Chemicals, Metals, and Pesticides Pits
78. D-Area Oil Disposal Basin
79. K-Area Diesel Tank Spill
80. L-Area Acid/Caustic Basin and L-Area Oil & Chemical Basin
81. Miscellaneous Chemical Basin
82. Motor Shop Oil Basin
83. N-Area Diesel Spill
84. N-Area Fire Department Training Facility
85. N-Area Hydrofluoric Acid Spill
86. Road A (Baxley Road) Chemical Basin
87. Silverton Road Waste Site
88. TNX Burying Ground

infiltrating the soil and whose output is discharge to springs, swamps, streams, rivers, and wells.

Water from the surface moves into the soil by percolating downward through the pore spaces between sediment grains; smaller pore spaces mean that less water flows through the sediment. The physical property that describes the ease with which water may move through the pore spaces and cracks in a solid is called permeability, which is determined largely by the number and size of pore spaces in the solid and by how the pore spaces are connected.

As water infiltrates the earth, it travels down through the unsaturated zone, where the pore spaces are filled partly with water and partly with air. Water moving through the unsaturated zone eventually reaches the top of the saturated zone (water table), where the pore spaces are completely filled with water. The water table generally follows, in subtle form, the contour of the surface topography. Springs, swamps, and beds of streams and rivers are the outcrops of the water table, where groundwater is discharged to the surface.

Groundwater beneath SRS flows slowly—at rates ranging from inches to several hundred feet per year—toward streams and swamps on site and into the Savannah River. Figures 10-2 (page 162) and 10-3 (page 163) illustrate the potentiometric contours and horizontal-flow directions of two regional aquifers monitored beneath SRS. Similar to contour lines on a weather map that connect points of equal barometric pressure, the figures' potentiometric surface contour lines connect below-ground regions of equal hydraulic head (elevation of the water in a well or piezometer).

Horizontal-flow directions of groundwater within these aquifers are indicated on figures 10-2 (page 162) and 10-3 (page 163) by bold arrows perpendicular to the contour lines. In both aquifers, the direction of flow beneath monitored waste sites generally is toward the Savannah River, the Savannah River Swamp, Upper Three Runs Creek, or Lower Three Runs Creek. Surface water in the swamp and creeks eventually flows into the Savannah River.

The flow of groundwater and the position of the water table may be complicated by variations in the permeability of the subsurface. Because the earth's permeability varies greatly, groundwater does not travel at a constant rate or without impediment. Strata that transmit water easily (such as those composed primarily of sand) are called aquifers, and strata that restrict water movement (such as clay layers) are called aquitards. A fully saturated aquifer with an aquitard lying above it is termed a confined aquifer.

Groundwater moves through aquifers toward natural exits, or discharge points, to reappear at the surface.

The direction of groundwater flow through an aquifer system is determined only partly by the permeability of the strata containing the aquifer. The hydraulic head is a function of the energy associated with elevation and the pressures exerted by surrounding water. Hydraulic gradient—the difference in hydraulic head over a specified distance—is the driving force for groundwater movement. Because hydraulic head is not just a function of elevation, downgradient is not necessarily synonymous with downhill. The downgradient direction will have a horizontal and vertical component, just as a household drain moves wastewater both horizontally and vertically toward the lowest point of exit. Aquitards deflect groundwater movement just as drainpipe walls control the direction of wastewater movement. In an aquifer constrained by aquitards such as horizontal clay layers, the downgradient direction tends to be more horizontal than vertical.

Monitoring wells are used extensively at SRS to assess the effect of operations on groundwater quality—generally to determine the effect of a specific site on groundwater quality nearby. Wells positioned to intercept the groundwater flowing away from a site are called downgradient wells, while wells placed to intercept groundwater before it flows under a site are called upgradient wells. Wells sampling groundwater flowing next to a site are called sidegradient wells. Any contamination of the downgradient wells not present in the upgradient wells at a site may be assumed to be a product of that site.

Wells are drilled to various depths in the saturated zone below the area to be monitored. A portion of the well casing, the screen, is perforated to allow water to enter the well. Thus, the screen zone refers to the zone of subsurface strata whose water is being sampled by the well. The water rises in the well casing to equilibrate with the hydraulic head of the water surrounding the well's screen zone. By comparing the water levels in adjacent wells screened in the same zone, the hydraulic gradient can be determined and the horizontal direction of groundwater flow estimated.

The vertical direction of groundwater movement between aquifers is controlled by the permeability of the aquitards and the relative difference in hydraulic head of the water on either side of an aquitard. Vertical gradients can be determined by comparing the water levels between adjacent wells screened on either side of an aquitard. If the water levels in deeper

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A sampler takes field measurements at a well in H-Area as part of the ongoing groundwater monitoring program at SRS. The well is one of approximately 1,600 wells monitored at 94 SRS locations.

wells are higher than those in shallower wells, the vertical component of flow is upward.

Geological and Hydrogeological Setting at SRS

SRS is located on the Upper Atlantic Coastal Plain, approximately 20 miles southeast of the Fall Line, which separates the Piedmont and Coastal Plain provinces. The site is on the Aiken Plateau, a relatively flat area that slopes southeastward and is dissected by several tributaries of the Savannah River.

Vertical and horizontal groundwater flow directions are determined in part by the permeability and continuity of geologic strata. So that the movement of groundwater and any hazardous constituents it may contain can be monitored effectively, researchers at SRS have undertaken many detailed studies of the strata beneath the site.

SRS is underlain by a 700- to 1,200-foot-thick, seaward-thickening wedge of Coastal Plain sediment composed of unconsolidated sands, clayey sands,

sandy clays, clays, and lesser amounts of calcareous sediment. These layers are underlain by dense Paleozoic crystalline igneous and metamorphic rock or younger consolidated sediments of the Triassic Period. The Triassic formations and the older igneous and metamorphic rocks are hydrologically isolated from the overlying Coastal Plain sediments by a regional aquitard. A cross section of the Coastal Plain sediments is presented in figure 10-4, page 164.

Within the Coastal Plain sediments, the sandy strata generally are permeable and may form aquifers. Strata rich in clays are made less permeable by the presence of minute, pore-filling clay particles. Clayey strata, therefore, are less permeable than sandy strata and tend to be aquitards.

Discussed in this report are three major water-bearing zones in Coastal Plain sediments, divided by regional aquitards, as shown in figure 10-4, page 164. In ascending order, these zones are the Dublin-Midville Aquifer System, the confined Gordon aquifer, and the unconfined Upper Three Runs aquifer in most areas (the latter two comprise the Floridian Aquifer System). Monitoring wells at SRS are used primarily

to sample water from these zones. In the *SRS Environmental Report for 1994*, the following nomenclature referred to the water-bearing zones (in ascending order): the Cretaceous zone, the Congaree-Fourmile zone, and the upper saturated zone.

Northwest of Upper Three Runs Creek, a different nomenclature is used for approximately the same zones. In this area, the lowest unit is the Crouch Branch aquifer, the next unit is the Lost Lake aquifer, and the upper unconfined unit is the M-Area aquifer. The Crouch Branch confining unit overlies the Crouch Branch aquifer, and within this unit a "middle sand" unit is monitored near A-Area and M-Area.

The deepest aquifer monitored at SRS occurs in sediments of geologic formations of Cretaceous age. These Cretaceous sediments are largely permeable quartz sands and sandy clays capable of yielding abundant water; they constitute a regionally important aquifer. The Dublin-Midville Aquifer System is separated from the overlying Gordon aquifer by a regional aquitard composed of sandy-clay and clay sediments.

The Gordon aquifer, a locally important source of groundwater, occurs in moderately to well-sorted sand and interbedded sandy-clay sediments capable of yielding several hundred gallons of water per minute. A local aquitard, composed predominantly of clay and identified in SRS literature as "Green Clay," overlies the Gordon aquifer, separating it from the Upper Three Runs aquifer. In the Savannah River Valley between SRS and Georgia, this aquitard and the sediments of the underlying Gordon aquifer have been eroded by river channel migration and incision.

Sediments of the Upper Three Runs aquifer are predominantly sandy clay and calcareous and generally yield low amounts of water. Numerous discontinuous clay-rich layers (including the "Tan Clay" of SRS literature) create local aquitards in the upper saturated zone, resulting in locally complex patterns of groundwater flow.

At SRS, the horizontal direction of groundwater movement is governed largely by the depths of incisions of the creeks and streams where water is discharged to the surface. The valleys of the smaller perennial streams allow discharge from the upper saturated formations. The valleys of major tributaries of the Savannah River drain formations of intermediate depth, and the valley of the Savannah River drains deep formations. Generally, groundwater in the deep Dublin-Midville Aquifer System flows toward and discharges into the Savannah River on both the Georgia and South Carolina sides of the

river. Groundwater in intermediate-depth lower Eocene-age formations (the Gordon aquifer) flows toward and discharges into Upper Three Runs Creek or the Savannah River, depending on proximity. Groundwater in younger sediments (the Upper Three Runs aquifer) generally flows toward and discharges into the nearest perennial stream, swamp, or river.

Few aquitards are continuous across SRS. Generally, in the northwestern part of the site (near A-Area and M-Area; figure 10-4, page 164), aquitards are less continuous, permitting vertical flow of groundwater. Where aquitards are more continuous, as they are in the southeastern portion of SRS, groundwater movement is predominantly horizontal. Along the Pen Branch fault (figure 10-4, page 164), aquitards (and transmissive zones) are offset, making the aquitards effectively discontinuous and increasing the likelihood of vertical interchange of water from one transmissive zone to another.

Beneath much of SRS, hydraulic head decreases with depth, so the vertical component of groundwater flow is downward. This is the case in A-Area and M-Area, where discontinuous aquitards and downward-decreasing hydraulic head allow the downward movement of water from the water table to deeper zones. This type of area is called an aquifer recharge zone (figure 10-5, page 165). However, because of the discharge of groundwater to the valleys of Upper Three Runs Creek and the Savannah River, the hydraulic head in sediments in the Gordon aquifer near these surface water features is less than the hydraulic head in the Dublin-Midville Aquifer System. Thus, the vertical hydraulic gradient is upward, from the lower to the upper sediments, in some areas. This upward flow occurs, for example, in the separations and waste management areas (in the center of SRS), where both the aquitard and an upward hydraulic gradient restrict downward flow of groundwater—and any associated hazardous substances—from the Gordon aquifer into the Dublin-Midville Aquifer System.

Uses of Groundwater in the Vicinity of Savannah River Site

Groundwater is used as a domestic, municipal, and industrial water supply throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County, South Carolina, are developed from the Cretaceous zone. Domestic water supplies are developed primarily from the Gordon aquifer and the Upper Three Runs aquifer. In Barnwell and Allendale counties of South Carolina, some municipal users are supplied from the Gordon aquifer and overlying units that thicken to the southeast.

At SRS, most groundwater production is from the Dublin-Midville Aquifer System, with a few lower capacity wells pumping from the Gordon aquifer. Every major operating area at the site has groundwater production wells. Total groundwater production at SRS is from 9 to 12 million gallons per day, which is similar to the volume pumped for industrial and municipal production within 10 miles of the site.

Description of Monitoring Program

The groundwater monitoring program at SRS gathers information to determine the effect of site operations on groundwater quality. The program's objectives are designed to

- obtain data to determine baseline conditions of groundwater quality
- demonstrate compliance with and implementation of applicable regulations and U.S. Department of Energy (DOE) orders
- provide data to permit the early detection of groundwater contamination
- report detected groundwater contamination
- identify existing and potential groundwater contamination sources and maintain surveillance of these sources
- provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources
- provide data that support information provided to the public
- maintain a continuous record of the effect of facility operations on groundwater quality
- provide data that will allow predictions of groundwater flow and transport models to be verified
- conduct scientific studies to describe the quantity and quality of groundwater at and near the site and the fate of contaminants in the subsurface

The groundwater monitoring program at SRS is conducted by the Environmental Geochemistry Group (EGG) of the Environmental Monitoring Section/Environmental Protection Department (EPD/EMS) of WSRC. To assist other departments in meeting their responsibilities, EGG provides the services for installing monitoring wells, collecting and analyzing samples, and reporting results.

The *Savannah River Site Environmental Monitoring Plan* (WSRC-3Q1-2, Section 2000) provides details

about the following aspects of the groundwater monitoring program:

- well siting, construction, maintenance, and abandonment
- sample planning
- sample collection and field measurements
- analysis
- data management
- related publications, files, and databases

The next four sections of this chapter present overviews of several of these topics, along with information specific to 1995.

Sample Scheduling and Collection

EMS schedules groundwater sampling either in response to specific requests from SRS personnel or as part of its ongoing groundwater monitoring program. These groundwater samples provide data for reports required by federal and state regulations and for internal reports and research projects. The groundwater monitoring program schedules wells to be sampled at intervals ranging from quarterly to triennially. Groundwater from new wells added to the program is analyzed for environmental-screening constituents (table 10-1, page 134) for four consecutive quarters. Except for a number of old wells not constructed properly for collecting samples for all analyses, the environmental-screening analyses are conducted once every 3 years only for the wells identified in *Savannah River Site Screening Program Wells* (ESH-EMS-950409).

Wells identified in ESH-EMS-950409 are sampled annually if their environmental-screening constituent concentrations are above certain limits. Phenolphthalein alkalinity was added as a field measurement during second quarter 1995. Alkalinity (as CaCO_3) also is measured in the field during most sampling events.

Personnel outside EMS may request sample collection as often as weekly. In addition to environmental-screening constituents, constituents that may be analyzed by request include suites of herbicides, pesticides, additional metals, volatile organics, and others. Radioactive constituents that may be analyzed by request include gamma emitters, iodine-129, strontium-90, radium-228, uranium isotopes, and other alpha and beta emitters.

Groundwater samples are collected from monitoring wells, generally with either pumps or bailers dedicated to the well to prevent cross-contamination among wells. Occasionally, portable sampling

Table 10-1 Environmental-Screening Constituents

Aluminum
Arsenic
Barium
Boron
Cadmium
Calcium
Chloride
Chromium
Fluoride
Gross alpha
Gross beta
Herbicides/pesticides suite ^a
2,4-Dichlorophenoxyacetic acid
Endrin
Lindane
Methoxychlor
Toxaphene
2,4,5-TP (Silvex)
Iron
Lead
Lithium
Magnesium
Manganese
Mercury
Nitrate as nitrogen
pH
Phenols ^a
Potassium
Selenium
Silica
Silver
Sodium
Specific conductance
Sulfate
Total dissolved solids
Total organic carbon
Total organic halogens
Total phosphates (as P)
Tritium

Gas Chromatographic Volatile-Organic-Analyses (GC VOA) Constituents

Carbon tetrachloride
Chloroform
Tetrachloroethylene
1,1,1-Trichloroethane
Trichloroethylene

a Herbicide/pesticide analyses and phenols are sampled as part of environmental-screening analyses for the first quarter of the initial four quarters for new wells, and on the basis of annual and semiannual screening limits.

equipment is used; this equipment is decontaminated between wells.

Sampling and shipping equipment and procedures are consistent with EPA, South Carolina Department of Health and Environmental Control (SCDHEC), and U.S. Department of Transportation (DOT) guidelines. EPA-recommended preservatives and sample-handling techniques are used during sample storage and transportation to both onsite and offsite analytical laboratories. Potentially radioactive samples are screened for total activity (alpha and beta emitters) prior to shipment to determine appropriate packaging and labeling requirements.

Deviations from scheduled sampling and analysis for 1995 are enumerated in the SRS quarterly groundwater monitoring reports cited on the first page of this chapter.

Approximately 46,000 radiological analyses and 347,000 nonradiological analyses were performed on groundwater samples collected from approximately 1,600 monitoring wells.

Analytical Procedures

In 1994, General Engineering Laboratories of Charleston, South Carolina, performed most of the groundwater analyses. Roy F. Weston, Inc., of Lionville, Pennsylvania, also performed groundwater analyses. The contracted laboratories are certified by SCDHEC to perform specified analyses.

The EMS radiological laboratory at SRS screened potentially radioactive samples for total activity prior to shipment and analyzed samples from certain K-Area wells for gross alpha, gross beta, and tritium. Environmental Physics of Charleston subcontracted radiological analyses from General Engineering Laboratories; TMA/Eberline of Oak Ridge, Tennessee, and Analytical Technologies, Inc., of Ft. Collins, Colorado, subcontracted radiological analyses from Roy F. Weston, Inc.

Full lists of constituents analyzed, analytical methods used, and the laboratories' detection limits are given in the SRS quarterly groundwater reports referenced earlier.

Evaluation of Groundwater Data

EMS receives analytical results and field measurements as reports and as ASCII files that are loaded into databases at SRS. Logbooks track receipt and transfer of data to the Geochemical Information Management System (GIMS) database, and computer programs present the data in a format that can be validated.

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Groundwater samples often are analyzed for volatile organic compounds, such as trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane. A common method for such analysis is gas chromatography/mass spectrometry (GC/MS), which is being used by EMS to support the SRS groundwater monitoring program's well drilling operations through the screening of field samples. Here, an EMS Water Quality Chemist loads samples into the autosampler of the GC/MS system for analysis.

Quality control practices include the following:

- verification of well names and sample dates for field and analytical data
- verification that all analyses requested on the chain-of-custody forms are complete for each laboratory
- identification of data entry problems (e.g., duplicate records, incorrect units)
- comparison of analytical data to historical data and review of the data for transcription, instrument, or calculation errors
- comparison of blind replicates and laboratory in-house duplicates for inconsistencies
- identification of laboratory blanks and blind blanks with elevated concentrations

Possible transcription errors and suspect results are documented and submitted to the appropriate

laboratory for verification or correction. No changes are made to the database until the laboratory documents the problem and solution. Changes to the database are recorded in a logbook.

The quarterly groundwater monitoring reports identify queried results that have been verified by the laboratory and list groundwater samples associated with blanks having elevated results. These reports also present the results of intralaboratory and interlaboratory quality assurance comparisons (chapter 11, "Quality Assurance").

Changes to the Groundwater Monitoring Program During 1995

Well Abandonments and Additions to the Sampling Schedule

During 1995, 83 wells were abandoned for the following reasons:

- Five wells at the chemicals, metals, and pesticides pits were abandoned because they were consistently dry or incorrectly screened.
- Seventy-one monitoring grid wells for the burial grounds were abandoned because of the proposed construction of an interim low-permeable soil cover over the old burial ground. Of those abandoned, 16 wells had been in the groundwater monitoring program.
- Seven wells were abandoned and replaced by six new wells at the burial grounds in preparation for the closure of the Low-Level Radioactive Waste Disposal Facility (LLRWDF).

The following 61 wells were monitored for the first time in 1995:

- Seven new wells were installed at the metallurgical laboratory seepage basin in compliance with the Resource Conservation and Recovery Act (RCRA) Part B permit application.
- One new well was installed at the A-Area burning/rubble pits in support of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) program.
- Twenty-three new BGO wells were installed to assess groundwater contamination between the Mixed Waste Management Facility (MWMF) and the old burial ground.
- Twelve new wells were installed at the chemicals, metals, and pesticides pits in support of the RFI/RI program.
- One replacement well was installed at the H-Area seepage basins in compliance with the RCRA Part B permit application.
- Three new wells were installed at the K-Area coal pile runoff containment basin in support of the RFI/RI program.
- Four new wells were installed at the interim sanitary landfill to comply with the SCDHEC municipal solid waste permit.
- Six new wells were installed at the K-Area, L-Area, and P-Area disassembly basins to complete the monitoring network of one upgradient and three downgradient wells to monitor each disassembly basin.
- Four new wells were installed at the C-Area burning/rubble pit in support of the RFI/RI program.

Changes in Scheduling Policy

Beginning in 1995, EPD changed its policy from semiannually to annually for scheduling analyses based on previous concentrations above certain limits

for environmental-screening constituents. In 1995, constituents were scheduled semiannually for analyses based on previous concentrations above certain limits for gas chromatographic volatile organic analyses, which include carbon tetrachloride, chloroform, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene. The decision to reduce the analysis frequency for constituents receiving the internal EMS Flag 2 designation was based on a historical review of the groundwater database and on geohydrology considerations.

Changes in Scheduling Procedures

During 1994, the only constituents scheduled for analyses based on previous concentrations above certain limits were environmental-screening analyses and gas chromatographic volatile organic analyses (table 10-1, page 134).

Applicable Monitoring Standards

The analytical results of samples taken from SRS monitoring wells that exceed several different types of standards are discussed in this chapter. Most constituents discussed are compared to the final federal primary DWS because it is South Carolina policy to classify groundwater aquifers as potential drinking water sources [SCDHEC, 1985]. The DWS can be found in Appendix D, "Drinking Water Standards." DWS are not always the standards applied by regulatory agencies to the SRS waste units under their jurisdiction. For instance, standards under RCRA are DWS, groundwater protection standards, background levels, and alternate concentration limits.

Two constituents having DWS, dichloromethane and bis(2-ethylhexyl) phthalate, are not discussed in this chapter. Both are common laboratory contaminants and are reported in groundwater samples with little or no reproducibility. Both are reported, with appropriate flags and qualifiers, in the data tables of the quarterly reports cited earlier.

The standard used for lead is the SCDHEC DWS. The federal standard of 15 µg/L is a treatment standard for drinking water at the consumer's tap; thus, it is inappropriate for groundwater.

Of the radionuclides discussed, only gross alpha, strontium-90, and tritium are compared to true primary DWS.

The standard used for gross beta is a screening standard; when public drinking water exceeds this standard, the supplier is expected to analyze for individual beta and gamma emitters. A gross beta result above the standard is an indication that one or

Radionuclide Regulations

The regulatory standards for radionuclide discharges from industrial and governmental facilities are set under the Clean Water Act, RCRA, and Nuclear Regulatory Commission and DOE regulations.

Discharges of radionuclides from DOE facilities are regulated under the Atomic Energy Act, as prescribed by DOE Order 5400.5, "Radiation Protection of the Public and the Environment."

The proposed drinking water maximum contaminant levels discussed in this chapter are only an adjunct to these release restrictions and are not used to regulate SRS groundwater.

more radioisotopes are present in quantities that would exceed the EPA annual dose equivalent for persons consuming 2 liters daily. Thus, for the individual beta and gamma radioisotopes (other than strontium-90 and tritium), the standard discussed in this chapter is the activity per liter that would, if only that isotope were present, exceed the dose equivalent. Similarly, the standards for alpha emitters discussed here are calculated to present the same risk at the same rate of ingestion.

Although radium has a DWS of 5 pCi/L for the sum of radium-226 and radium-228, the standards discussed here are the proposed standards of 20 pCi/L for each isotope separately. Radium-226, an alpha emitter, and radium-228, a beta emitter, cannot be analyzed by a single method. Analyses for total alpha-emitting radium, which consists of radium-223, -224, and -226, are compared to the standard for radium-226.

Four other constituents without DWS are discussed in the text when their values exceed certain levels. These constituents are specific conductance at values equal to or greater than 100 $\mu\text{S}/\text{cm}$, alkalinity (as CaCO_3) at values equal to or greater than 100 mg/L, total dissolved solids (TDS) at values equal to or greater than 200 mg/L, and pH at values equal to or less than 4.0 or equal to or greater than 8.5. The selection of these values as standards for comparison is somewhat arbitrary; however, these values exceed levels usually found in background wells at SRS. The occurrence of elevated alkalinity (as CaCO_3), specific conductance, pH, and TDS within a single well may indicate leaching of the grouting material used in well construction, rather than degradation of the groundwater.

Groundwater Monitoring Results

The following sections describe the groundwater monitoring results for approximately 100 locations (figure 10-1, page 128) within designated areas at SRS. The sections are arranged in the following order: acid/caustic basins; burning/rubble, rubble, and metals burning pits; coal pile runoff containment basins, ash basins, and coal piles; disassembly basins; seepage and retention basins; operating buildings and facilities; plume monitoring; radioactive waste storage and disposal facilities; sanitary landfill and interim sanitary landfill; sludge application sites; and other sites. Table 10-2, beginning on page 158, presents an overview of the well network for the monitored locations. The discussions of recent trends in the data are based on the results presented in the groundwater monitoring chapters of the annual SRS environmental reports from 1990 through 1994 and for the first three quarters of 1995. Mechanical failure or inaccessibility prevented the sampling of some wells throughout the year. Other wells were dry or needed to be added to the purge-water containment program before further sampling could occur. The quarterly groundwater monitoring reports referenced earlier identify wells for which scheduled analyses could not be performed—and specify the reason.

Geographical descriptions in the text are based on true north rather than SRS grid coordinates. All figures are oriented by Universal Transverse Mercator grid coordinates. Figure 10-6, page 166, illustrates the entire site; the areas covered in more detailed figures in this chapter are superimposed on figure 10-6.

Acid/Caustic Basins

The acid/caustic basins in F-Area, H-Area, K-Area, L-Area, P-Area, and R-Area are unlined earthen pits (approximately 50 by 50 by 7 feet deep). These pits received dilute sulfuric acid and sodium hydroxide solutions used to regenerate ion-exchange units in power plant water purification processes at the reactor and separations areas in the center of SRS. The basins allowed mixing and neutralization of the dilute solutions before their discharge to nearby streams.

The basins were constructed between 1952 and 1955. They are uncovered, and most are dry except during periods of prolonged precipitation. The R-Area and L-Area basins were abandoned in 1964 and 1968, respectively. The other basins remained in service until 1982, when the water purification systems either were shut down or modernized. However, the H-Area

basin continued to receive steam condensate from a hose box and drainage from a chemical pad until the basin was abandoned in 1985.

The F-Area, H-Area, K-Area, and P-Area basins are RCRA-regulated units. SRS stabilized the H-Area and P-Area acid/caustic basins according to an Interim Status Closure Plan (Revision 3, February 5, 1992) that proposes the closure of those four basins. During July through September 1993, the basins were dewatered, vegetation was removed and disposed of, the basins were filled with compacted soil from the Burma Road clay pit, a grass cover was established, and the fences were reinstalled. Soil along the F-Area, H-Area, K-Area, and P-Area acid/caustic sewer lines was sampled for characterization in November and December 1993.

Work plans for characterization of the L-Area and R-Area acid/caustic basins have been submitted to EPA Region IV and SCDHEC as part of the RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process for determining the extent of contamination at these basins. Since the first L-Area work plan was submitted, the L-Area characterization has been combined with characterization of the L-Area Oil and Chemical Basin; see "Other Sites" (page 155) for further information and monitoring results.

F-Area Acid/Caustic Basin

The F-Area acid/caustic basin is east of F-Area (figure 10-7, page 167). During 1995, analytical results for groundwater samples were similar to those of recent years. Gross alpha, which consistently has been above DWS in one or more wells, was detected above that level in three wells during 1995.

As in 1994, total alpha-emitting radium exceeded the proposed standard for radium-226 in one well. Radium-226, which exceeded the same standard in three wells in 1994, exceeded DWS in only one well in 1995. TDS exceeded DWS in two wells, and alkalinity, gross beta, nitrate as nitrogen, nitrate-nitrite as nitrogen, and pH were above their respective standards in one well each. As in past years, specific conductance exceeded the standard in several wells. Lead, which was elevated in 1993, did not exceed its DWS for the second year in a row.

H-Area Acid/Caustic Basin

The H-Area acid/caustic basin is southwest of H-Area near the tank farm (figure 10-7, page 167). In 1995, as in recent years, tritium activity exceeded the DWS in all wells in this area. Specific conductance exceeded the standard in three wells, as it has in one

or more wells for several years. Carbon tetrachloride and heptachlor epoxide, which were detected above the primary DWS for the first time in 1994, did not exceed their standards in 1995.

K-Area Acid/Caustic Basin

The K-Area acid/caustic basin is on the east side of K-Area (figure 10-8, page 168). As in the past, specific conductance was elevated in most of the wells at this basin in 1995. No other analytes were detected above DWS.

P-Area Acid/Caustic Basin

The P-Area acid/caustic basin is east of P-Area and Road F (figure 10-9, page 169). In 1995, specific conductance was elevated in three of the six wells. Alkalinity and radium-228 were detected above their standards in one well each.

R-Area Acid/Caustic Basin

The R-Area acid/caustic basin is south of R-Area, just south of Road G (figure 10-10, page 170). No radioactive or chemical constituents were detected above standards in 1995.

Burning/Rubble, Rubble, and Metals Burning Pits

From 1951 to 1973, burnable wastes—such as paper, wood, plastics, rubber, oil, degreasers, and drummed solvents—were received and burned monthly in one or more of the burning/rubble pits in the following areas: A, C, D, F, K, L, N, P, and R. In 1973, waste no longer was burned at the pits, which were covered with a layer of soil. Rubble wastes—including paper, wood, cans, concrete, and empty galvanized-steel barrels and drums—then were disposed of in the pits until they reached capacity and were covered with soil. All burning/rubble pits were inactive by 1981, and all are covered except the R-Area pit, which has not been backfilled. Similarly, lithium-aluminum alloy, aluminum pieces, metal drums, other metal scraps, and plastic pipe were deposited and burned periodically in the A-Area metals burning pit, beginning about 1952. In 1974, the solid materials remaining on the site were covered with soil, and the pit was regraded. The site is inactive.

The Burma Road rubble pit consists of two excavated earthen pits that may contain paint cans, fluorescent light fixtures, metal, concrete, lumber, poles, and glass. Unknown quantities of refuse were deposited here from approximately 1973 through 1983. The pit is inactive and has been covered with soil.

All these pits are RCRA/CERCLA units. Work plans to characterize fully the extent of contamination have

been submitted to EPA and SCDHEC. Soil, surface, and groundwater sampling and analysis took place during 1993 and 1994 at several of these pits, after the work plans were approved.

A-Area Burning/Rubble Pits and A-Area Ash Pile

These burning/rubble pits and the A-Area ash pile (active since 1979) are west of Road D, south of A-Area (figure 10-11, page 171). Revision 2 of the RFI/RI work plan was submitted to regulators in October 1993. As in much of the rest of A-Area and M-Area, trichloroethylene was detected above DWS during 1995. Specific conductance also was detected above its standard in one well.

A-Area Metals Burning Pit

The A-Area metals burning pit is south of the burning/rubble pits (figure 10-11, page 171). In 1995, as in previous years, alkalinity, pH, and specific conductance were elevated in one well, indicating contamination by grout.

As in the past and as in the rest of A-Area and M-Area, chlorinated volatile organics were detected above their DWS at this site during 1995. Tetrachloroethylene and trichloroethylene were above their DWS in three wells, and gross alpha was above its standard in one well.

Burma Road Rubble Pit

The Burma Road rubble pit is southwest of F-Area (figure 10-7, page 167). In 1995, lead and specific conductance were above standards, similar to results since groundwater at these pits first was sampled in 1990. Tritium, which also has been consistently above its standard, was above its DWS in seven wells during 1995. Chromium and nickel, which exceeded their DWS for the first time in 1994, again were above DWS in 1995. Gross alpha and gross beta, which exceeded their standards for the first time in 1994, again were elevated. For the first time, mercury and thallium were above DWS in one well each during 1995.

C-Area Burning/Rubble Pit

The C-Area burning/rubble pit is west of C-Area (figure 10-12, page 172). Two wells were not sampled from 1992 through 1995 because past trichloroethylene levels require containerizing their purged water. During 1995, as in past years, one of the other two wells contained levels of trichloroethylene slightly above its DWS, and both

contained thallium slightly above its DWS. Tritium, which had been above its DWS in both wells sampled in 1994, was not detected above its standard.

D-Area Burning/Rubble Pits

Soil and groundwater RFI/RI assessments at these pits, which are west of D-Area (figure 10-13, page 173), were undertaken during 1993; reports were submitted to EPA and SCDHEC during 1994. During 1995, pH exceeded the acidic standard and specific conductance exceeded its standard in one well each, as they have since 1988.

F-Area Burning/Rubble Pits

Soil and groundwater RFI/RI assessments at these pits, which are north of Road C and west of F-Area (figure 10-7, page 167), were undertaken during 1993; a rubble pit where burning did not occur was included. Reports were submitted to EPA and SCDHEC during 1994.

During 1995, tetrachloroethylene and trichloroethylene consistently exceeded their DWS in three wells each. Carbon tetrachloride, which exceeded its DWS in two wells in 1994, was not above DWS in 1995. These results generally are similar to those of recent years. Nitrate as nitrogen and TDS exceeded their DWS in one well. Specific conductance exceeded its standard in four wells.

As in recent years, gross alpha exceeded its DWS in two wells. Gross beta exceeded its screening standard in one well.

K-Area Burning/Rubble Pit

The K-Area burning/rubble pit (figure 10-8, page 168) is northeast of K-Area. During 1995, as in recent years, tetrachloroethylene and trichloroethylene were detected above their DWS. Specific conductance, which was elevated in one well during 1994, was not above its standard in 1995.

L-Area Burning/Rubble Pit

At this location northwest of L-Area (figure 10-8, page 168), no radioactive or chemical constituents were detected above their standards during 1995. Lead has been above its standard in at least one well in recent years.

N-Area Burning/Rubble Pits

These pits are north of N-Area (figure 10-12, page 172). During 1995, the only constituent above its standard at this site was lead in one well.

N-Area Burning/Rubble Pit South

This pit is southeast of N-Area (figure 10-12, page 172). During 1995, as in previous years, no constituents were detected above their standards.

P-Area Burning/Rubble Pit

This pit is west of P-Area (figure 10-9, page 169). During 1995, tetrachloroethylene and trichloroethylene were above their standards in two wells. As in recent years when chlorinated volatile organics have been elevated, carbon tetrachloride was above its standard in one well.

R-Area Burning/Rubble Pits

These pits are southeast of R-Area and Road G (figure 10-10, page 170). During 1995, no chemical or radiological constituents were detected above their standards. Lead, which was above its DWS in one well in 1993, and specific conductance, which was elevated in three wells for the first time in 1993, did not exceed their standards.

Coal Pile Runoff Containment Basins, Ash Basins, and Coal Piles

Electricity and steam at SRS are generated by burning coal. Coal piles originally existed in the following areas: A, C, D, F, H, K, L, P, and R. The facilities generally contained a 90-day reserve of coal that was not rotated. During long-term exposure to the environment, chemical and biological oxidation of sulfur compounds in coal resulted in the formation of sulfuric acid.

The R-Area coal pile was removed in 1964, and the L-Area coal pile was removed in 1968. To achieve compliance with the National Pollutant Discharge Elimination System (NPDES) permit issued in 1977, coal pile runoff containment basins in A-Area and D-Area were completed in October 1978, and basins in C-Area, F-Area, H-Area, K-Area, and P-Area were completed in March 1981. The coal piles in C-Area and F-Area were removed in 1985. In 1991, the K-Area coal pile was reduced to a 2-inch base, and 75 percent of the P-Area coal pile was removed.

Currently, rainwater runoff from the remaining coal piles in A-Area, D-Area, H-Area, K-Area, and P-Area flows into the coal pile runoff containment basins via gravity flow ditches and sewers. The basins allow mixing of the runoff and its seepage into the subsurface, thus preventing the entry of large surges of low-pH runoff into surface streams. The basins in C-Area and F-Area also still collect runoff, although no coal remains at either location. All these basins are RCRA/CERCLA units. The R-Area coal

pile wells are sampled to support investigations of the R-Area reactor seepage basins, but the site itself is not a RCRA/CERCLA unit.

Ash sluice water from the D-Area and K-Area powerhouses has been discharged to the D-Area ash basins and the K-Area ash basin, respectively, since 1951. These, like other ash basins and ash piles, are site evaluation units under the Federal Facility Agreement (FFA) executed during 1993 between DOE-SR, EPA, and SCDHEC. Sampling for a soils assessment at the K-Area basin was conducted in January 1995, and soils characterizations at the C-Area coal pile runoff containment basin took place during the summer of that year.

A-Area Coal Pile Runoff Containment Basin

This basin is southeast of A-Area (figure 10-11, page 171). During 1995, as in the past, two wells monitoring this basin had elevated specific conductance. Levels of gross alpha above DWS were found in two wells, and total alpha-emitting radium above its proposed standard in one well. Gross beta also was above DWS in one well. No other chemical or radioactive constituents were detected above their standards at this site.

C-Area Coal Pile Runoff Containment Basin

This basin is southeast of C-Area (figure 10-12, page 172). During 1995, no chemical or radioactive constituents or parameters exceeded their standards at this site.

D-Area Coal Pile Runoff Containment Basin and Ash Basins

The containment basin is south and the ash basins southwest of D-Area (figure 10-13, page 173). Results in 1995 generally were similar to those of recent years. Analytes above their DWS included trichloroethylene, gross alpha, and metals, including arsenic, cadmium, copper, lead, and nickel. Tritium and total alpha-emitting radium, which exceeded their standards in 1994, were not elevated in 1995. Gross beta exceeded its screening standard in two wells. DWS were exceeded as follows: by alkalinity in one well, TDS in eight wells, specific conductance in nine wells, and sulfate in six wells. Meanwhile, pH exceeded the acidic standard in four wells.

F-Area Ash Basin

F-Area ash basin 281-F, east of F-Area and south of the F-Area acid/caustic basin (figure 10-7, page 167), was monitored for the first time during second quarter 1994. Alkalinity and specific conductance each exceeded their standards during 1995. TDS exceeded its standard in two wells, and mercury exceeded its DWS in one well for the first time.

F-Area Coal Pile Runoff Containment Basin

This basin is southeast of F-Area (figure 10-7, page 167). During 1995, no chemical or radioactive constituents exceeded their standards at this site. Lead and total alpha-emitting radium, which had exceeded their standards in one well in recent years, were reported below their standards during 1995.

H-Area Coal Pile Runoff Containment Basin

This basin is east of H-Area (figure 10-7, page 167). In 1995, as in past years, tritium exceeded its DWS in two wells. Trichloroethylene was above its DWS in one well. Specific conductance was elevated in three wells, and pH was above the acidic standard in two wells. Lead, which has been detected above its DWS in an upgradient well in the past, was not elevated in any of the wells. Gross alpha, which also had been above its DWS in recent years, was not above DWS in 1995.

K-Area Ash Basin

This basin is southwest of K-Area (figure 10-8, page 168). During 1995, gross alpha was detected above its DWS in one downgradient well. As in the past, alkalinity was elevated in one well and specific conductance was elevated in two wells.

K-Area Coal Pile Runoff Containment Basin

This basin is west of K-Area (figure 10-8, page 168), between the K-Area ash basin and reactor seepage basin. In 1995, tritium slightly exceeded its DWS in one well upgradient to the basin. In one downgradient well, gross alpha was above its DWS, specific conductance was elevated, and pH exceeded the acidic standard. Specific conductance also was elevated in two other wells; TDS was elevated in two wells; and nitrate-nitrite as nitrogen was above DWS in one well. These results are similar to those of past years, when gross alpha and tritium levels have varied within an order of magnitude of their DWS in different wells. Lead was above its DWS in one well and chromium in two wells.

P-Area Coal Pile Runoff Containment Basin

This basin is southeast of the coal pile and south of P-Area (figure 10-9, page 169). Wells monitoring the basin were not sampled during 1995. In past years, specific conductance, cadmium, and acidic pH have been elevated.

R-Area Coal Pile

Two wells were installed in 1990 inside the boundaries of the former coal storage area, west of

the R-Area reactor building (figure 10-10, page 170), originally for groundwater assessment in relation to the R-Area coal pile. One of the wells first was sampled during second quarter 1992; the other first was sampled in 1994. Both are being sampled to support the RI for the R-Area reactor seepage basins.

During 1995, alkalinity (as CaCO_3) and high (basic) pH were elevated above their standards in one well and TDS in another well.

Disassembly Basins

The disassembly basins, also called fuel and target storage basins, are concrete-lined, open tanks of water next to the reactor rooms inside the reactor buildings. Irradiated assemblies (reactor fuel and target rods) were rinsed and stored in the basins prior to their shipment to the separations areas. Some radioactivity was transferred to the basin water from leaks in porous components and as a liquid or oxide corrosion film on the irradiated components.

Sand filters were used to remove radioactive particulates from the disassembly basin water. The filtered water was circulated through deionizers to remove additional constituents and was purged periodically through regenerated deionizers to the reactor seepage basins.

The disassembly basins are on the site evaluation list of the FFA.

C-Area Disassembly Basin

As in recent years, lead and tritium were above their DWS in wells at the C-Area disassembly basin (figure 10-12, page 172). Conductivity, which has been elevated occasionally during the past several years, was not above its standard during 1995.

K-Area Disassembly Basin

Tritium was detected above its DWS in all five wells at the K-Area disassembly basin (figure 10-8, page 168), and lead and tetrachloroethylene were above their DWS in a few wells. Specific conductance was elevated in three wells.

L-Area Disassembly Basin

During 1995, lead and tetrachloroethylene exceeded their DWS in one well monitoring the groundwater below this basin (figure 10-8, page 168). Nitrate-nitrite as nitrogen exceeded its DWS in one new well, and tritium was above its standard in two new wells. Specific conductance was elevated in two wells.

P-Area Disassembly Basin

In 1995, tritium in all four wells at the P-Area disassembly basin (figure 10-9, page 169) was

detected at levels as high as one order of magnitude above its DWS. Lead exceeded its DWS in one well, and specific conductance was above its standard in another.

R-Area Disassembly Basin

Gross alpha, which exceeded its DWS in one well at the R-Area disassembly basin (figure 10-10, page 170) in 1994 for the first time, was not above its standard in 1995. Specific conductance was elevated in two wells during 1995; it was elevated in all three wells from 1990 through 1994. Lead was detected above its DWS in two wells, as it has been since 1992.

Seepage and Retention Basins

Seepage, retention, and settling basins have been used at SRS to store or dispose of wastewater from various operations. Since 1957, active reactor seepage basins have received low-level radioactive purge water from the disassembly basins. Although many radionuclides have been discharged to the basins, almost all of the radioactivity is due to tritium and small amounts of cesium-137, cobalt-60, and strontium-90.

Purge of Disassembly Basin Water to Seepage Basins

When the reactors first began operation, a continuous purge of basin water to surface streams was used to cool the assemblies and maintain clarity in the basins. When concentrations of tritium in reactor moderator—and therefore in the disassembly basins—increased, the purpose of purging became more to control employee exposure. The purge process was modified to reduce the amount of tritium released to surface streams. First, the purge flow was reduced. Then, the vertical tube storage sections of the basins were isolated so that water could be circulated through a portable filter and deionizer system. Moderator fluid was flushed from components before they were placed in the disassembly basins. Permanent sand filters were installed, and overflow weirs were closed. Because of these improvements, it was possible to replace continuous purging with periodic purging.

During the periodic purges of the disassembly basins, fresh filtered water was added to the basins at the same rate that contaminated water was removed through the ion-exchange system. Purging frequency depended on the types of assemblies stored in the basins and the frequency of discharge operations. For example, during one of the periods when K-Area, L-Area, and P-Area reactors were in operation, reactor basins were purged twice yearly.

Purge water was pumped directly from the disassembly basins to the seepage basins until the 1960s, when the use of mixed-bed deionizers and sand filters to reduce the radioactivity began. From 1970 to 1978, the seepage basins for active reactors were bypassed, and the filtered, deionized purge water was discharged directly into nearby streams. In 1978, the seepage basins for reactors in C-Area, L-Area, and P-Area were reactivated. The K-Area reactor seepage basin was used from 1957 to 1960 only. The R-Area reactor seepage basins have been filled and covered with asphalt. The K-Area and R-Area reactor seepage basins are RCRA/CERCLA units.

The three C-Area reactor seepage basins were active, periodically receiving purge water, until the C-Area reactor was shut down in 1985. The L-Area reactor seepage basin was used from 1958 until 1968 and from 1985 until the reactor was placed in warm standby in 1988. The L-Area reactor was placed in shutdown status in 1993 and has not been restarted.

The P-Area reactor was shut down for maintenance and safety improvements in 1988 and has not been restarted. The C-Area, L-Area, and P-Area basins are on the FFA site evaluation list.

The K-Area retention basin, which also is on the FFA list, was used for disposal of purge water from the K-Area disassembly basin from 1965 through 1993. The reactor was shut down for maintenance and safety upgrades in 1988 and has not been restarted.

Because the reactors have been shut down and the basins no longer receive new assemblies, the frequency of purges has been decreased. The K-Area disassembly basin last was purged in 1993; the L-Area and P-Area basins last were purged in 1991.

Purges from the disassembly basins to the reactor seepage basins cause increased tritium concentrations in groundwater from well sites downgradient of the basins. Figures 10-14 and 10-15, pages 174 and 175, show the activity of tritium purged to the L-Area and P-Area reactor seepage basins and the tritium activity at downgradient well sites. Both basins had been inactive for at least 8 years prior to receiving the purges shown in the figures.

The vertical bars in each figure represent total curies of tritium purged to the seepage basins during each year. The line graphs above the bars show the tritium activities in downgradient wells below each basin. Each line represents an individual well. The highest tritium activity was plotted when multiple sampling events took place during one quarter. A logarithmic scale is used for the line graphs to dampen the effect

of variability in the groundwater samples and give a clearer picture of the trend of the data.

There are two causes for the decline in tritium activities in the groundwater. Tritium has a 12.3-year half-life, so approximately 5.4 percent of it disappears each year because of radioactive decay. The rest of the decrease is due to mixing of the groundwater with fresh rainwater from the surface or with other groundwater that has lower tritium activities. As the groundwater mixes, some of the tritium moves with the groundwater away from the basins to points of discharge in streams.

The L-Area disassembly basin was purged to the seepage basin beginning in 1985; it last was purged in 1991. Activities in the groundwater began increasing about a year after the purges began and rose from a level of 100–200 pCi/mL to around 4,000 pCi/mL, with a single reported activity of approximately 10,000 pCi/mL in 1991. Tritium activities in the groundwater have decreased steadily since the purges to the basin were discontinued.

The P-Area disassembly basin was purged to the seepage basins from 1978 through 1991. Purges in P-Area were considerably higher in activity than purges in L-Area, as shown by the differences in the arithmetic scales on the right of each graph. The P-Area seepage basins also received purges for more years than the L-Area basin. Tritium concentrations in the groundwater rose rapidly to approximately 350,000 pCi/mL and have decreased more slowly than at L-Area. This difference is influenced by the higher hydraulic gradient in L-Area and the greater amount of contamination in P-Area.

C-Area Reactor Seepage Basins

These basins are about 650 feet west of the C-Area reactor building (figure 10-12, page 172). One well monitoring the basins was not sampled because high levels of trichloroethylene require containerization of its purge water. During 1995, as in recent years, tritium was above its DWS, in one well by as much as three orders of magnitude. Lead was above its DWS in two wells and trichloroethylene exceeded its DWS in one well. Specific conductance and alkalinity were above their standards in one well. These results are similar to those of past years.

F-Area Seepage Basins and Inactive Process Sewer Line

Beginning in 1955, the F-Area seepage basins received F-Area wastewater containing low-level radioactivity and chemicals, including chromium, mercury, nitric acid, and sodium hydroxide. The

basins operated under RCRA interim status from 1980 until they were taken out of service in the fourth quarter of 1988. Clay caps were completed early in 1991, and SCDHEC accepted the RCRA closure certification for these basins April 26, 1991. A RCRA Part B permit was approved for the seepage basins October 5, 1995. The F-Area seepage basins are located southwest of Road C (figure 10-7, page 167). The sewer line goes from northwest of the F-Area canyon building to north of the F-Area seepage basins.

The portion of the sewer lines within the fenced limited-access area is regulated under CERCLA, while the portion from the fence to the seepage basins is governed by RCRA, along with the similar sewer line in H-Area. The RCRA portion of the lines has been extensively characterized, both for soils and groundwater contamination. A draft screening baseline risk assessment based on closure options was submitted in October 1994. An expedited investigation of the CERCLA portion of the lines was authorized by the regulators to characterize soils, and results were provided to the regulators in August 1992. An RFI/RI work plan was submitted in February 1992 to propose a more complete characterization. As required by the new RCRA Part B permit, a Phase III assessment plan for the F-Area and H-Area inactive process sewer lines was submitted to SCDHEC on December 1, 1995. The scope of the plan was to define the horizontal and vertical extent of groundwater contamination from the process lines.

During 1995, as in the past, the groundwater in many wells in the vicinity of the F-Area seepage basins was characterized by low pH, high nitrate and nitrate-nitrite as nitrogen concentrations, and elevated specific conductance. TDS also was above its standard in many wells. Three wells, including one sewer line well, had an elevated level of alkalinity. Cadmium, lead, mercury, and thallium were detected above their DWS in several wells monitoring the Upper Three Runs aquifer zone. Beryllium and nickel were detected above their DWS in a few wells each. The only organic constituents detected above their DWS were carbon tetrachloride in one sewer line well and trichloroethylene in five wells.

Radionuclide contamination is widespread in the Upper Three Runs zone near the basins. Most of these wells contain tritium above its DWS. Approximately two-thirds of such wells exhibit gross alpha, gross beta, strontium-90, and iodine-129 above their standards. Other radionuclides found above their proposed standards in several Upper Three Runs zone wells include americium-241, curium-243/244, radium-226, radium-228, strontium-89, total

alpha-emitting radium, uranium-233/234, uranium-235, and uranium-238. Cesium-137, curium-245/246, and plutonium-238 were above their standards in one to four wells each. These results are similar to those of recent years, when more isotopes were analyzed than in the past.

Tritium was above its DWS in seven of the nine sewer line wells, including the wells near the canyon building and associated facilities. Other radionuclide contamination along the sewer line is limited to the wells closer to the tank farm and seepage basins. Gross alpha and gross beta were above their standards in two and three wells, respectively.

Contamination in the Gordon aquifer zone at the F-Area seepage basins is less extensive than in the Upper Three Runs zone. Tritium activity exceeded its DWS in several of the seepage basin wells monitoring the Gordon aquifer zone. Iodine-129, nitrate and nitrate-nitrite as nitrogen, gross alpha, pH, strontium-90, thallium, and TDS were above their standards in at least one well each. Elevated specific conductance, found in most of the wells monitoring the zone, may result from the natural occurrence of soluble calcium carbonate minerals in the Gordon aquifer and associated formations. Elevated pH and alkalinity in a few wells indicate that leaching of well grout may be affecting the water quality in these wells.

Ford Building Seepage Basin

The Ford Building seepage basin, in the southeast portion of N-Area (figure 10-12, page 172), received low-level radioactive wastewater from Ford Building operations (repairing heat exchangers) from 1964 to January 1984. The basin is a RCRA/CERCLA unit.

In 1995, tritium was above its DWS in one well monitoring this basin. Specific conductance was elevated in two wells. These results are similar to those of recent years.

H-Area Retention Basins

A small, unlined earthen retention basin (the old H-Area retention basin) was used from 1955 to 1973 to provide temporary emergency storage for cooling water from the chemical separations process that contained radionuclides and possible trace quantities of chemicals. That basin is open but inactive and is a CERCLA unit. Preliminary screening of remedial technologies has been performed, and a Phase I RI work plan for preliminary characterization was approved in October 1993. Soil samples were obtained at the old H-Area retention basin in November 1993 and in January 1994. A Phase II

work plan was submitted to EPA and SCDHEC in May 1994.

A larger, rubber-lined retention basin replaced the original basin in 1973 and still is in use for receipt of diverted cooling water or tank farm stormwater runoff. Both basins are southeast of the intersection of Road 4 and Road E (figure 10-7, page 167).

In 1995, as in past years, tritium was above its DWS in four of the six wells monitoring these basins. Thallium was above its standard in one well. No other chemical or radiological constituents were detected above their standards.

H-Area Seepage Basins and Inactive Process Sewer Line

Starting in 1955, the H-Area seepage basins received wastewater from H-Area containing low-level radioactivity and chemicals, including nitric acid, mercury, and sodium hydroxide. Basin 3 has been inactive since 1962. Basins 1, 2, and 4 operated under RCRA interim status from 1980 until they were taken out of service in the fourth quarter of 1988. Clay caps were completed early in 1991, and SCDHEC accepted the RCRA closure certification for these basins in October 1991. A RCRA Part B permit for the seepage basins was approved in October 1995.

The basins are southwest of H-Area and the intersection of Road E and Road 4 (figure 10-7, page 167), and the sewer line extends from the southwest portion of H-Area to north of the H-Area seepage basins. See "F-Area Seepage Basins and Inactive Process Sewer Line," page 143, for more information on the sewer lines.

During 1995, as in the past, the groundwater in many wells in the vicinity of the H-Area seepage basins was characterized by high nitrate-nitrite as nitrogen concentrations and elevated specific conductance. TDS was above its standard in several wells, as was alkalinity in three Upper Three Runs zone wells. Cadmium, copper, lead, mercury, and sulfate were detected above their DWS in one well each monitoring the Upper Three Runs zone. The pH level exceeded the basic standard in a few wells and the acidic standard in others. The only organic constituent detected above DWS was tetrachloroethylene in three wells in the Upper Three Runs zone.

Radionuclide contamination is widespread in the Upper Three Runs zone near the basins. More than half of the wells contained tritium above its DWS. Approximately half of the wells exhibited gross beta levels above its standard. Gross alpha, iodine-129, strontium-89, and strontium-90 were above their

standards in several wells. Other radionuclides elevated above their standards included carbon-14 in five wells, plutonium-238 in three wells, and cobalt-60, radium-228, and total alpha-emitting radium in one well each. These results are similar to those found in recent years, when more isotopes were analyzed than in past years.

Tritium was above its DWS in most of the Upper Three Runs zone sewer line wells. Iodine-129 and strontium-90 were above their standards in one sewer line well, and gross beta in two wells. Alkalinity, lead, nitrate-nitrite as nitrogen, and acidic and basic pH were above their standards in one well each. TDS was elevated in one sewer line well and specific conductance in three.

Contamination in the Gordon aquifer zone is less extensive than in the Upper Three Runs zone. Tritium exceeded its DWS in five seepage basin wells monitoring the Gordon aquifer zone. Iodine-129, nitrate-nitrite as nitrogen, ruthenium-106, and strontium-90 exceeded their standards in two seepage basin wells each. In the Gordon aquifer zone wells along the sewer line, alkalinity, lead, and pH were above their standards in one well each.

Polychlorinated biphenyls, which were detected above their standard in two wells in 1994, were not elevated in 1995.

TDS was above its standard in a few Gordon aquifer zone wells across the entire seepage basin area, including the sewer line. Elevated specific conductance, found in most of the wells monitoring this zone, may result from the natural occurrence of soluble calcium carbonate minerals in the Gordon aquifer and associated formations. Elevated pH and alkalinity in a few wells may indicate leaching of well grout.

K-Area Reactor Seepage Basin

This basin is west of K-Area (figure 10-8, page 168). During 1995, as in the past, tritium exceeded its DWS in all wells monitoring this basin, reaching levels three orders of magnitude above its DWS in some wells. Trichloroethylene and tetrachloroethylene were detected above their DWS in one well each.

K-Area Retention Basin

This basin is northwest of K-Area (figure 10-8, page 168). In 1995, tritium was detected in all four wells, as it has been since these wells first were sampled in 1991. Specific conductance was elevated in one well. No other constituents were detected above their standards.

L-Area Reactor Seepage Basin

This basin is southeast of L-Area, adjacent to the L-Area oil and chemical basin (figure 10-8, page 168). During 1995, tritium exceeded its DWS in two wells. For the third year in a row, lead, which had been elevated in at least one well in the past, was not detected above its DWS.

M-Area Hazardous Waste Management Facility

The unlined M-Area settling basin, in operation from 1958 until 1985, received wastewater containing metal-cleaning solvents, depleted uranium, and other chemicals and metals from fuel fabrication processes in M-Area. Because surface water flowed from this basin, it is classified as a settling basin rather than a seepage basin. Water from the basin flowed through an overflow ditch to Lost Lake, a shallow upland depression. A seepage area formed adjacent to the ditch and Lost Lake. The M-Area hazardous waste management facility, a RCRA-regulated unit south of A-Area and M-Area and west of Road D (figure 10-11, page 171), comprises the settling basin, overflow ditch, seepage area, and Lost Lake. A closure cap was completed on the basin during 1989-1990, and closure under RCRA was certified by SCDHEC on April 26, 1991. A RCRA Part B permit was approved for the M-Area facility in October 1995.

Since the beginning of a full-scale recovery system for groundwater remediation in April 1985, groundwater flow has changed markedly near this facility, and changes over time in concentrations of analytes are difficult to interpret. See the "Plume Monitoring" section of this chapter (page 149) for more information on remediation.

As in past years, chlorinated volatile organics were the primary constituents above DWS among the point-of-compliance wells during 1995.

Trichloroethylene and tetrachloroethylene were detected above their DWS in numerous wells. In five wells, 1,1-dichloroethylene was above its standard. Thallium was elevated in seven wells.

Gross alpha and gross beta were elevated above their standards in one well each. Specific conductance was elevated in several wells, nitrate-nitrite as nitrogen exceeded its DWS in 10 wells, and chromium and lead were elevated in one well each. Alkalinity was above its standard in six wells, and pH exceeded the acidic standard in nine wells. Trichloroethylene was reported above its DWS in one background well.

Metallurgical Laboratory Seepage Basin

The Metallurgical Laboratory seepage basin, at the eastern edge of A-Area (figure 10-11, page 171), received wastewater effluent from the Metallurgical Laboratory building from 1956 until 1985.

Wastewater released to the basin consisted of small quantities (5 to 10 gallons per day) of laboratory wastes—mostly rinse water—from metallographic sample preparation (degreasing, cleaning, etching) and corrosion testing of stainless steel and nickel-based alloys. Noncontact cooling water (approximately 900 gallons per day) also was discharged.

The RCRA Part B permit for the hazardous waste management facility—comprising the seepage basin, the process sewer line leading to it, and the adjacent Carolina bay—was approved by SCDHEC in October 1995. The basin was dewatered, backfilled, and capped with low-permeable clay.

Consistent with results from previous years, several of the wells at this basin had levels of chlorinated volatile organics, including tetrachloroethylene and trichloroethylene, above their DWS in 1995. Lead, nickel, and thallium were above their DWS in one well each. Five wells had elevated levels of specific conductance, two had elevated pH, and one had elevated alkalinity. These parameter results may be the effect of grout contamination.

New TNX Seepage Basin

The new TNX seepage basin, in the east section of T-Area across Road A-4.7 from the TNX process area (figure 10-13, page 173), replaced the old TNX seepage basin and operated from 1980 to 1988. The new basin is part of the TNX Area Operable Unit and will be characterized in accordance with the RFI/RI work plan for that unit. The work plan was submitted to regulators on November 14, 1995, and characterization activities were scheduled to begin on January 31, 1996.

Results during 1995 were very similar to those of recent years. No radioactive or chemical constituents were detected above their DWS, but specific conductance was elevated in one sidegradient/upgradient well.

Old F-Area Seepage Basin

The old F-Area seepage basin, a RCRA/ CERCLA unit and the first seepage basin constructed in F-Area, was used for disposal of wastewater from the canyon building from November 1954 until May 1955, when it was abandoned. The basin is north of F-Area

(figure 10-7, page 167). During operation, the seepage basin received a variety of wastewaters, including evaporator overheads, laundry wastewater, and an unknown amount of chemicals. For three months in 1969, spent nitric acid solutions used to etch depleted uranium were discharged to the basin. In 1984, low-level contaminated water was released to the basin.

A revised RFI/RI work plan was submitted to EPA and SCDHEC in February 1993, and characterization was initiated during that year. A report of a unit assessment at the basin was submitted in July 1994.

Groundwater monitoring results in 1995 were consistent with those of previous years at this site. Gross alpha and tritium were above their standards in three wells. Gross beta, iodine-129, and strontium-90 were above their standards in two wells, and uranium-233/234 and uranium-238 were above their standards in one well. Nitrate-nitrite as nitrogen, which was elevated in two wells, was the only chemical constituent exceeding its DWS. Specific conductance was elevated in five wells, and pH exceeded the acidic standard in two wells.

Old TNX Seepage Basin

The old TNX seepage basin, in the southwest corner of T-Area (figure 10-13, page 173), received waste from pilot-scale tests conducted at TNX from 1958 to 1980. In 1981, the basin wall was breached and the impounded water was drained into the adjacent wetlands. The basin then was backfilled with a sand and clay mixture, and the top was capped with clay. This basin is a RCRA/CERCLA unit and is part of the TNX Area Operable Unit. See "New TNX Seepage Basin" for more information on the unit.

During 1995, nitrate-nitrite as nitrogen exceeded its DWS in one well at this site. Elevated levels of specific conductance were detected in three wells, and TDS was elevated in one well. Carbon tetrachloride exceeded its DWS in two wells, as did trichloroethylene in four wells and tetrachloroethylene in one well. Tritium, which was above DWS in one well, was the only radioactive constituent detected above standards.

P-Area Reactor Seepage Basins

These basins are southwest of the reactor building (figure 10-9, page 169). In 1995, tritium exceeded its DWS in six of the seven wells monitoring these basins, as it generally has in all the wells in the past. Lead was detected above its DWS in two wells.

R-Area Reactor Seepage Basins

On November 8, 1957, an experimental fuel element failed during a calorimeter test in the emergency

section of the R-Area disassembly basin. Following this incident, the original seepage basin received approximately 2,700 Ci of gross beta activity, including strontium-90 and cesium-137, each of which has a half-life of about 30 years. Much of the released radioactivity was contained in that basin, which was backfilled in December 1957. Five more basins were put into operation in 1957 and 1958 to assist in containing the radioactivity.

In 1960, Basins 2 through 5 were closed and backfilled. The ground surface above Basins 1 through 5 was treated with herbicide and covered with asphalt. In addition, a kaolinite cap and dike were constructed over and around Basin 1 and the northwest end of Basin 3 to minimize lateral movement of the radioactive contamination. Basin 6, which received water directly from the disassembly basin from 1960 until 1964, was backfilled in 1977. The basins are northwest of R-Area (figure 10-10, page 170).

A revised RFI/RI work plan for this RCRA/CERCLA unit was submitted in May 1995.

Cadmium and lead exceeded their DWS in numerous wells during 1995. Gross beta was above its screening standard in many of the wells, and gross alpha was elevated in one well. Mercury and chromium, which were detected above their DWS in 1994, were not elevated in 1995. Tritium exceeded its DWS in two wells. Levels of thallium, low pH, and specific conductance exceeded their standards in one well each.

These results are consistent with those found in recent years, when the number of wells with elevated constituents increased above past years. Total alpha-emitting radium, which had been above the proposed DWS for radium-226 in 34 wells during 1993, did not exceed that standard in any wells during 1995. Strontium-90, which had been above its proposed standard in several wells during 1993, was elevated in four wells in 1995.

Savannah River Laboratory Seepage Basins

The Savannah River Laboratory seepage basins (figure 10-11, page 171)—located across the road from the Savannah River Technology Center (SRTC), formerly the Savannah River Laboratory—received low-level radioactive laboratory wastewater through underground drains until they were taken out of service in October 1982. Two basins were put into operation in 1954; two more were added in 1958 and

1960, respectively, to provide additional holding capacity.

An exception to the practice of discharging only low-level alpha or beta-gamma wastewater was made in 1971, when 0.68 Ci of curium from a leaking separator pit in the Savannah River Laboratory radioactive waste tanks was disposed of in the basins. Approximately 34 million gallons of wastewater were discharged to the basins during their operating life.

The basins are a RCRA/CERCLA unit. A closure plan revision was submitted to SCDHEC for review in December 1993. The closure will consist of placement of a RCRA-style cap over the basin.

In 1995, chlorinated volatile organics—specifically, tetrachloroethylene and trichloroethylene—were detected above their DWS in several wells at this site. Tritium was above its DWS in three wells and plutonium-238 in one well. Specific conductance was elevated in one well and pH in two wells. These results are similar to those of previous years.

Mercury was above its DWS in one well for the second year in a row. Gross alpha, radium-228, and ruthenium-106, which were above their standards in 1994, were not elevated in 1995.

Operating Buildings and Facilities

F-Area Canyon Building and A-Line Uranium Recovery Facility

At the canyon building (figure 10-7, page 167), irradiated product from the reactors is dissolved using nitric acid, and the desired radionuclides are separated from fission products. At the A-Line uranium recovery facility, adjacent to the canyon building, uranium oxide is produced from uranyl nitrate.

In 1995, most of the groundwater monitoring results were similar to those of previous years. 1,2-dichloroethane exceeded its DWS in at least one well during the year; nitrate-nitrite as nitrogen was found above its DWS in two wells; and gross alpha, gross beta, total alpha-emitting radium, and tritium exceeded their standards in at least one well each. Strontium-90 was above its proposed DWS in two wells at this site, with activities up to 1,000 times the standard. Specific conductance was above its standard consistently in five wells, and alkalinity was above its standard in one well.

Results for lead were consistent with those of recent years, when this constituent was elevated in more wells than it had been previously.

F-Area Effluent Treatment Cooling Water Basin

The F-Area effluent treatment cooling water basin, south of F-Area (figure 10-7, page 167), receives diverted cooling water from the separations processes. The cooling water is sent from the basin to the F-Area and H-Area effluent treatment facility (ETF) if contaminated or to a permitted outfall if uncontaminated. The ETF, on the south side of H-Area, was placed in service in 1988 to treat wastewater formerly sent to the F-Area and H-Area seepage basins. In addition to cooling water, it also receives separations area stormwater runoff and condensed overheads from the evaporators in the tank farms. The treatment facility removes hazardous and radioactive contaminants from these low-level liquid wastes and concentrates them for immobilization as saltstone.

In 1995, as in previous years, no radioactive or chemical constituents were detected above their standards at the F-Area effluent treatment cooling water basin.

H-Area Auxiliary Pump Pit

The H-Area auxiliary pump pit facility will pump high-level radioactive sludge and precipitate from the H-Area tank farm to the S-Area low-point pump pit en route to the vitrification facility. When the pumps are shut down, this facility at the east end of H-Area (figure 10-7, page 167) will collect the solution in a temporary holding tank via gravity flow lines.

No chemical or radioactive constituents were detected above their standards at this site in 1995.

H-Area Canyon Building

As in F-Area, materials from the reactors are dissolved at the canyon building (figure 10-7, page 167), and the desired radionuclides are separated from waste products.

In 1995, tritium exceeded its DWS in four wells monitoring this site. Tetrachloroethylene, trichloroethylene, and pH were above their standards in one well each. Specific conductance was elevated in four wells. These results are similar to those of previous years, although lead, which was above its standard in 1994, was not elevated during 1995.

H-Area Effluent Treatment Cooling Water Basin

See "F-Area Effluent Treatment Cooling Water Basin." The H-Area effluent treatment cooling water basin is southwest of H-Area (figure 10-7, page 167).

As in recent years, all four wells consistently had levels of tritium above its DWS. No chemical or other radiological constituents were detected above their standards.

K-Area Tritium Sump

A single well, installed in 1992, monitors the water table just west of the K-Area reactor building (figure 10-8, page 168). The well was placed near the K-Area process water storage tank, which stores water collected in sumps within the K-Area reactor building. Tritium activity in this sump water has been reported at greater than 5 Ci/mL.

In 1995, tritium activity was above its DWS, as it has been since the groundwater below the K-Area tritium sump was first monitored in 1992. No other constituents were detected above their standards.

N-Area Hazardous Waste Storage Facility

Building 645-N of the hazardous waste storage facility has been in service since 1983, 645-2N since 1987, and 645-4N since 1984. Buildings 645-N and 645-4N contain hazardous waste, and building 645-2N contains mixed waste (a mixture of low-level radioactive waste and hazardous waste). Wastes are stored inside the buildings in drums placed on diked concrete floors designed to contain liquid spills. This facility, an active RCRA-regulated unit operated under SCDHEC Hazardous Waste Permit SC1 890 008 989, is northwest of N-Area (figure 10-12, page 172).

In 1995, as in recent years, no radioactive or chemical constituents were detected above their standards in the groundwater below these buildings.

S-Area Facilities

S-Area (figure 10-7, page 167) contains several facilities for processing high-level radioactive waste from the F-Area and H-Area tank farms into borosilicate glass solidified within stainless steel canisters. The glass will be stored temporarily in specially designed storage buildings within S-Area. Eventual permanent disposal is expected to be in an offsite federal geologic repository.

In 1995, as in previous years, tritium exceeded its DWS in two wells, and tetrachloroethylene and trichloroethylene exceeded their DWS in one well.

S-Area Low-Point Pump Pit

The S-Area low-point pump pit, at the south end of S-Area (figure 10-7, page 167), will receive high-level radioactive sludge and precipitate from the H-Area tank farm and pump it to the defense waste processing facility (DWPF) vitrification building; it

also will receive waste being recycled from the vitrification building back to the tank farm. As at the H-Area auxiliary pump pit, when the pumps are shut down, the sludge and precipitate remaining in the line will drain back into a temporary holding tank via gravity flow lines.

Tritium exceeded its DWS in one well during 1995. No other radiological or chemical constituents have been detected above their standards at this site since 1989.

S-Area Vitrification Building

The S-Area vitrification building (figure 10-7, page 167), also known as the S-Area canyon building, contains the process and auxiliary equipment to incorporate high-level radioactive waste into leach-resistant glass. The facility will begin radioactive operations in April 1996.

Two major compliance agreements affect the site—the 1991 SRS Land Disposal Restrictions Federal Facility Compliance Agreement between DOE and EPA and the 1993 FFA. After startup, removal of the waste stored in the tank farms is expected to require 24 years.

In 1995, tritium exceeded its DWS in three wells downgradient to sidegradient of the building. Specific conductance was elevated in the same three wells and one additional well, and alkalinity was elevated in one well.

Z-Area Low-Point Drain Tank

The Z-Area low-point drain tank facility, in southeastern S-Area (figure 10-7, page 167), receives low-level radioactive salt solution from the H-Area tank farm and pumps it to the Z-Area salt solution holding tank. When the H-Area pump is shut down, the low-point drain tank can collect the solution remaining in the lines via gravity flow.

In 1995, as in previous years, tritium in both wells monitoring this facility was the only chemical or radiological constituent detected above its DWS. Specific conductance was elevated above its standard in one well.

Z-Area Saltstone Manufacturing and Disposal Facility

The Z-Area saltstone manufacturing and disposal facility (figure 10-7, page 167) processes and permanently disposes of low-level radioactive salt solution supernatant from the underground storage tanks at F-Area and H-Area and from ETF

concentrate. Z-Area began radioactive operations in June 1990.

In November 1992, a tank in the Z-Area saltstone manufacturing and disposal facility overflowed, and a portion of the liquid leaked from the building into a storm drain. Approximately 2 gallons of solution reached a drainage pipe that flows into a series of sedimentation basins and eventually into McQueen Branch. Sediment samples showed small amounts of cesium-137 exceeding those amounts observed in the Savannah River, but within the activity ranges in site streams.

In 1995, specific conductance was elevated above its standard in two wells and alkalinity in one well, while pH exceeded the basic standard in two wells.

Plume Monitoring

A-Area and M-Area

In addition to the groundwater monitoring conducted at specific locations in A-Area and M-Area, numerous plume definition wells also monitor a 5-square-mile area to assess the extent of volatile organic contamination (figure 10-11, page 171). The first plume definition wells were installed soon after discovery of the contamination in June 1981.

The plume definition well network extends from the region north of SRTC, between Road 1 and the SRS boundary, south to wells near the miscellaneous chemical basin and the metals burning pit, and from Tims Branch in the east toward the Silverton Road waste site in the west. The plume encompasses approximately three square miles and consists primarily of trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane.

1995 Groundwater Monitoring Results The groundwater plume beneath A-Area and M-Area was characterized during 1995, as in the past, by chlorinated organic solvent concentrations—primarily trichloroethylene and tetrachloroethylene—at or above DWS. Other volatile chlorinated organics, such as carbon tetrachloride, chloroform, and 1,1-dichloroethylene, also were detected above their DWS in a few wells.

The highest concentrations of chlorinated organic solvents were detected in many M-Area aquifer and upper and lower Lost Lake aquifer zone wells in the vicinity of known point sources in A-Area and M-Area. From 1990 through 1995, trichloroethylene was reported above its DWS in wells within approximately 2,000 feet of the nearest SRS boundary. Concentrations of chlorinated organic solvents and chlorinated volatile organics in the

Middle Sand aquifer zone of the Crouch Branch confining unit and the Crouch Branch aquifer of the Dublin-Midville Aquifer System are nearly as widespread as in the M-Area aquifer and Lost Lake aquifer zones.

In the M-Area aquifer zone, metals (lead and thallium), nitrate-nitrite as nitrogen, and radionuclides (including gross alpha, gross beta, plutonium-238, and total alpha-emitting radium) exceeded DWS in a few wells. Elevated levels of alkalinity, basic pH, and specific conductance in a few wells in this zone indicate the possible influence of well grout. A pH value below the acidic standard also was detected in one M-Area aquifer zone well.

Groundwater monitoring results in the upper and lower Lost Lake aquifer zone wells are consistent with those from the M-Area aquifer zone. Specific conductance, elevated pH, alkalinity, and nitrate-nitrite as nitrogen were detected above their standards in several wells in each zone. Lead, mercury, nitrate as nitrogen, and radionuclides (gross alpha, gross beta, total alpha-emitting radium, and tritium) exceeded their standards in four or fewer wells in the upper Lost Lake aquifer zone. Gross beta, mercury, pH, and tritium exceeded DWS in two or fewer wells in the lower Lost Lake aquifer zone.

Tetrachloroethylene was detected during 1995 above its DWS in approximately one-fifth of the Middle Sand aquifer zone wells and one-eighth of the Crouch Branch aquifer wells, as was trichloroethylene in approximately half the wells in the Middle Sand aquifer zone and more than one-fourth of those in the Crouch Branch aquifer zone.

Trichloroethylene was detected above its DWS in seven wells in the Crouch Branch aquifer in 1995. Constituents detected above their standards in a few wells in the Middle Sand aquifer zone were lead, nickel, pH, and specific conductance. Constituents detected above their standards in two or fewer wells in the Crouch Branch aquifer included cadmium, mercury, and pH.

The distribution of trichloroethylene in the groundwater generally is linked to hydraulic gradients and proximity to point sources. Low horizontal gradients in the M-Area aquifer zone and downward vertical gradients from the water table to the Dublin-Midville zone have resulted in the downward transport of trichloroethylene into lower zones. Horizontal flow in the Lost Lake aquifer zone to the south and southwest has resulted in the transport of trichloroethylene into regions in this zone downgradient of surface point sources.

Separations and Waste Management Areas

A number of wells were installed in the separations areas (figure 10-7, page 167) in 1951 and 1952. These wells, which range from approximately 15 to 90 feet in depth, measure water table elevations and monitor for radioactive constituents (gross alpha, gross beta, and tritium) in the groundwater in and around F-Area and H-Area. They have steel casings that could affect the metal concentrations in the water.

Lead and cadmium exceeded their DWS in nearly all the wells monitoring this plume in 1995. Tritium was detected above its DWS in five wells; gross alpha exceeded its DWS in one well; and specific conductance was elevated in two wells. These results are similar to those obtained since 1993, when these wells were monitored for chemical constituents for the first time.

T-Area (TNX)

Because operations in this area have caused a contaminant plume, primarily of volatile organics, TNX groundwater (figure 10-13, page 173) is a RCRA/CERCLA unit. An Interim Action Proposed Plan and an Interim Record of Decision were issued for the TNX Groundwater Operable Unit in 1994. The Interim Record of Decision's objectives are to

- reduce potential risk to human health and the environment
- maintain risk at acceptable levels to the onsite worker at the seep line
- remove volatile organic compound (VOC) contamination in the groundwater near the plume core (remediate the 500 parts per billion and greater tetrachloroethylene concentration)
- stabilize the plume by inhibiting further migration of elevated levels of VOCs toward a swamp (that drains into the Savannah River) located southwest of T-Area
- prevent further aquifer degradation

The selected remedy to accomplish the Interim Record of Decision goals is the hybrid groundwater corrective action, which consists of "pump and treat," a proven technology for the treatment of groundwater contaminated with VOCs, and an airlift recirculation well, which is considered an innovative technology. The pump and treat technology is scheduled to be implemented by September 1996. The Airlift Recirculation Well has been installed and is undergoing testing and evaluation. It could begin operations as early as March 1996.

During 1995, nitrate or nitrate-nitrite as nitrogen exceeded DWS standards in three of the TNX

assessment wells. Elevated levels of trichloroethylene were found in two wells. The trichloroethylene levels were in wells in the vicinity of the swamp. Elevated levels of specific conductance were detected in several wells.

Carbon tetrachloride and tetrachloroethylene, which have been found above DWS in wells downgradient of the new TNX seepage basin and upgradient of the old TNX seepage basin in past years, were not elevated during 1995.

Radioactive Waste Storage and Disposal Facilities

Burial Grounds

The burial grounds, located in E-Area between F-Area and H-Area in the center of SRS (figure 10-7, page 167), have been used for storage and disposal of radioactive solid waste produced at SRS or shipped from other facilities since 1952. The original area, known as the old burial ground, contains low-level alpha and beta-gamma trenches, intermediate-level beta-gamma trenches, and alpha waste trenches. As the trenches were filled, they were covered with soil. When the old burial ground was filled in 1974, operations moved to the adjacent LLRWDF.

Until 1965, transuranic (TRU) waste was placed in plastic bags and cardboard boxes and buried in earthen trenches. Between 1965 and 1974, lower level TRU waste was buried unencapsulated in trenches, and higher level TRU waste was buried in retrievable concrete containers or encapsulated in concrete. Since 1974, TRU wastes contaminated with greater than 0.01 Ci/g have been stored in watertight containers on concrete pads with monitoring sumps. TRU waste storage pads 1-19 are on the FFA's list of RCRA-regulated units.

Since mid-1984, newly generated low-level beta-gamma waste has been placed in metal boxes or metal drums. Currently, it is disposed of in engineered trenches and covered with at least 4 feet of soil. Some wastes that do not have forms that are easily placed in containers are disposed of in shallow land-burial slit trenches.

Mixed wastes (low-level radioactive waste and hazardous waste) stored or disposed of within the old burial ground and portions of the LLRWDF include cadmium, lead, mercury, and tritiated pump oil. Some of the waste is contained in welded stainless steel containers or metal drums and stored within concrete cylinders. Degraded radioactive organic solvents and tritiated pump oil have been stored in 22 underground storage tanks in the old burial ground. In addition,

two areas of the old burial ground were used for incineration of solvents.

The burial ground complex, comprising the old burial ground, solvent storage tanks S01-S22, and the portions of the LLRWDF not otherwise regulated, is a RCRA/CERCLA unit. A Revision 2.0 RFI/RI work plan was submitted in December 1994. Field investigations were conducted at the complex from 1993 to 1995; three reports on separate phases of the investigations were submitted to EPA and SCDHEC in 1995.

Solvent storage tanks S23-S30 are RCRA-regulated units. The tritiated pump oil from mixed waste storage tank S32 has been removed and incinerated in the beta-gamma incinerator; closure under RCRA of that tank by grouting was certified by SCDHEC in September 1988.

The newer burial ground, the LLRWDF, contains two regulated sections. Closure under RCRA of one section referred to as the MWMF, where disposal of mixed waste was halted in 1986, was certified by SCDHEC in April 1991. A field investigation plan was submitted in September 1993 and a Revision 3 RCRA Part B post-closure permit application was submitted in November 1995. A new corrective action plan is being developed in connection with Revision 3. Revision 1 of the field investigation plan, submitted in June 1994, outlines all field characterization activities to identify groundwater contamination horizontally and vertically away from the burial ground complex.

Generally, since March 1986, only radioactive wastes certified as free of hazardous materials have been accepted for disposal in the burial grounds. However, mixed wastes in the form of rags and wipes used for radioactive decontamination that contained RCRA-listed solvents were disposed of until January 1990 in portions of the LLRWDF outside the MWMF. A Revision 1 closure and post-closure plan for the solvent rags portion—10 discrete areas comprising approximately 21 noncontiguous acres—was submitted to SCDHEC in January 1994.

The sections of the LLRWDF currently being operated, known as the Solid Waste Disposal Facility (SWDF), contain trenches for only radioactive waste. Concrete vaults, known as the E-Area vaults, have been constructed east and north of the LLRWDF for disposal of solid radioactive waste. The first waste was placed there in September 1994.

Mixed waste storage building 643-29E, within the boundaries of the LLRWDF, has been in use since March 1987. A review of the operating procedures for the adjacent mixed waste storage building,

643-43E, was completed in July 1995, and the facility began receiving waste later that same month. Both buildings are RCRA-regulated units. A hazardous waste/mixed waste disposal facility is being proposed for permanent disposal of hazardous and mixed wastes in specially engineered vaults. RCRA Part B permitting issues, a review of the site treatment plan for mixed wastes, and funding deferrals have delayed construction of the hazardous waste/mixed waste vaults, which were scheduled to begin operation in 1999.

Burial Ground Expansion (E-Area Vaults) During 1995, one well at this site in the northern section of E-Area (figure 10-7, page 167) could not be sampled because its purge water requires special disposal procedures because previous levels of pH exceeded its standard.

Results for these wells generally were similar in 1995 to those of the past several years. Tritium remains in excess of its DWS in several wells, and lead and trichloroethylene exceeded their standards in one well each.

During 1995, as in recent years, alkalinity, pH, and specific conductance exceeded their standards in at least one well monitoring the Gordon aquifer zone.

Alkalinity, TDS, and specific conductance in excess of their standards, and pH in excess of the basic standard in at least one well in the Upper Three Runs aquifer zone suggest the continued influence of well grout, as do similar results during recent years in the Gordon aquifer zone wells.

Hazardous Waste/Mixed Waste Disposal Facility This proposed site is northwest of the burial ground expansion (figure 10-7, page 167). In 1995, as in recent years, tritium was detected above its DWS in two wells. Lead and TDS, which have been elevated in past years, were not above standards in 1995.

Old Burial Ground The old burial ground is in the southern portion of E-Area (figure 10-7, page 167). In 1995, as in recent years, most wells monitoring the Upper Three Runs zone at this site had tritium at or above its DWS. The highest tritium activity, up to four orders of magnitude above the DWS, was recorded in samples from wells within the facility's boundaries, especially along the southern border of the facility. Gross alpha and gross beta were above their applicable standards in groundwater below the old burial ground. Some metals exceeded their DWS in one or more wells, as in past years; antimony was elevated in three wells, mercury in five, lead in 11, and cadmium in 17.

Concentrations of trichloroethylene above its DWS were reported for several wells in the Upper Three Runs zone, generally in the southwest corner of the old burial ground. Tetrachloroethylene was above its DWS in four wells, and chloroethane exceeded its DWS in two wells. One well was not sampled during 1995 because previous trichloroethylene values were high enough that its purge water requires containerization.

Several wells within the Upper Three Runs and Gordon aquifer zones showed levels of alkalinity, pH, and specific conductance above their respective standards. Three wells were not sampled during 1995 because previous pH values exceeded standards and their purge water would require containerization. Three sampled wells within the Upper Three Runs zone had pH in excess of the basic standard, and two had pH in excess of the acidic standard during 1995.

In 1995, the extent and location of the tritium and chlorinated solvent plumes changed little from previous years.

Radioactive Waste Burial Ground A single network of wells monitors the LLRWDF, which includes the MWMF. Tritium exceeded its DWS in many Upper Three Runs zone wells by as much as three orders of magnitude. Gross alpha exceeded its standard in one Upper Three Runs zone well, and carbon-14 in another.

Concentrations of trichloroethylene were detected above DWS in several wells. Tetrachloroethylene was detected above its DWS in at least one well. Lead and antimony were found above their DWS in one well each. Elevated pH above the basic standard and elevated specific conductance were detected in several wells, while elevated alkalinity, TDS, and pH above the acidic standard were found in three wells.

In the Gordon aquifer zone, alkalinity, pH, and specific conductance were elevated in most wells. TDS was above its standard in one well. Tritium and gross beta were above their DWS in one well. Benzene, which was detected above its DWS in 1994, was not elevated in 1995.

These results are similar to those obtained in recent years.

Tank Farms

Liquid radioactive wastes are stored and processed at the tank farms, which are comprised of subsurface tanks containing high-level aqueous radioactive wastes in the form of sludges, supernatant liquid of varying salt concentrations, and saltcake. Approximately 129 million liters of waste are stored in the tanks.

The high-level liquid waste volume is reduced in the tank farm evaporators. Certain tanks are used for pretreatment of the wastes before they are processed at the DWPF into saltstone (low-level waste) or a glass form (high-level waste). As described earlier, saltstone manufacturing and disposal is ongoing; vitrification was tested during 1995, and the DWPF will begin production operations in 1996.

Pretreatment processes at the tank farms include in-tank precipitation and extended sludge processing.

More information about the function of the tank farms may be found in previous sections of this chapter, including the discussions of the F-Area effluent treatment cooling water basin, the H-Area auxiliary pump pit, S-Area, the S-Area low-point pump pit, the S-Area vitrification building, the Z-Area low-point drain tank, and the Z-Area saltstone manufacturing and disposal facility.

F-Area Tank Farm The F-Area tank farm, in the southwest portion of F-Area (figure 10-7, page 167), is comprised of 22 subsurface tanks. In 1961, Tank 8 was overfilled, causing soil and possible groundwater contamination.

During 1995, cadmium, gross alpha, and lead were detected above their DWS, and gross beta and specific conductance were elevated above their standards in many of the wells at the F-Area tank farm. Tritium was above its DWS in two wells. Mercury and nitrate-nitrite as nitrogen were above their DWS in at least one well each, and pH exceeded the basic standard in two wells.

Because of previous high levels of total organic halogens, these wells were analyzed for volatile organic compounds for the first time during fourth quarter 1994. High levels of trichlorofluoromethane (Freon 11) were reported in two wells in 1994, and sampling was performed again in first quarter 1995. This compound, which does not have a DWS, may have been accidentally released from a compressor in the area, or it may have been used as a degreaser in past years. Resampling for confirmation in 1995 again indicated elevated levels of trichlorofluoromethane in two wells.

High specific conductance and low pH values in some wells indicate probable grout contamination.

Because of restrictions on the disposal of purge water, wells at the tank farms are bailed and not purged.

H-Area Tank Farm The H-Area tank farm, at the south end of H-Area (figure 10-7, page 167), is comprised of 29 subsurface tanks. In 1960, Tank 16 leaked an unknown quantity (a few tens of gallons to

a few hundred gallons) of waste into the soil. The tank's remaining waste was removed by 1972.

Revision 2 of a RCRA/CERCLA work plan for Tank 16 was submitted to EPA and SCDHEC in November 1992. Characterization activities began in August 1993 and continued in 1994. To fulfill the Tank 16 RFI/RI work plan requirements, 40 new wells were installed during 1994.

Several other releases of waste from H-Area tanks have occurred, including a spill of approximately 100 gallons at Tank 13 in 1983. In 1989, approximately 500 pounds of volume-reduced waste leaked from a transfer line at Tank 37. The leak sites have been cleaned up or stabilized to prevent the further spread of contamination.

Cadmium, lead, and tritium were above their DWS in numerous wells in 1995. Gross alpha was above its DWS in two wells during the year, and gross beta exceeded its screening standard in three wells. Iodine-129 and ruthenium-106 exceeded their primary or proposed DWS in one well each. Cesium-137 and trichloroethylene, which had been detected above their DWS in 1994, were not elevated in 1995.

Specific conductance was elevated in more than half of the H-Area tank farm wells. Eight wells had pH levels above the basic standard; one had levels above the acidic standard; alkalinity was elevated in three wells; and TDS was above its standard in two wells.

Sanitary Landfill and Interim Sanitary Landfill

The sanitary landfill, south of Road C (figure 10-16, page 176), began receiving waste from office, cafeteria, and industrial activities during 1974. Materials such as paper, plastics, rubber, wood, cardboard, rags, metal debris, pesticide bags, empty cans, carcasses, asbestos in bags, and sludge from the site's wastewater treatment plant are placed in unlined trenches and covered daily with soil or a fabric substitute. The original section of the landfill and its southern expansion, with a total area of approximately 54 acres, have been filled. Operations at the portion of approximately 16 acres known as the northern expansion, or the interim sanitary landfill, were discontinued in November 1994.

Sanitary landfills are intended to receive only nonradioactive, nonhazardous waste. However, until October 1992, some hazardous wastes (specifically, solvent-laden rags and wipes used for cleaning, decontamination, and instrument calibration) were buried in portions of the original 32-acre landfill and its southern expansion. As required by a settlement

agreement between DOE and SCDHEC, a RCRA post-closure permit application for the original landfill and its southern expansion was submitted to SCDHEC in March 1993.

Monitoring at the interim sanitary landfill is governed by SCDHEC Modified Municipal Solid Waste Permit 025500-1120, which became effective in February 1995.

During 1995, trichloroethylene and chloroethene exceeded their DWS, and specific conductance was elevated in numerous wells in the original sanitary landfill and its southern expansion. Tritium and tetrachloroethylene were detected above their DWS in eight and nine wells, respectively, and alkalinity was above its standard in 11 wells. TDS was elevated in three wells and benzene in five wells, and pH exceeded its acidic standard in 10 wells. Tritium and benzene have been detected above their DWS for several years.

Other constituents reported above their DWS in at least two wells in the original landfill and southern expansion were mercury, 1,2-dichloroethane, 1,4-dichlorobenzene, cis-1,2-dichloroethene, and 1,1-dichloroethylene, which was elevated in one downgradient well in the interim sanitary landfill as well. These chlorinated volatile organics have been above their DWS consistently for several years.

Radium-228 and cadmium were elevated in one well each in 1995. Lead, which has been detected above its DWS in past years, was not elevated. Eleven wells monitoring this site could not be sampled because they required purge-water containerization due to the presence of mercury in the wells.

Gross alpha was detected above its DWS in four wells in the original sanitary landfill and one well in the interim sanitary landfill. Thallium was above its standard in four interim sanitary landfill wells, three of which are downgradient. In 1994, gross alpha was the only constituent above its DWS in the interim sanitary landfill, and in earlier years, no constituents exceeded their standards.

Sludge Application Sites

These sites originally were the subject of a research program using domestic sewage sludge to reclaim borrow pits and to enhance forest productivity at SRS. In 1980, as permitted by SCDHEC, sludge was applied to the following application sites: K-Area, Kato Road, Lower Kato Road, Orangeburg, PAR Pond, Road F, Sandy (Lucy), Second PAR Pond Borrow Pit, and 40-Acre Hardwood. After sludge was applied to the sites, hardwoods and pines were

planted to quantify the effectiveness of the sludge as a fertilizer and soil conditioner.

As permitted by SCDHEC IWP-175, sludge from Aiken and Augusta municipal wastewater treatment plants was applied to the following sites: F-Area, H-Area, Kato Road, Lower Kato Road, Orangeburg, Road F, Sandy (Lucy), Second PAR Pond Borrow Pit, and 40-Acre Hardwood. All are on the FFA site evaluation list. Wastewater sludge was applied to the K-Area and PAR Pond sites in 1981 and 1988. All these sludge application permits have expired; revegetating of the sites is continuing.

In November 1993, SCDHEC approved the discontinuation of groundwater monitoring at the Kato Road, Lower Kato Road, Orangeburg, Road F, Sandy (Lucy), and 40-Acre Hardwood sites because they have not received applications of sewage sludge since 1981, and historical monitoring results show no impact from sludge applications. Monitoring was canceled after first quarter 1994.

F-Area Sanitary Sludge Land Application Site

The F-Area sanitary sludge land application site covers 8 acres southeast of F-Area (figure 10-7, page 167). Sludge from SRS sanitary wastewater treatment plants was disposed of at this location from 1987 until third quarter 1990. A closure plan was approved for the site in November 1993. Groundwater monitoring will continue because of the proximity of the wells to the old burial ground.

In 1995, as in previous years, lead and copper were above their DWS in one or two wells. Tritium also exceeded its DWS in two wells, and specific conductance was above its standard in one well.

H-Area Sanitary Sludge Land Application Site

Sewage sludge from SRS sanitary wastewater treatment plants was disposed of at this 13-acre site southeast of H-Area (figure 10-7, page 167) from November 1990 to May 1992. A closure plan for the site was approved in November 1993. In 1995, lead was the only analyte exceeding its DWS at the site; it was elevated in only one well, as it has been since 1989.

K-Area Sludge Land Application Site (Formerly K-Area Borrow Pit)

In 1981, sludge from Aiken and Augusta municipal wastewater treatment plants was applied to the K-Area and PAR Pond borrow pits under SCDHEC permit IWP-175. In 1988, the N-Area sanitary sewage sludge lagoon was closed, and the lagoon sludge was applied to the K-Area and PAR Pond

borrow pits. In 1989, the K-Area location, now called the K-Area sludge land application site, which covers 17 acres southeast of K-Area (figure 10-8, page 168), was declared a RCRA/CERCLA unit because of the presence of chlordane in the lagoon sludge applied to the site.

In 1995, no analytes were detected above standards. Lead generally had been the only analyte reported above its DWS in previous years.

PAR Pond Sludge Land Application Site (Formerly PAR Pond Borrow Pit Site)

In 1981, sludge from Aiken and Augusta municipal wastewater treatment plants was applied to the K-Area borrow pit and to this site under SCDHEC permit IWP-175. In 1988, the N-Area sanitary sewage sludge lagoon was closed, and the lagoon sludge was applied to the K-Area and PAR Pond borrow pits. In 1989, this site, covering 22 acres south of PAR Pond (figure 10-9, page 169), became a RCRA/CERCLA unit because of the presence of chlordane in the lagoon sludge applied to the site. Chlordane never has been detected in the groundwater below this site.

In 1995, chromium, gross alpha, gross beta, lead, and specific conductance were detected above their standards in one well each. Chromium, gross alpha, and gross beta had been above their standards in past years. Radium-226, which was above its standard in 1994, was not elevated in 1995.

Second PAR Pond Borrow Pit Sewage Sludge Application Site

This site is in the eastern portion of SRS, on the east edge of PAR Pond (figure 10-9, page 169). In 1995, gross alpha exceeded its DWS in all three wells. Gross beta was detected above its standard in one well. These results were consistent with those of past years. During 1993, lead had been detected above its DWS in two wells for the first time in at least 5 years; it was not elevated during 1995. Radium-226, which was elevated in 1994, was not detected above its standard in 1995.

Other Sites

B-Area Gas Station

Elevated benzene, which could be the result of old underground gasoline or diesel storage tanks, has been detected near B-Area (figure 10-16, page 176). EMS has inspected the area and believes there may be two underground storage tanks southeast of B-Area. The first suspected tank appears to be at an abandoned gas station between Kato Road and Road

C-2. The second appears to be an old diesel tank in front of a storage and laboratory facility.

Groundwater from the well cluster east of this site was analyzed only on the basis of previous results above flagging criteria in 1995. No radiological or chemical constituents exceeded their standards at this site.

Chemicals, Metals, and Pesticides Pits

The chemicals, metals, and pesticides pits were used from 1971 to 1979 to dispose of drummed oil, organic solvents, and small amounts of pesticides and metals. In 1984, the pits, which are west of Road C approximately 2 miles southeast of N-Area (figures 10-8, page 168, and 10-12, page 172), were excavated to form two trenches, backfilled, and capped. During excavation, most of the contaminated material (liquid in original drums, free liquid drummed during excavation, and contaminated soil) was moved to the hazardous waste storage facility. The chemicals, metals, and pesticides pits are a RCRA/CERCLA unit. Soils and groundwater characterization reports were submitted in the second half of 1995.

Tetrachloroethylene and trichloroethylene were detected above their DWS in several wells monitoring this site in 1995. Specific conductance also exceeded its standard in numerous wells, and pH exceeded the basic standard in three wells, probably because of the presence of naturally occurring carbonate rock. Lead was above its DWS in two wells and lindane above its in one well. These results are similar to those of previous years. Gross alpha, which had exceeded its DWS for the first time in several years in 1994, was not elevated during 1995.

D-Area Oil Disposal Basin

The D-Area oil disposal basin was constructed in 1952 and received waste oil products from D-Area that were unacceptable for incineration in the powerhouse boilers. These waste oils may have contained hydrogen sulfide, chlorinated organics, or other chemicals. In 1975, the oil basin was removed from service and backfilled with soil. The basin is a RCRA/CERCLA unit also known as the D-Area oil seepage basin. The site, north of D-Area (figure 10-13, page 173), is monitored according to the RFI/RI work plan. An interim action proposed plan was submitted to EPA and SCDHEC in November 1993 to remove (1) drums located within the basin; (2) debris buried at the site; and (3) soils visibly contaminated by the leaking drums (visible threat source material). Pending regulatory approval—originally anticipated in 1994—the

interim action is expected to be completed by May 1996.

In 1995, tetrachloroethylene and trichloroethylene consistently were detected above their DWS in one well monitoring this site. Specific conductance exceeded its standard in the same well. These results are similar to those obtained since 1988.

K-Area Diesel Tank Spill

Following the discovery in 1989 of a leaking buried diesel supply line, most of the diesel-contaminated soil was removed from this area—in the center of K-Area, north of the K-Area disassembly basin (figure 10-8, page 168)—except where continued excavation would have jeopardized the structural integrity of an underground storage tank. Because some of the diesel-contaminated soil was left in place, SCDHEC required the installation of a monitoring well, which was removed from the sampling schedule in 1995.

L-Area Acid/Caustic Basin and L-Area Oil and Chemical Basin

From 1961 to 1979, the L-Area oil and chemical basin received small quantities of radioactive oil and chemical waste that could not be discharged to effluent streams, regular seepage basins, or the 200-Areas' waste management systems. The waste came from throughout SRS, primarily from the reactor areas and the contaminated-equipment workshop through a pipeline known to have leaked. The basin, a radiologically controlled area south of L-Area (figure 10-8, page 168), has been inactive since 1979.

Groundwater below the acid/caustic basin has been affected by its proximity to the oil and chemical basin. The two areas were combined as one operable RCRA/CERCLA unit in the RFI/RI Phase II work plan for the L-Area oil and chemical basin.

In 1995, carbon-14 exceeded its proposed DWS in two wells in this area—as it did in numerous wells in 1994, when it was elevated for the first time. Tetrachloroethylene and thallium were above their standards in several wells, and tritium was elevated in four wells. Gross beta and lead were detected above their DWS in one well each. As in previous years, alkalinity, specific conductance, and TDS were above their standards in some of the wells in this area, suggesting the influence of grout.

Miscellaneous Chemical Basin

The miscellaneous chemical basin, in operation by 1956, was closed and graded in 1974. No records

document the materials disposed of at this location, west of Road D near the A-Area metals burning pit (figure 10-11, page 171). However, soil gas investigations revealed volatile organics in the near-surface soils at the basin. It is assumed that the site was used for disposal of waste solvents, liquid chemical wastes, and possibly waste oil. The basin is inactive and, with the A-Area metals burning pit, is a RCRA/CERCLA unit.

Tetrachloroethylene and trichloroethylene were detected above DWS in several wells monitoring this site in 1995, and carbon tetrachloride was elevated in one well. Alkalinity, pH, and specific conductance were elevated in two wells, probably because of grout contamination. These results are similar to those that have been obtained since 1988. Gross alpha and gross beta were above their DWS in one well, as was lead. These results are similar to those obtained prior to 1993.

Motor Shop Oil Basin

This unlined basin was placed in service in 1977 to receive liquid effluent from the Motor Shop, including trace quantities of engine oil, grease, kerosene, ethylene glycol, and soap. All waste passed through an oil skimmer prior to discharge into the basin. All discharges to the basin were terminated in August 1983. The basin is inactive but collects rainwater during periods of heavy precipitation.

The basin is at the south edge of A-Area (figure 10-11, page 171), near NPDES Outfall A-14, a source of volatile organics. It is a RCRA/CERCLA unit.

Tetrachloroethylene and trichloroethylene were detected above their DWS in one well during 1995. These results are similar to those of previous years.

N-Area Diesel Spill

Repairs were completed in January 1995 to leaking tanks and distribution lines buried at the diesel fuel storage facility southeast of the hazardous waste storage facility in N-Area. The tanks were filled with inert material and the lines were disconnected. (figure 10-12, page 172). The initial phase of characterization of the diesel contamination was begun in 1995 and will be completed prior to May 1996, when a report is scheduled to be issued to regulators.

Results for tetrachloroethylene and trichloroethylene were above their DWS in several wells during 1995. Specific conductance exceeded its standard in one well, and pH exceeded its basic standard in one well. These results are similar to those obtained since the wells first were sampled in 1990.

N-Area Fire Department Training Facility

The fire department training facility, also known as the N-Area burnable-oil basin, is a shallow pit surrounded by an 18-inch-high asphalt dike. It was used from 1979 to 1982 by the SRS Fire Department to train personnel in the use of firefighting equipment. After this time, the area was excavated and backfilled. The facility, at the southeast end of N-Area near the Ford Building seepage basin (figure 10-12, page 172), is on the FFA site evaluation list.

The only constituents analyzed during 1995 were aluminum and total petroleum hydrocarbons; neither of these exceeded applicable standards during 1995.

N-Area Hydrofluoric Acid Spill

It is uncertain whether a spill occurred at the hydrofluoric acid spill area or if contaminated soil or containers were buried there. The spill or burial occurred prior to 1970, and an identification sign is the only evidence that material was released. This location, at the south end of N-Area near Road 3 (figure 10-12, page 172), is a RCRA/CERCLA unit.

During 1995, no radiological or chemical constituents had results above applicable standards at this site.

Road A (Baxley Road) Chemical Basin

The Road A chemical basin is reported to have received miscellaneous radioactive and chemical aqueous waste, but no records of the materials disposed of at the basin are available. The basin was closed and backfilled in 1973. Located east of D-Area (figure 10-13, page 173), it is a RCRA/ CERCLA unit.

During 1995, no radiological or chemical constituents exceeded their standards at this site. Lead had exceeded its DWS at this site consistently during the previous 5 years.

Silverton Road Waste Site

The Silverton Road waste site, south of Silverton Road (figure 10-11, page 171), was used for disposal of metal shavings, construction debris, tires, drums, tanks, and miscellaneous other items. The startup date

is unknown, and no records of waste disposal activities were kept. Operations at this location ended in 1974, and the waste material is covered with soil and vegetation. The site is a RCRA/CERCLA unit.

Soil and groundwater RFI/RI assessments at this waste site began in 1993 and concluded with the submission of a final quality control summary report in August 1994.

Trichloroethylene and carbon tetrachloride were detected above their DWS in two wells monitoring this site in 1995. Lead, which was elevated in recent years, was not found above its DWS during 1995. Alkalinity, specific conductance, and basic pH exceeded standards in one well. Ruthenium-106, which was detected above its proposed DWS in 1994, was not elevated in 1995.

TNX Burying Ground

The TNX burying ground was created to dispose of debris from an experimental evaporator that exploded at TNX in 1953. The buried material included contaminated conduit, tin, drums, structural steel, and depleted uranium. Although most of this material was excavated and sent to the LLRWDF between 1980 and 1984, an estimated 27 kg of uranyl nitrate remains buried at this location. The TNX burying ground, located within the T-Area fence (figure 10-13, page 173), is a RCRA/CERCLA unit and is part of the TNX Area Operable Unit. "New TNX Seepage Basin," page 146, has more information on the unit.

Specific conductance exceeded its standard in four wells during 1995 and nitrate-nitrite as nitrogen in three wells, while pH and TDS exceeded their respective standards in one well. Gross alpha was elevated in two wells and mercury in one. Trichloroethylene was above its DWS in four wells, tetrachloroethylene in one, and carbon tetrachloride in three.

During 1994, all constituents above standards occurred in one downgradient well. This well also contained elevated levels in 1995, along with other wells at the site.

Table 10-2 Aquifer and Gradient Assignments of Wells

Page 1 of 4

Location (Well Series)	Upper Saturated Zone Wells				Lower Zone Wells	Figure
	Up	Down	Side	Una ^a		
Acid/Caustic Basins						
F-Area (FAC)	1	2	4		4	10-7
H-Area (HAC)	1	2	1			10-7
K-Area (KAC)	2	3	4			10-8
P-Area (PAC)	2	3	1			10-9
R-Area (RAC)	1	1	2			10-10
Burning/Rubble, Rubble, and Metals Burning Pits						
A-Area Burning/Rubble Pits and A-Area Ash Pile (ARP)	1	2	2			10-11
A-Area Metals Burning Pit (ABP)	2	2	1		2	10-11
Burma Road Rubble Pit (BRR)	2	5	1		6	10-7
C-Area Burning/Rubble Pit (CRP)	2	1	1			10-12
D-Area Burning/Rubble Pits (DBP)	2	2	1			10-13
F-Area Burning/Rubble Pits (FBP)	5	3	2			10-7
K-Area Burning/Rubble Pit (KRP)	1	1	2			10-8
L-Area Burning/Rubble Pit (LRP)	1	2	1			10-8
N-Area Burning/Rubble Pits (CSR)				4		10-12
N-Area Burning/Rubble Pit South (CBR)	1	2	1			10-12
P-Area Burning/Rubble Pit (PRP)	1	1	2			10-9
R-Area Burning/Rubble Pits (RRP)	1	2	1			10-10
Coal Pile Runoff Containment Basins, Ash Basins, and Coal Piles						
A-Area Coal Pile Runoff Containment Basin (ACB)	1	2	1			10-11
C-Area Coal Pile Runoff Containment Basin (CCB)	1	1	2			10-12
D-Area Coal Pile Runoff Containment Basin and D-Area Ash Basin (DCB)	3	12				10-13
F-Area Ash Basin (FAB)	2	2				10-7
F-Area Coal Pile Runoff Containment Basin (FCB)	2	3	1			10-7
H-Area Coal Pile Runoff Containment Basin (HCB)	2	2				10-7
K-Area Ash Basin (KAB)	2	1	1			10-8
K-Area Coal Pile Runoff Containment Basin (KCB)	2	3	1			10-8
R-Area Coal Pile (RCP)		1			1	10-10
Disassembly Basins						
C-Area (CDB)		2				10-12
K-Area (KDB)		5				10-8
L-Area (LDB)	1	3				10-8

a Unassigned

Table 10-2 Aquifer and Gradient Assignments of Wells

Page 2 of 4

Location (Well Series)	Upper Saturated Zone Wells				Lower Zone Wells	Figure
	Up	Down	Side	Una ^a		
P-Area (PDB)	1	1	2			10-9
R-Area (RDB)	1	2				10-10
Seepage and Retention Basins						
C-Area Reactor Seepage Basins (CSB)	1	3	2			10-12
F-Area Seepage Basins and Inactive Process Sewer Line (F, FSB, FSL)	4	28	7	11	50	10-7
Ford Building Seepage Basin (HXB)	3	2				10-12
H-Area Retention Basins (HR3, HR8)	2	2	1			10-7
H-Area Seepage Basins and Inactive Process Sewer Line (HSB, HSL)	5	38	7	19	75	10-7
K-Area Reactor Seepage Basin (KSB, K301P)	2	2	1			10-8
K-Area Retention Basin (KRB)	1	3				10-8
L-Area Reactor Seepage Basin (LSB)	1	1	2			10-8
M-Area Hazardous Waste Management Facility (MSB point-of-compliance and background wells)	5	11	1		29	10-11
Metallurgical Laboratory Seepage Basin (AMB)	1	11	2		12	10-11
New TNX Seepage Basin (YSB)	1	1	2			10-13
Old F-Area Seepage Basin (FNB)	1	2	2		3	10-7
Old TNX Seepage Basin (XSB)		4	1		2	10-13
P-Area Reactor Seepage Basins (PSB)	1	5	1			10-9
R-Area Reactor Seepage Basins (RSA, RSB, RSC, RSD, RSE, RSF, P20)	19	13	4		2	10-10
Savannah River Laboratory Seepage Basins (ASB)	3	2	3		13	10-11
Operating Buildings and Facilities						
F-Area Canyon Building and A-Line Uranium Recovery Facility (FAL, FCA, NBG, P28)	1	8	5		3	10-7
F-Area Effluent Treatment Cooling Water Basin (FET)	1	3				10-7
H-Area Auxiliary Pump Pit (HAP)		1				10-7
H-Area Canyon Building (HCA)	2	2			4	10-7
H-Area Effluent Treatment Cooling Water Basin (HET)	1	3				10-7
K-Area Tritium Sump (KSM)		1				10-8
N-Area Hazardous Waste Storage Facility (HWS)	1		1			10-12
S-Area Background (SBG)	2	2	2			10-7
S-Area Low-Point Pump Pit (SLP)		2				10-7
S-Area Vitrification Building (SCA)	4	3	1	2		10-7
Z-Area Low-Point Drain Tank (ZDT)		1	1			10-7

a Unassigned

Table 10-2 Aquifer and Gradient Assignments of Wells

Page 3 of 4

Location (Well Series)	Upper Saturated Zone Wells				Lower Zone Wells	Figure
	Up	Down	Side	Una ^a		
Z-Area Saltstone Manufacturing and Disposal Facility (YSC, ZBG)	2	4			2	10-7
Plume Monitoring						
A-Area and M-Area Plume (ABP, ABW, AC, ACB, AMB, AOB, ARP, ASB, MCB, MSB, SRW)						
In this context, these wells help delineate a contaminant plume over a 5-square-mile area; it is inappropriate to assign a gradient designation to them.						10-11
Separations and Waste Management Areas (E, F, and H) Plume (Z 9, ZW)				11		10-7
T-Area Assessment and Background (TNX, P26)	2	8	4		1	10-13
Radioactive Waste Storage and Disposal Facilities						
Burial Ground Expansion (E-Area Vaults) (BGX)	3	6	3		6	10-7
Hazardous Waste/Mixed Waste Disposal Facility (HMD)	1	3				10-7
Old Burial Ground (BG, BGO, MGA, MGC, MGE, MGG)		41	1		34	10-7
Radioactive Waste Burial Ground (BG, BGO, HSB 85)	2	14	10		37	10-7
F-Area Tank Farm (FTF)	4	21	2			10-7
H-Area Tank Farm (HTF, P27, [Tank 16], HAA [Tank 16])		37			30	10-7
Sanitary Landfill and Interim Sanitary Landfill (LFW)	5	63	9		16	10-16
Sludge Application Sites						
F-Area Sanitary Sludge Land Application Site (FSS)	1	1	2			10-7
H-Area Sanitary Sludge Land Application Site (HSS)		2	1			10-7
K-Area Sludge Land Application Site (KSS)	1	2				10-8
PAR Pond Sludge Land Application Site (PSS, SSS 17)	1	2	1			10-9
Second PAR Pond Borrow Pit Sewage Sludge Application Site (SSS 25-27)	2	1				10-6
Other Sites						
B-Area Gas Station (P29)				1	2	10-16
Chemicals, Metals, and Pesticides Pit (CMP)	3	3	4		17	10-8
D-Area Oil Disposal Basin (DOB)				4		10-13
L-Area Acid/Caustic Basin and Oil and Chemical Basin (LAC, LAW, LCO)	4	7	3		13	10-8
Miscellaneous Chemical Basin (MCB)		2	2		3	10-11
Motor Shop Oil Basin (AOB)	1	1	1			10-11
N-Area Diesel Spill (CSD)				9		10-12
N-Area Fire Department Training Facility (CSO)		2				10-12

a Unassigned

Table 10-2 Aquifer and Gradient Assignments of Wells

Page 4 of 4

Location (Well Series)	Upper Saturated Zone Wells				Lower Zone	Figure
	Up	Down	Side	Una ^a	Wells	
N-Area Hydrofluoric Acid Spill (CSA)	1	1	2			10-12
Road A (Baxley Road) Chemical Basin (BRD)	2	3				10-13
Silverton Road Waste Site (SRW)	5	13	2		19	10-11
TNX Area Burying Ground (TBG)	1	6			1	10-13

a Unassigned

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Figure 10-2 Potentiometric Surface and Horizontal Groundwater Flow Directions of the Gordon Aquifer at SRS During the First Quarter of 1995

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Figure 10-3 Potentiometric Surface and Horizontal Groundwater Flow Directions of the Dublin-Midville Aquifer System at SRS During the First Quarter of 1995

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Figure 10-4 Geologic Cross Section of Coastal Plain Sediments at SRS

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Figure 10-5 Vertical Gradient Relationships Between the Gordon Aquifer and Dublin-Midville Aquifer Systems at SRS During the First Quarter of 1995.

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Figure 10-6 Overall View of the Savannah River Site, Showing Areas Covered by Other Figures

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Figure 10-7 Separations and Waste Management Areas: Major Facilities and Groundwater Monitoring Wells

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Figure 10-8 K-Area and L-Area and the Chemicals, Metals, and Pesticides Pits: Major Facilities and Groundwater Monitoring Wells

Figure 10-9 P-Area and PAR Pond: Major Facilities and Groundwater Monitoring Wells

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Figure 10-10 R-Area: Major Facilities and Groundwater Monitoring Wells

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Figure 10-11 A-Area and M-Area: Major Facilities and Groundwater Monitoring Wells

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Figure 10-12 C-Area and N-Area: Major Facilities and Groundwater Monitoring Wells

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Figure 10-13 D-Area and T-Area (TNX): Major Facilities and Groundwater Monitoring Wells

Figure 10-14 Tritium Purges and Groundwater Activities in Downgradient Wells at the L-Area Seepage Basin

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Figure 10-15 Tritium Purges and Groundwater Activities in Downgradient Wells at the P-Area Seepage Basins

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Figure 10-16 Sanitary Landfill and Sludge Sites: Major Facilities and Groundwater Monitoring Wells

Quality Assurance

To Read About . . .

Turn to Page . . .

<i>QA/QC for EMS Laboratories</i>	177
<i>Internal QA Program</i>	178
<i>External QA Program</i>	179
<i>QA/QC for Subcontracted Laboratories</i>	180
<i>Nonradiological Liquid Effluents</i>	180
<i>Stream and River Water Quality</i>	182
<i>Groundwater</i>	182
<i>Soil/Sediment</i>	184

THE Environmental Monitoring Section (EMS) of the Savannah River Site's (SRS) Environmental Protection Department maintains a quality assurance/quality control (QA/QC) program to continuously verify the integrity of data generated by its own environmental monitoring program and by its subcontracted laboratories. Each aspect of the monitoring program, from sample collection to data reporting, must address QA, QC, and quality assessment standards defined in the *Savannah River Site Environmental Monitoring Program Quality Assurance Plan*, section 8000, WSRC-3Q1-2. This chapter summarizes the QA/QC program. Tables containing the 1995 QA/QC data can be found in *SRS Environmental Data for 1995*, WSRC-TR-96-0077. A complete description of the EMS QA/QC program can be found in section 1110 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1 (SRS EM Program), which was issued in June 1995.

Guidelines and applicable standards for the QA/QC environmental monitoring program can be found in appendix A, "Applicable Guidelines, Standards, and Regulations," of this document. Figure 11-1 shows the guidance documents that support the EMS QA/QC program. Detailed information about federal, state, and local QA regulations and standards can be found in the SRS EM Program.

QA/QC for EMS Laboratories

General objectives of the QA/QC program include validity, traceability, and reproducibility of reported

results; comparability of results within data bases; representativeness of each sample to the population or condition being measured; and accuracy and precision.

Training for Personnel

EMS personnel must understand and comply with all requirements applicable to the activities with which they are involved. Consequently, appropriate training courses nurture the employees' understanding and fulfillment of their responsibilities. Courses include training on applicable QA procedures, Occupational Safety and Health Administration-mandated training, and General Employee Training. Regulations and procedures that govern the environmental monitoring program are emphasized.

EMS technicians begin with specific training determined by job assignment. The section's technical work is based on procedures in the WSRC-3Q1 series of manuals:

- "Environmental Sampling Procedures," WSRC-3Q1-3
- "Environmental Radiochemistry Procedures," WSRC-3Q1-4
- "Environmental Water Quality Procedures," WSRC-3Q1-5
- "Environmental Counting Room Procedures," WSRC-3Q1-6
- "Environmental Data Management and Computer Support Procedures," WSRC-3Q1-10

Guidance Documents that Support Programs

- International Organization for Standardization (ISO) 9000 Series of Standards
- *Specifications and Guidelines for Environmental Data Collection and Environmental Technology Programs*, ANSI/ASQC E-4
- General Requirements for the Competence of Calibration and Testing Laboratories
ISO/IEC Guide 25-1990

Figure 11-1 SRS EM Program QA/QC Document Hierarchy/Relevant Guidance Documents

Internal QA Program

Specific QA checks and accepted practices are conducted by each EMS group, as described in the following paragraphs.

Field Sampling Group

Blind-Sample Program EMS routinely conducts a blind-sample program for field measurements of pH and conductivity to assess the quality and reliability of field data measurements.

During 1995, blind pH field measurements were taken for 36 samples, and blind conductivity field measurements were taken for 37 samples. All of the field pH measurements were within the U.S. Environmental Protection Agency's (EPA) suggested acceptable control limit of ± 0.4 pH units of the true (known) value [SRS Data, 1996]. Ninety-seven percent of the conductivity measurements differed from the true value by less than 15 percent, which is

the EMS internal QA/QC requirement; the remaining 5 percent were outside of this control limit.

Instrumentation Calibration EMS personnel also measure chlorine, dissolved oxygen, and temperature in water samples, but because of the difficulties in providing field standards, these measurements are not suitable for a blind-sample program. Therefore, quality control of these analyses relies instead on instrumentation calibration, per the WSRC-3Q1 procedure series.

Chemistry and Counting Laboratories

Laboratory performance is evaluated through instrument checks, control charts, and data analyses. In the chemistry group, graphical and numerical trending is conducted on technician and method performance, with reports generated for sample results that exceed warning limits. The Counting Laboratory runs source checks and instrument backgrounds and performs calibrations regularly to monitor and characterize instrumentation.

Routine samples prepared and counted in EMS laboratories are subject to a variety of QC checks to assess and ensure validity. These checks make up 30 percent of the analytical workload. The Environmental Chemistry and Analysis group prepares spikes, blanks, duplicates, and blind samples to check the performance of routine analyses. Spikes and blanks are used to calculate a recovery efficiency of an analytical method, to adjust for background radiation, and to evaluate counting equipment performance.

Blind samples, the radionuclide composition of which is unknown to the technicians preparing or counting the samples, provide a constant check on the proficiency of the chemistry and counting laboratories. Based on matrix availability, blind and spiked samples are prepared from National Institute of Standards and Technology-traceable material or standardized against National Institute of Standards and Technology material. Upon completion of analyses, ratios between the measured and true values are calculated, and the results are added to control charts to identify trends. To address the high relative error of radioactive measurements at low levels, the difference between measured and true values is evaluated against standard deviation units of the true value. During 1995, blind samples were analyzed for tritium, gamma-emitting radionuclides, gross alpha, and gross beta. The results of these blind samples were used to validate analytical work in the chemistry and counting laboratories.

Data Verification and Validation

Results received from the Counting Laboratory are electronically evaluated by the Environmental Monitoring Computer Automation Project (EMCAP). Sample parameters—such as air flows, counting aliquots, and decay times—are flagged if values

exceed preset limits or vary significantly from previous entries. Also, maximum and minimum radioactive acceptance levels, based on historical results, are calculated for all routine environmental samples. Sample results outside the acceptance range are submitted for individual review, which frequently results in analytical reruns, recounts, recalculations, or resampling for verification.

Before data are reported, they must be reviewed and validated by qualified personnel. Electronic verification is performed on 100 percent of the data stored in EMS data bases. Through this verification, data anomalies are removed or data are rejected if there is disagreement with EMS QA/QC policies. The validation methods and criteria are documented in QAP 21-1 of WSRC-1Q and in the EMS "Environmental Geology Procedures," WSRC-3Q1-7. Quality control requirements for managing, evaluating, and publishing environmental monitoring data are defined in WSRC-3Q1-2, section 8250.

External QA Program

The EMS laboratory participates in two interlaboratory comparison programs to track performance accuracy. Under both programs, the U.S. Department of Energy (DOE) and EPA send samples to participating laboratories throughout the year and compare the laboratories' results to true values. These comparisons not only test the accuracy of procedures, but compare SRS with other laboratories nationwide.

The DOE Quality Assurance Program (QAP) tests the quality of environmental data reported to DOE by its contractors. Reference samples for this program—including soil/sediment, water, vegetation, and air filter samples—are prepared by the DOE/EML (Environmental Measurements Laboratory) and sent to participating laboratories.

Statistical Terms Used in this Chapter

coefficient of variation measure of precision calculated as the standard deviation divided by the average of a set of values; usually multiplied by 100 to be expressed as a percentage

mean measurement of central tendency, commonly called the average

mean relative difference measure of reproducibility of identical chemical analyses

median middle value of a set of data when the data are ranked in increasing or decreasing order

percent difference measure of accuracy used to compare "known" values with laboratory measurements; represents the absolute difference between the known and measured value divided by the true value; usually multiplied by 100 to be expressed as a percentage

standard deviation indication of the dispersion of a set of results around the average of samples collected

t-test statistical test of significance frequently employed by laboratories to assess the comparability of two sets of data

Analytical results are reported to the Environmental Measurements Laboratory within 90 days and compared with the test results of other laboratories. The DOE/EML evaluates the results and distributes them to the participating laboratories.

The second program is administered by the Quality Assurance Division (QAD) of the EPA Environmental Monitoring System Laboratory in Las Vegas. This division is responsible for QC of environmental radiological measurements. EPA provides participating laboratories with water, air filter, and milk samples that contain a variety of radionuclides with activity concentrations near environmental background levels. The QAD program enables EMS to document the accuracy of radiological analysis data, to identify instrument and procedural problems, and to compare analysis performance with other participating laboratories.

Control charts are maintained for the QAD results according to EPA control limits. For QAP results, the control charts are maintained according to DOE/EML control limits. Historical trends alert EMS to a method bias that may be occurring in its laboratories.

Most of the results reported by EMS in the QAD program were within EPA control limits. The results reported by EMS in the QAP program generally fell within the DOE/EML control limits, but several results did not fall within these limits. An internal (EMS) quality assurance evaluation report explaining the reason for these occurrences and describing corrective actions taken to prevent recurrence is expected to be issued in January 1996. The results generally showed the greatest bias in samples with low activity levels and in difficult matrices for chemical separation. Both the QAD and QAP programs indicate that 95 percent of the EMS analyses fall within the applicable limits, according to the standards of intercomparison agencies, and that they compare favorably with those of other environmental laboratories.

QA/QC for Subcontracted Laboratories

Subcontracted laboratories providing analytical services must have a documented QA/QC program and meet the quality requirements defined in WSRC-1Q. The subcontracted laboratories used during 1995 are listed in table 11-1.

EMS personnel perform an annual evaluation of each subcontracted laboratory to ensure that the laboratories maintain technical competence and follow the required QA programs. Each evaluation

Table 11-1
Subcontracted Laboratories for 1995

General Engineering Laboratories

groundwater
soil/sediment
waste characterization

Roy F. Weston, Inc.

groundwater
soil/sediment
metals analyses for SRS streams
and the Savannah River
waste characterization

Environmental Physics

groundwater radiological analyses
soil/sediment
waste characterization

ThermoAnalytical, Inc.

subcontracted groundwater radiological
analyses for Roy F. Weston, Inc.
soil/sediment
waste characterization
NPDES analyses (January–August)
metals analyses for SRS streams
and the Savannah River

Shealy Environmental

NPDES analyses (September–December)
metals analyses for SRS streams
and the Savannah River
soil/sediment
domestic water analysis

includes an examination of laboratory performance with regard to sample receipt, instrument calibration, analytical procedures, data verification, data reports, records management, nonconformance and corrective actions, and preventive maintenance. EMS provides reports of the findings and recommendations to each laboratory and conducts followup evaluations as necessary.

Nonradiological Liquid Effluents

Nonradiological liquid effluent samples are collected at each permitted SRS outfall according to requirements in the National Pollutant Discharge Elimination System (NPDES) permit issued by the South Carolina Department of Health and

Quality assurance within the Environmental Monitoring Section (EMS) is developed and maintained through multiple levels of review and through sophisticated computer analysis routines, which trend and track EMS radiological data, by location, on a historical basis. Here, with the section's alpha spectroscopy system in the background, an EMS chemist reviews analytical data. The chambers to his left contain isotopic plutonium samples that have been analyzed by the system.

Al Mamatey Photo
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Environmental Control (SCDHEC). Effluent samples are analyzed by EMS for temperature, pH, dissolved oxygen, and chlorine and by a subcontracted laboratory for other constituents, such as fecal coliform, metals, organics, and oil and grease. ThermoAnalytical, Inc. (TMA), was the primary subcontractor for the NPDES program during the first 8 months of 1995. In September 1995, a new contract was issued to Shealy Environmental Services, Inc., the primary subcontractor for the remainder of the year.

Interlaboratory Comparison Program

Interlaboratory comparison studies are used to compare the quality of results between laboratories performing the same analyses. During 1995, TMA and EMS participated in interlaboratory comparison studies conducted by EPA.

All subcontracted laboratories analyzing NPDES samples must participate in the EPA Discharge Monitoring Report Laboratory Performance Evaluation program. Under this program, EPA sends—to participating laboratories—performance samples containing constituents normally found in industrial and municipal wastewaters.

These water samples have known chemical parameters, such as chemical oxygen demand, and contain known concentrations of constituents, such as total suspended solids, oil and grease, and certain trace metals. EPA provides a final comprehensive report to the program participants. The report contains a statistical analysis of all data, as well as

documentation of the known sample value, with stated acceptance limits and warning limits. Accepted variations from the known sample value depend on a variety of factors, including the precision of the analysis and the extent to which the results can be reproduced.

In 1995, TMA ran analyses for 29 parameters under the EPA program. EMS performed analyses for only two of the EPA parameters, chlorine and pH. Results for 28 of the 29 analyses run by TMA were within the acceptable range of 80 percent of the true values, as set forth by EPA. One analysis, nitrate as nitrogen, was outside the acceptable range, and an investigation is being conducted to determine the reason for this discrepancy. Results for both parameters analyzed by EMS were within the 80-percent acceptance range.

Intralaboratory Comparison Program

The intralaboratory program compares performance within a laboratory by analyzing duplicate and blind samples throughout the year. TMA and Shealy analyzed 471 duplicate samples for various parameters during 1995. Percent difference calculations showed that 384 of these samples were within the EMS internal QA/QC requirements of 20 percent. Forty-seven exceedances involved either total suspended solids, oil and grease, or biological oxygen demand, the analyses of which typically produce highly variable results. Nine exceedances occurred because results at or near the analytical detection limit produce large percent variations for small differences in actual data. The remaining 31

exceedances appeared to be related to analytical error at the subcontracted laboratories.

TMA and Shealy also analyzed 73 blind samples submitted by EMS. Percent difference calculations showed that 62 of these samples were within the acceptable range of 20 percent. Of the 11 exceedances, seven were for total suspended solids and oil and grease; two others—for zinc—were the result of data at or near the analytical detection limit; and the remaining two—for aluminum—appeared to be related to analytical error at the subcontracted laboratory.

Steps are being taken to improve the quality of the subcontracted laboratory analytical programs, although no investigation of TMA analytical programs was conducted because the existing laboratory contract expired and was issued to Shealy in September 1995.

EMS personnel had performed a data validation audit of TMA in 1994 to ensure that the laboratory had maintained technical competence throughout the year. Ten percent of all NPDES samples analyzed by TMA were evaluated for instrument calibration, analytical procedures, data verification, and data reports. EMS reported the findings and recommendations to TMA in March 1995. No followup evaluations were required.

Stream and River Water Quality

Metals analyses of samples from SRS streams and the Savannah River are also performed by a subcontracted laboratory. The water quality program requires quality checks of 10 percent of the samples to verify the analytical results. Split samples were sent for metals analyses to subcontractor laboratories TMA (during the first two quarters of 1995) and Shealy (during the third and fourth quarters), and to verifying laboratory Roy F. Weston, Inc. (during all four quarters). Based on paired *t*-tests on six sets of differences for 12 metals, it was concluded that the average difference was not statistically different from zero at the 95-percent confidence limits for the first three quarters of 1995 for all the metals except sodium and iron. For these two metals, all six results for the split samples from Weston were less than the results from TMA in the first two quarters and Shealy in the third quarter. Significant differences for iron and sodium indicate that there is a systematic bias between the two sets of laboratories. Blind samples will be submitted to both laboratories in 1996 to resolve these discrepancies.

Laboratory methodology and analysis reproducibility between the subcontracted and the verifying

laboratories were checked during the first three quarters of 1995. Water samples from all EMS water quality field locations were composited into one sample, then split into three duplicates for the subcontracted laboratory and three for the verifying laboratory. Each sample was analyzed for a group of 12 metals. The subcontracted laboratory was TMA for the first two quarters of 1995 and Shealy for the third and fourth quarters; the verifying laboratory was Weston for all four quarters.

Mean relative difference (MRD) calculations exceeded 20 percent in nine instances, indicating a lack of agreement between the subcontracted and verifying laboratories. Duplicate instances occurred for aluminum in the first three quarters and zinc in the second and third quarters. A blind-standards study will be conducted in 1996 to investigate the anomalies.

The average percent coefficient of variation for analyses in the first quarter was below 10 percent, an indication that result reproducibility was satisfactory. The average percent coefficient of variation for analyses in the second and third quarters exceeded 10 percent for both the subcontracted and verifying laboratories. The second-quarter average percent coefficient of variation was 13.95 for Weston and 13.32 for TMA. The third-quarter average percent coefficient of variation was 11.45 for Weston and 16.54 for Shealy. For individual analyses, there were four instances in which the coefficient of variation exceeded 20 percent in the second quarter and eight such instances in the third quarter. In six instances, the actual analytical data were at or near the detection limit for the analyses. Small differences in results at or near the detection limit can cause large statistical calculation fluctuations that do not actually indicate a problem with reproducibility. Duplicate instances occurred for aluminum (TMA in the second quarter and Shealy and Weston in the third quarter) and for zinc (TMA and Weston in the second quarter and Weston and Shealy in the third quarter). Fourth-quarter split-sample results were not sent from Weston to EMS in time for inclusion in this report.

Groundwater

Groundwater analyses at SRS are performed by subcontracted laboratories. During 1995, General Engineering Laboratories and Weston were the primary subcontractors for nonradiological analyses. Environmental Physics, TMA, and Analytical Technologies, Inc., were the primary subcontractors for radiological analyses.

During 1995, approximately 5 percent of the samples collected (radiological and nonradiological) were

QA Terminology in the Laboratory

quality assurance (QA) planned and systematic actions taken to provide adequate confidence in monitoring and measurement data

quality control (QC) overall system of activities that control and verify the quality of monitoring and measurement data

accuracy degree of agreement between a measurement and an accepted reference or true value

bias systematic (constant) underestimation or overestimation of the true value

precision measure of mutual agreement among individual measurements of the same property

spiked sample sample to which a known amount of a substance has been added

duplicate sample repeated but independent determinations on the same sample

split sample portions taken from the same sample and analyzed by different technicians or laboratories

blind sample (blind duplicate or blind blank) mock sample of known constituent(s) or concentration(s); used as a control

blanks clean samples analyzed to establish a baseline or background value used to adjust or correct results

standard reference materials materials with certain properties certified by the National Institute of Standards and Technology

control chart graphical chart of a field-measured value or of an analytical result

submitted to the primary laboratory for analysis as blind duplicates and to a verification laboratory as a QA check. Blind blanks, representing 5 percent of the samples sent to each laboratory, were submitted to General Engineering and Weston. The laboratories' results were evaluated on the basis of the percentage within an acceptable concentration range of certified standard values.

A statistical measure, the MRD, is calculated to assess result reproducibility and laboratory performance. The laboratories also analyze approximately 10 percent of samples as intralaboratory QA checks. Interlaboratory comparisons were conducted between General Engineering/Weston and Environmental Physics/TMA or Analytical Technologies.

As in past years, General Engineering and Weston results for QC standard samples were within the 80-percent acceptance range utilized by the EMS QA/QC program. Laboratories that fall outside this range are reevaluated by EMS.

During 1995, General Engineering and Weston participated in EPA water pollution and water supply studies. Of 150 samples analyzed for the water pollution studies, General Engineering reported one sample each of chloride and nitrogen by Kjeldahl method and two samples each of nitrate as nitrogen and total phenolics outside the acceptable range. Analyses for one sample each of lead, manganese, orthophosphate, and toluene and two samples of fluoride were acceptable but near the acceptance limits. During 1995, Weston analyzed 76 constituents as part of a water pollution study and reported several

results outside the acceptable range, including one sample each of alkalinity, chloride, pH, selenium, sodium, specific conductance, and total residual chlorine and two samples each of calcium, dibromochloromethane, magnesium, and oil and grease. Results for one sample each of bromoform, chloride, 1,2-dichlorobenzene, lead, potassium, sodium, specific conductance, sulfate, total phenolics, and total residual chlorine were acceptable but near the acceptance limits.

In the water supply studies, General Engineering reported nine of 132 results outside the acceptable range, including one sample each of antimony, boron, calcium, chlordane, dichloromethane, fluoride, methoxychlor, thallium, and total xylenes. Weston reported nine of 207 results outside the acceptable range for one sample each of acenaphthylene, aluminum, benzo(b)fluoranthene, carbon tetrachloride, nitrate as nitrogen, residual free chlorine, sodium, simazine, and vinyl chloride.

Full results for all these QA/QC evaluations, including MRD calculations, where appropriate, may be found in the following groundwater reports:

- *The Savannah River Site's Groundwater Monitoring Program, First Quarter 1995* (ESH-EMS-950393)
- *The Savannah River Site's Groundwater Monitoring Program, Second Quarter 1995* (ESH-EMS-950394)
- *The Savannah River Site's Groundwater Monitoring Program, Third Quarter 1995* (ESH-EMS-950395)

- *The Savannah River Site's Groundwater Monitoring Program, Fourth Quarter 1995* (ESH-EMS-950396)

Data management personnel perform several additional functions to ensure the quality of the data released by EMS. Two people enter the data for each entry in a double-entry system that helps minimize errors. The specified data-deliverable format required by EMS of its subcontracted laboratories allows for 100-percent electronic verification of all field, shipping, invoice, and analytical data.

Soil/Sediment

Environmental investigations of soils, sediments, and surface waters, primarily for Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) units, are performed by subcontracted laboratories. Table 11-1 lists the primary subcontractors for soil/sediment analyses.

EMS personnel validated and managed approximately 350,000 analytical records during soil/sediment investigations in 1995. Data are validated according to EPA/CERCLA validation guidelines for Definitive Data (formerly QA Objective 3 Data) unless specified otherwise by site customers. EMS delivers about 10 project summary reports per year; each includes

- a project QA/QC summary
- a discussion of validation findings
- tables of validated and qualified data

Although *Data Quality Objectives Process for Superfund* (EPA-540-R-93-071) identifies QA issues to be addressed, it does not formulate a procedure for how to evaluate these inputs, nor does it propose pass/fail criteria to apply to data and documents. Hence, the validation program necessarily contains elements from—and is influenced by—several sources, including

- *Data Quality Objectives Process for Superfund*, EPA final guidance, EPA-540-R-93-071

- *QA/QC Guidance for Removal Activities*, interim final guidance, EPA-540-G-90-004
- *National Functional Guidelines for Organic Data Review*, Multi-Media, Multi-Concentration (OLM 01.0), and Low Concentration Water (OLC 01.0), draft, June 1991
- *Test Methods for Evaluating Solid Waste*, EPA, November 1986, SW-846, Third Edition
- *Data Validation Procedures for Radiochemical Analysis*, WHC-SD-EN-SPP-001

As they do in the groundwater program, data management personnel in the soil/sediment program perform additional functions to ensure the quality of the data released by EMS. Two people enter the data for each entry to help eliminate errors, and all field, shipping, invoice, and analytical data is 100 percent verified.

Relative percent difference for the soil/sediment program is calculated for field duplicates and laboratory duplicates. A summary of this information can be found in each project report prepared by the Environmental Geochemistry Group of EMS, through which the reports are available upon request. Standards are not being used with this program because of the difficulty in achieving a blind homogenous soil standard.

Laboratory Data Record Reviews

In addition to an annual evaluation, laboratory data record reviews are performed once per quarter for groundwater and once per project for soil/sediment. A predetermined percentage of the analyses for the indicated time frame is selected for inspection by a team of validators. The samples selected for review usually have been flagged by the electronic verification of the data. A description of the activities performed during a record review, an example check list, and a report description can be found in the Environmental Geochemistry Group Operating Handbook, ESH-EMS-95-0061.

Special Surveys and Projects

To Read About . . .**Turn to Page . . .**

<i>Tritium Migration</i>	185
<i>Mitigation Action Plan for Pen Branch Reforestation</i>	189
<i>ANSP River Quality Surveys</i>	191

IN addition to routine sampling and special sampling during nonroutine environmental releases, special sampling for radiological and nonradiological surveys is conducted on and off site by the Savannah River Site (SRS) Environmental Protection Department's Environmental Monitoring Section (EMS) and other groups, such as the Savannah River Technology Center (SRTC) the Academy of Natural Sciences of Philadelphia (ANSP), and the U.S. Geological Survey (USGS). This year's chapter also includes an update (moved from chapter 2, "Environmental Compliance") of the ongoing Trans-River Flow Project, which addresses tritium migration from SRS.

Both short- and long-term radiological and nonradiological surveys are used to monitor the effects of SRS effluents on the environment at SRS and in the site's immediate vicinity

All conclusions discussed in this chapter are based on available samples and/or analyses. Because of sampling and/or analytical difficulties, some sample analyses may be missing. Details about the number of samples analyzed and the results of those analyses appear in *SRS Environmental Data for 1995* (WSRC-TR-96-0077).

Savannah River Swamp Survey

During the 1960s, an area of the Savannah River Swamp between Steel Creek Landing and Little Hell Landing was contaminated by failed fuel elements that leaked radioactivity into the P-Area storage basin. Periodic radiological surveys of the swamp have been conducted since 1974 to characterize the amount and movement of this activity. A comprehensive survey scheduled for 1995 could not be conducted because of safety concerns resulting from high water levels in the swamp; however, the survey has been rescheduled for 1996.

Trans-River Flow Project

Many regions of the United States are planning for increased water supply demands as a result of population and industrial growth. Groundwater often is the most practical source of new water supply because of its general good quality and availability near the source of need. However, groundwater is vulnerable to contamination and, once contaminated, presents near insoluble remediation problems. Thus, many communities are concerned about maintaining the quality of their groundwater reservoirs. One area of such concern is along the South Carolina-Georgia state line near SRS.

The site has produced nuclear materials for national defense since the early 1950s, and a variety of hazardous materials—including radionuclides (such as tritium), volatile organic compounds, and trace metals—are disposed of or stored at SRS locations. As a result, groundwater beneath an estimated 5 to 10 percent of the site has been contaminated.

The Trans-River Flow Project was initiated in 1988 to address Georgia officials' concerns about the possibility that tritium-contaminated groundwater was migrating from SRS to Georgia. However, USGS research has confirmed that no threat exists from the tritium in question. The research is complemented by a Georgia Department of Natural Resources (GDNR) project investigating possible tritium contamination of the Upper Three Runs (water table) aquifer, and work continued in 1995 on both of the projects, which are being funded by DOE.

Development of a USGS computer model for this Central Savannah River Area (CSRA) regional groundwater study was completed in 1994. The model is being used to quantitatively relate the groundwater flows of the area's aquifers to each other and to surface discharge into the area's streams. (The

CSRA is an 18-county area in Georgia and South Carolina that surrounds Augusta, Georgia, and includes SRS.)

The study covers most of eight counties around the site (Aiken, Allendale, and Barnwell in South Carolina; Burke, Jefferson, Jenkins, Screven, and Richmond in Georgia), as shown in figure 12-1. It is believed to be one of the largest and most detailed modeling studies ever conducted on both sides of a major river. The database includes 3,745 wells, 55,163 water level measurements dating to the 1800s, and 584 hydrologic property measurements. The model divides the vertical section into seven aquifers to a depth of up to 1,400 feet. Preliminary aquifer thickness and potentiometric maps have been produced for pre-1953 and current conditions. The river and recharge packages were incorporated into the model in 1995, and calibration is continuing.

Drilling for stratigraphic, hydrologic, and geochemical information continued in Georgia, with

pump tests to determine aquifer characteristics completed at Brigham's Landing, Thompson Oak, Girard, and Millhaven during 1995. The research phase is scheduled to extend through 1996, and the final report is due in 1997.

Trans-River Flow

Two issues were raised concerning the possible migration of contaminated groundwater offsite from SRS:

- Is groundwater flowing from SRS through aquifers in South Carolina and beneath the Savannah River into Georgia (herein called the trans-river flow)?
- Under what pumping scenarios could such groundwater movement occur?

Trans-river flow is a term that describes a condition whereby groundwater originating on one side of a river migrates beneath the river floodplain to discharge points located on the other side of the river. Natural factors controlling the potential for

Figure 12-1 Study Area

The United States Geological Survey regional groundwater study of the Central Savannah River Area is contained primarily within these eight counties surrounding SRS.

USGS Graphic

trans-river flow include (1) water-bearing properties of aquifers and confining units; (2) thickness and areal extent of confining units; and (3) hydraulic gradient.

The Savannah River acts as a hydrologic "sink" into which groundwater from surrounding and underlying aquifers discharges (figure 12-2). This sink is thought to have formed as the river eroded through the uppermost confining units and subsequently was filled with permeable alluvium. It is possible, however, that some groundwater can flow beneath the river to the opposite side of the river from its point of origin in response to natural or human-induced hydraulic gradients.

A major difference in the water geochemistry has been defined between the Georgia and the South Carolina sides of the Savannah River. Near the South end of SRS, where groundwater from South Carolina could flow under the river because of pumping in the Lower Midville Aquifer, the Georgia water is much higher in pH, specific conductivity, and total alkalinity.

Water reaching the river from Georgia is older, probably because of longer travel distances and slower travel rates in rocks of lower permeability. Oxygen isotopes of water more than 10,000 years old show the effects of the glacial period, when the lighter fraction was locked up in the continental ice cap. Midville water at the Millers Pond well cluster in Georgia, for example, is 15,000 years old. These differences may be used to determine the origin of water for springs in the vicinity of the Savannah River, an important feature of the hydrologic model.

Potentiometric-surface maps for all aquifers have been revised based on new data and a quality assurance check of the project database. For each of the maps, the area of the groundwater divide, or "saddle," under the Savannah River south of SRS was reduced to a narrower reach than was shown on previous maps. This reduces the potential for water from South Carolina to flow into Georgia in response to heavy agricultural pumping.

Evaluation of water level data from the spring and fall of 1992 indicates that seasonal fluctuations generally were within 5 feet of normal and thus have little influence on the configuration of the potentiometric-surface maps. Similar evaluation of long-term trends from the project database of more than 54,000 water level measurements indicates that there has been little change in water level over time (generally less than 15 feet) in the study area. Maximum declines were approximately 25 feet—in some areas of the Midville Aquifer.

USGS Graphic

Figure 12-2 Groundwater Flow

The upper block shows that the Savannah River is the regional sink into which groundwater ultimately flows in the Central Savannah River Area. The lower block indicates how groundwater from South Carolina could flow into the river in response to heavy agricultural pumping in Georgia.

Water Quality

Analysis of water sampled from 14 test wells and two existing municipal wells indicates that the water is within the U.S. Environmental Protection Agency

(EPA) primary drinking water standards, having no detectable concentrations of contaminants in the deeply buried aquifers [EPA, 1993]. Concentrations of tritium below the EPA maximum contaminant level of 20,000 parts per liter were detected in a 100-foot-deep well in northern Burke County, Georgia [Clarke et al., 1994]. The source and extent of tritium concentrations in shallow groundwater in Georgia have been reported [Summerour et al., 1994].

Base-Flow Studies

Since 1991, the Georgia Geologic Survey and the state's Environmental Protection Division Environmental Radiation Program have conducted base flow studies each autumn as part of the Trans-River Flow Project. Sampling normally is conducted after at least two weeks without significant rainfall. Under these conditions, the water entering

springs and small streams is believed to reflect tritium values in the Upper Three Runs (unconfined) aquifer.

When conditions are appropriate, a rapid collection of water samples from suitable sites is conducted in eastern Burke County. The samples are analyzed at the Georgia Institute of Technology's Environmental Radiation Laboratory. After analysis, the tritium values are plotted and contoured on a base map. Figure 12-3 shows the positions of the 500-pCi/L contours for the tritium values from the 1991-1995 base flow studies. The 500-pCi/L value is 2.5 percent of the EPA maximum concentration limit.

The 500-pCi/L contours—as well as the 1,000-, 1,500-, and 2,000-pCi/L contours (not indicated in the figure)—show a trend of decreasing area (or decreasing tritium concentration) during the 5-year period of these measurements. The 1993 500-pCi “island” (on the west side side of the figure) is

96X00624.01.AIL

Figure 12-3 Comparison of Contours

The map compares 500-pCi/L contours in Burke County, Georgia, based on the results of Georgia Geologic Survey and Georgia Environmental Protection Division Environmental Radiation Program base flow studies conducted each autumn as part of the Trans-River Flow Project.

Test wells have been constructed at the Thompson Oak site in Burke County, Georgia, where pump tests to determine aquifer characteristics were completed during 1995. In the background are cooling towers at Georgia Power Company's Vogtle Electric Generating Plant. The Thompson Oak site is being developed as part of a cooperative effort involving the U.S. Department of Energy, the U.S. Geological Survey, and the Georgia Department of Natural Resources.

USGS Photo (96X02586.13)

attributable to the first-time collection from sites near and west of Waynesboro, Georgia. The tritium values from the 1995 base flow study ranged from 1,600 pCi/L (8 percent of the EPA maximum concentration limit in two samples) to <100 pCi/L (below detection limits).

Mitigation Action Plan for Pen Branch Reforestation

The significant reduction in the production mission of the SRS reactors has resulted in the reevaluation of the mitigation strategies identified in the 1991 Mitigation Action Plan (MAP) and its 1992 update. The Mitigation for Wetlands Adversely Impacted by Operations is the only section of the MAP that remains as an active program element. At the direction of DOE, it has been agreed by all parties involved with the reporting process that the *SRS Environmental Report* will be used as the document to report annual progress on the reforestation portion of the commitment [New, 1994].

A precise history of the regulatory commitment for the reforestation can be found in the MAP 1992

Update [DOE, 1992]. Since that time, the change in mission relating to K-Reactor and the increased technical information on the extent of damage and natural recovery in the Pen Branch corridor and delta have altered the details of the reforestation effort. The following paragraphs describe the implementation of mitigation measures related to the reforestation mitigation actions that took place during 1995—and to which DOE is committed.

Reforestation of the Pen Branch Corridor and Delta by Natural Succession

Natural revegetation has been occurring in the Pen Branch delta since K-Reactor last operated for an extended period of time (1988). Aerial photography and aircraft-acquired multispectral data determined in 1992 that an area of 583 acres was included in the swamp and marsh area that either had been or could be clearly affected, resulting in tree canopy loss or vegetation damage [Blohm, 1995]. This is a substantial reduction from the 670 acres estimated in the final Environmental Impact Statement [DOE, 1990].

During 1995, an extensive survey of natural regeneration of forest species was conducted around the outer perimeter of the delta region of Pen Branch. Results of that survey indicated that approximately 100 acres of the delta had sufficient bald cypress (*Taxodium distichum*) seedlings and saplings to consider the areas reforested. These areas were mapped with Global Positioning System recorders and are included in a Geographic Information System layer for the Pen Branch area. All areas of the Pen Branch corridor above Risher Pond Road (Road A-13.2) also are considered to have been reforested by natural regeneration to a bottomland hardwood forest type.

Reforestation of the Pen Branch Corridor and Delta by Planting

The Pen Branch corridor and delta are expected to be reforested by the year 2000 with indigenous wetlands species. The reforested areas will be managed until successful reforestation has been achieved. This is the preferred method of mitigation for Pen Branch because of a shorter restoration time frame. Observations during 1994 and 1995 indicate that

cypress and tupelo are becoming reestablished naturally in portions of the Pen Branch delta, as indicated earlier. Intervention into this natural process will be considered only to maximize survival of the desired species.

Areas of the Pen Branch corridor and delta that are judged not to be revegetating satisfactorily are being replanted with indigenous bottomland forest species appropriate for the soil types and hydrologic regime. The initial seedling planting of the entire corridor and delta areas has been completed. This consisted of planting approximately 31 acres of the lower corridor with a mixture of flood-tolerant hardwood species and cypress seedlings in 1993. An additional 47 acres of the upper corridor were planted with a mixture of bottomland hardwood species seedlings in 1994. Species planted have included water and pignut hickory, sycamore, green ash, swamp and water tupelo, black gum, persimmon, cherrybark and water oak, bald cypress, and swamp chestnut oak. The actual species planted in an area was determined by the expected hydrology of the area and the flood tolerance of the species. Seedlings are being planted at approximately 450 trees per acre. Permanent

Environmental Sciences Section Photo (96X01098.03)

Research personnel involved in various biological restoration projects gather at Pen Branch during the summer of 1995 to compare findings and discuss future plans in connection with reforestation of the Pen Branch corridor and delta by replanting. The meeting included representatives of the Savannah River Technology Center, the Savannah River Ecology Lab, the Savannah River Forest Station, the University of South Carolina-Aiken, Clemson University, and the University of Georgia.

monitoring plots have been installed to assess the survival of the seedlings in the corridor area.

In 1995, the upper corridor section was replanted with seedlings because of the mortality that occurred from feral hog predation on the original planted seedlings. During the replant effort, much more herbaceous material was present in the corridor. Very little hog damage was seen following the 1995 replanting effort. Also in 1995, the delta area was planted for the first time with bald cypress, water tupelo, and, on drier ridges, green ash seedlings. Approximately 90 acres were planted at seedling densities of 450–500 seedlings per acre. Within each of the areas that have been planted, there are areas that will serve as untreated controls to assess the effectiveness of the reforestation effort. Twenty-eight acres of the delta were left in the control strips in 1995. This acreage—part of that committed to in the MAP—will be assessed at a later date to see if it will reforest naturally because of its proximity to the mitigated acreage. If not, it may receive planting at a later date.

During the 3 years of planting in the corridor and delta area, approximately 85,000 seedlings have been planted. New monitoring plots of the areas planted in 1995 will be installed in 1996 to follow seedling development and survival and to indicate areas where later replanting may be necessary to assure adequate stocking to meet mitigation goals. An establishment report detailing all activities associated with the reforestation is in final review and will be issued in 1996.

Compensatory Mitigation

Compensatory migration will provide equivalent mitigation at sites other than Pen Branch, either by enhancing degraded wetlands or creating new ones. This option will be evaluated in detail following the evaluation of the success of reforesting Pen Branch corridor and delta in the year 2000; however, it is the least desired option.

Academy of Natural Sciences of Philadelphia River Quality Surveys

Overview

The Environmental Research Division of ANSP has been conducting biological and water-quality surveys of the Savannah River since 1951. These surveys are designed to assess potential effects of SRS contaminants and warm water discharges on the

general health of the river and its tributaries. This is accomplished by looking for patterns of biological disturbance that are geographically associated with the site, and for patterns of change over seasons or years that indicate improving or deteriorating conditions.

The ANSP surveys examine algae, rooted aquatic plants, protozoa, insects and other macroinvertebrates, fish, and basic water chemistry. Detailed studies (comprehensive surveys) of all components have been conducted roughly every 4 years, and studies (cursory surveys) of certain groups of organisms, notably a type of algae called diatoms, have been conducted annually. Multiple levels of the aquatic food web are studied because no single group is reliably the best indicator of ecosystem health and because there is a broad consensus that maintaining the integrity of the entire system is important.

The study design employed in the ANSP comprehensive Savannah River surveys includes four sampling stations: three exposed to SRS influence (stations 3, 5, and 6) and one unexposed reference station (station 1) upriver (figure 12–4). Multiple exposed stations are required because of the complex pattern of SRS inputs along the river. Potential impacts are assessed by determining whether differences exist—between the exposed and reference stations—that are either greater or of a different character than would be expected if they were due merely to natural differences among sampling sites.

For example, the character of differences among stations is judged in part by comparing the individual species collected. Evidence of impact exists if a station shows elevated abundances of species known to tolerate pollution and depressed abundances of species known to be sensitive to pollution. If this pattern is detected at the exposed stations, but not at the reference station, SRS is implicated. If, however, the pattern is seen at the reference station, the impact must be due to sources upstream from the study area.

Other types of evidence for impact include

- decreased numbers of species
- decreased cumulative numbers of individuals
- numerical dominance by a small proportion of the species present
- decreased individual growth rates (e.g., in fish)
- decreased body weights of individuals relative to their lengths.

These patterns arise because pollution tends to reduce individual and population growth rates in a majority of species, while a few are able to thrive under such conditions.

Figure 12-4 Academy Survey Sampling Sites

The Academy of Natural Sciences of Philadelphia has established specific sampling locations for surveys of the Savannah River—three exposed to SRS influence (stations 3, 5, and 6) and one unexposed reference station (station 1).

96X00236.03.AIL (modified)

Determining whether exposed and reference stations differ is complicated by the fact that considerable variation exists even among samples collected at the same time from the same location. Apparent differences therefore may be misleading if each station is characterized by only a single sample. For this reason, the ANSP surveys typically collect multiple samples from each station, making it possible to quantify both of the important components of variation: within and among stations. Compelling evidence for station differences exists if variation among samples from different stations is significantly greater than (average) variation among samples from the same station, as judged by appropriate statistical techniques. Otherwise, apparent station differences can be explained simply by natural variability.

The ANSP surveys also address variation over time. Important components of temporal variation include seasonal trends, multiyear trends, and trendless variability. All these components can be assessed using the unique data set generated by ANSP's long-term monitoring program in the Savannah River (figure 12-5). Regular sampling with standardized collection techniques has continued largely unmodified since the early 1950s, making this one of the most comprehensive ecological data sets available

for any of the world's rivers. Unfortunately, the complete ANSP data set has not been analyzed or integrated with biological and chemical information from other sources (e.g., SRS and state and federal agencies) monitoring the Savannah River. The following, however, does present an examination of notable trends over approximately the past 10 years.

Such long-term records of biological change are valuable for several reasons. Because they allow the normal degree of year-to-year variability at a site to be quantified, changes observed from one survey to the next can be assessed to determine whether they fall within the normal range, much as one would use a control chart (figure 12-6). Changes outside this range provide evidence of altered conditions at the study site.

These data sets also are useful in distinguishing between potential impacts of SRS and variation caused by other factors. In particular, part of the biological variation observed over time is caused by documented changes in river flow, wastewater treatment methods, dredging activities, and so on. Correlations between the known history of such changes on one hand, and components of variation in long-term data sets on the other, provide evidence that these components were not caused by activities at SRS.

Finally, long-term data sets can provide compelling evidence for multiyear trends of improvement or deterioration in ecosystem health. For example, preliminary analyses of some of ANSP's long-term data suggest that there has been an increase in the number of different kinds of aquatic insects living in the river since 1958, as shown in figure 12-5(c). Because aquatic insect diversity is believed to be a sensitive measure of environmental quality, this pattern may indicate a long-term trend of improving water quality in the river.

Progress Reports

The 1995 ANSP studies on the Savannah River included biweekly diatometer monitoring throughout the year, cursory surveys in the vicinity of SRS (algae, aquatic macrophytes, insects and fish), and sampling near Vogtle Electric Generating Plant in September (algae, aquatic macrophytes, protozoa, noninsect macroinvertebrates, insects, and fish). Plant Vogtle stations lie within the area potentially impacted by SRS and are examined to note

measurable influences to river health issuing from Plant Vogtle that potentially can be separated from those contributed by the SRS facilities. Analysis of samples from these studies is under way. Progress to date for each study component is reported in the following paragraphs.

Diatometer Monitoring

Periphyton is an assemblage of simple plants (e.g., algae) that attach to rocks and other underwater surfaces in the river. Diatoms, a type of periphyton, are collected using devices called Catherwood Diatometers that float glass microscope slides in the water. The diatoms attach to the slides and can be scraped off and examined in the laboratory.

In 1995, diatoms were collected continuously at locations above SRS (reference station 1), below Steel Creek (exposed station 5), and below Lower Three Runs Creek (exposed station 6). Samples were analyzed for each biweekly exposure period to determine the number and relative abundances of diatom species. More detailed analyses were performed on slides for two exposure periods (slides

ANSP Graphic

Figure 12-5 Long-term Biological Data

Examples from the ANSP's long-term biological data set for the Savannah River include (a) number of diatom species in diatometers; (b) number of algal taxa; (c) number of insect taxa; and (d) average number of fish—all at station 6.

Figure 12-6 Station 5 Diatom Species

Shown are the number of diatom species in diatometers at station 5, with the 1995 values (asterisked line) superimposed on the mean plus or minus 1 standard deviation (other three lines) during the period 1978–1995. Exposure periods represent 26 2-week intervals during which diatometers were deployed in the Savannah River.

ANSP Graphic

removed April 24 and October 24). Water quality was assessed by comparing stations and sampling periods based on the relative abundance and richness of species and on the species' ecological requirements and tolerances.

As in the previous 7 years of study (based on completed analysis of 21 of the 26 biweekly exposure periods), the number of diatom species (species richness) was consistently lower at exposed station 6 (below Lower Three Runs Creek) than at the reference station (station 1). In addition, the number of species at station 5 (below Steel Creek) was similar to that at station 1 and consistently higher than that at station 6. A similar trend was observed for percent dominance, an index measuring the degree of numerical dominance by a small proportion of the species. Percent dominance generally was higher at station 6 than at stations 1 or 5.

Although numbers of species normally fluctuate from year to year, there has been a trend toward decreased numbers of species at station 6 since studies began in 1954, as indicated in figure 12-5 (a). This decrease has been particularly dramatic since 1988. The decreased species richness and increased percent dominance at station 6, compared to stations 1 and 5, indicate a less diverse biota. As in past years (1988–1995), diatom communities at station 6 suggest that some component(s) of water quality is poorer, probably resulting from conditions on Lower Three Runs Creek. No differences in water quality between stations 1 and 5 are apparent.

Conclusion Decreased diatom diversity in the Savannah River at exposed station 6 suggests that

some component(s) of water quality is poorer relative to upstream locations, apparently reflecting the influence of Lower Three Runs Creek.

Algae and Aquatic Macrophyte Studies

The cursory algal studies were carried out on the Savannah River at the reference station above SRS and at the two exposed stations below SRS. Although sample analysis is incomplete, preliminary results suggest there has been no significant change in water quality at any of the stations since 1994.

The comprehensive algal study carried out on the Savannah River near Plant Vogtle revealed 75 algal species at station V-1 (reference, above Plant Vogtle) and 95 algal species at Station V-2 (exposed, below Plant Vogtle). These results are within the range found during the previous six surveys at these stations (figure 12-7), suggesting there was no major change in water quality in 1995.

The numbers of algal and aquatic macrophyte species recorded during 1995 were fundamentally similar to those present during previous Savannah River surveys. The dominant algal flora consisted of species characteristic of moderate to high nutrient levels and typical of southeastern coastal plain rivers. There is no evidence indicating that Plant Vogtle had an adverse effect on water quality in the river in 1995.

Conclusions Preliminary analysis of 1995 algal communities above and below SRS provides no evidence of an impact of site operations on Savannah River water quality.

The number of algal species collected in 1995 above and below Plant Vogtle was similar to that of previous years, suggesting that water quality did not change and that Plant Vogtle did not contribute to any degradation of water in the SRS area.

Protozoa Studies

Differences in diversity between the two Plant Vogtle stations in 1995 are within the range of variation observed in past surveys. The 61 species from station V-1 and 65 from station V-2 lie in the range of variability—54 to 80 species (typically between 60 and 70) for station V-1 and 54 to 75 species (typically between 57 and 68) for station V-2—observed in past studies. The variation observed in previous studies probably has two main sources: variable water levels, with changes due to scouring and to shifting substrates, and the absence of dense aquatic vegetation since 1990. The greatest numbers of species at both stations were recorded before 1990, when conspicuous beds of aquatic plants provided a stable, sheltered substrate for the protozoan community.

Conclusion The protozoan communities above and below Plant Vogtle in 1995 indicate no detrimental

impact on water quality, while long-term trends reflect (1) the availability of suitable substrates and (2) variable water levels. Plant Vogtle did not contribute to any degradation of water in the SRS area.

Noninsect Macroinvertebrate Studies

Initial examinations of the 1995 macroinvertebrate collections above and below Plant Vogtle indicate 14 species. This is a decline from the number of species taken in each of the 1990, 1991, and 1993 surveys and exceeds by 1 the 13 species taken in 1994. All five of these collections were made in years during which the submerged vascular plant beds were absent, and the numbers are lower in diversity than during 1985–1988, when beds of submerged plants were present. Differences between stations in 1995 (11 species from station V-1 and 10 from station V-2) are within the expected 1 to 3 species (mean 1.2) typical of past surveys.

Conclusion The noninsect macroinvertebrate communities above and below Plant Vogtle in 1995 indicate no impact on water quality, while long-term trends probably reflect the loss of submerged vascular plant habitat and elevated water levels.

ANSP Graphic

Figure 12-7 Algal Taxa

The graph's data points show the number of algal taxa at stations above (V-1) and below (V-2) Vogtle Electric Generating Plant on the Savannah River adjacent to SRS.

An EMS sampling technician exchanges Catherwood Diatometers at one of three stations on the Savannah River near SRS. The diatometers, exchanged on a biweekly basis, float glass microscope slides in the water. Diatoms, a type of unicellular algae, attach to slides and then can be scraped off and examined in the laboratory to help researchers determine water quality.

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Insect Studies

The 1994 cursory aquatic insect surveys indicate that water quality conditions below SRS (stations 5 and 6) may be better than water quality conditions above the site (reference station 1), at least during certain times of the year. Specifically, both diversity (the Shannon-Wiener index) and community evenness were higher at the two downriver stations (5 and 6) than at station 1 during certain seasons of the year. Also, the pollution tolerance scores at stations 5 and 6 were at times lower than those at station 1. These combined results may indicate that environmental impacts occur upriver of SRS and that during certain seasons some component(s) of water quality then improves as the pollutants are carried downriver.

During 1994, the ANSP initiated the first thorough investigation of long-term ecological changes of the aquatic insect assemblage in the Savannah River; these data have been collected continuously since 1958. This study of the long-term patterns of aquatic insects indicates that the number of insect taxa generally has increased through the course of the survey (figure 12-8), perhaps as a result of greater efforts to control pollution sources throughout the Savannah River drainage basin. This study also indicates that the number of insect taxa generally has been greater below SRS (station 6) than above it (station 1), as indicated in figure 12-8; this may indicate that the "health" of the river nearly always has been better below the site.

Analyses of the long-term patterns for aquatic insects were extended in 1995 to include the 1994 cursory surveys' results, which highlight a potentially important pattern in the average number of insect

taxa found above and below SRS. Specifically, the average number of insect taxa found at station 6 was relatively low in 1994—both in comparison to previous years' data at station 6 and to levels at station 1 for 1994 (figure 12-8). Such relatively low numbers of insect taxa appear to represent a recent pattern that may indicate that pollution sources entering the Savannah River between stations 1 and 6 have had negative impacts on the insect assemblage at station 6.

Conclusion The 1994 cursory surveys suggest that the water quality of the Savannah River may be better below SRS than above it, at least during certain times of the year. These results are consistent with the patterns for the long-term aquatic insect studies, although recent patterns below the site may indicate that pollution sources not identified by the 1994 ANSP study are entering the river between the upstream and downstream stations.

The 1994 studies in the area of Plant Vogtle detected no significant differences between the insect assemblages above and below the plant, suggesting that Plant Vogtle did not contribute to any degradation of water in the SRS area.

Fish Studies

Recent Savannah River surveys have maintained consistent sampling protocols to provide long-term monitoring of patterns of fish communities along the river in the vicinity of SRS. "Cursory" fish studies, involving a single fall survey using one technique at stations 1, 5, and 6, were conducted in 1994 and 1995. More intensive surveys of two sites—station V-1 (above the Plant Vogtle station) and station V-2

ANSP Graphics

Figure 12-8 Long-Term Trends

This top graph shows long-term trends in the mean number of insect taxa collected from the Savannah River above (station 1) and below (station 6) SRS. The lower graph shows the long-term trend in the difference between the mean number of insect taxa collected above (station 1) and below (station 6) the site.

(below the Plant Vogtle Station)—were conducted in 1994 and 1995, as well.

The 1994 survey was conducted using rotenone sampling in backwater habitats, as in past years. In 1995, the sampling technique was changed to electroshocking because of increasing concerns about the potential environmental effects of rotenone sampling. Sampling was conducted in the same backwater habitats as in previous surveys. Electroshocking was effective in collecting a variety of sizes and taxa of fish. A more thorough comparison of the collecting efficiencies of the electroshocking and rotenone sampling methods will be conducted as part of the final analysis of data from the 1995 collections.

The 1994 collections were similar to those of recent years, during which the major pattern has been a decrease in submerged macrophytes (aquatic plants), accompanied by shifts in abundances of some species that are typical of vegetation or open habitats. There also has been an increase in the frequency of occurrence of some species typical of small tributary streams in the area, although the abundance of these species in the river remains very low. White perch were recorded in the river—and in the area, as far as is known—for the first time on ANSP surveys during 1994. The perch (two were discovered) may have been introduced at upstream reservoirs. There was large variation among fish populations within different backwater sites, and there was no evidence of station difference in fish communities.

Surveys in the vicinity of Plant Vogtle were conducted in 1994 and 1995 using techniques similar to those used in the 1985–1992 Plant Vogtle surveys. Analysis of the 1995 collections will be completed in 1996. The 1994 Plant Vogtle collections were similar to those of past years. Among-year differences typically are greater than among-station differences. As in the cursory surveys, the major changes over time are interpretable as shifts in abundance of different species in response to decreases in aquatic macrophytes in the study area. The increase in frequency of tributary species occurrence in the river noted in the cursory surveys also has been seen in the Plant Vogtle surveys. Four specimens of redeye bass were reported from the Plant Vogtle stations (two at V-1 in 1994 and one each at V-1 and V-2 in 1995), representing new records for the surveys. These probably are derived from upstream riverine or reservoir populations. A white perch was collected at station V-2 in 1995; the species initially was recorded during the 1994 cursory surveys. Stations V-1 and V-2 generally are similar in species occurrence and abundance, although there is a

tendency toward higher species richness at station V-2.

Within comparable habitats, differences in species abundance among the Plant Vogtle samples are related to microhabitat characteristics of the sampling sites. Such microhabitat variation explains much of the apparent variation in abundance between the two stations.

Condition (length-weight relationships of two species) and growth rates of young-of-year of one species (age-length relationships derived from otolith estimates of age) have been analyzed to compare aspects of individual fish performance at the two stations. In general, among-year differences are the major effect; these may reflect among-year differences in environmental factors (temperature patterns, etc.). However, there were also significant station differences. Condition was greater at station V-2 in 1994, although it was greater at station V-1 in 1993. Over all years, growth rates have been higher at station V-2, although there is large among-year difference and there was little between-station difference in 1994.

Conclusion Preliminary analysis of the cursory and Plant Vogtle fish survey data suggests that water quality remains similar to that found in previous years and that Plant Vogtle did not contribute to any degradation of water in the SRS area. Variation in species composition and richness tended to be greater between years than among stations.

Chemistry and Bacteriology Studies

Since the beginning of the water quality sampling of the Savannah River near Plant Vogtle, 28 different water quality elements have been analyzed from stations above and below the facility. Most analytes, however, generally are not substantially impacted by this facility and are more related to in-stream processes and upstream sources. From 1985 to 1995, most water quality parameters did not vary to any great degree in the river. However, the levels of the plant nutrients phosphorus and nitrogen exhibited some decrease during this period. For example, phosphorus is a very important nutrient for plants, but higher levels can result in increased levels of nuisance plants in the river. Once these plants die, decomposition by bacteria can consume significant amounts of oxygen in the water, limiting fish and other sensitive organisms within the river. Historically, phosphorus was contained in detergents, which many municipal and industrial wastewater treatment plants did not remove during treatment. Since approximately 1986, phosphorus-containing detergents have been banned; as a result, phosphorus concentrations decreased from 1985 to 1995 (figure

Figure 12-9 Total Phosphorous

Concentrations of total phosphorous are shown for stations V-1 (above Plant Vogtle) and V-2 (below Plant Vogtle) during the 11-year period from 1985 to 1995. No surveys were conducted at Plant Vogtle during 1989 and 1992.

Ileaf Graphic

Figure 12-10 Biochemical Oxygen Demand

Biochemical Oxygen Demand is shown for stations V-1 (above Plant Vogtle) and V-2 (below Plant Vogtle) during 1985-to-1995 period.

Ileaf Graphic

12-9). Also, with better upstream wastewater treatment, the oxygen demand of the water—as measured by the biochemical oxygen demand—has decreased (figure 12-10), helping to improve the overall water quality of the river in this area.

Conclusion Water quality in the vicinity of Plant

Vogtle has improved since 1986 because of improvement in upstream wastewater treatment. Indications are that certain forms of nitrogen and phosphorus have decreased during the past 10 years, lowering the oxygen demand of the water. Plant Vogtle did not contribute to any degradation of water in the SRS area.

Applicable Guidelines, Standards, and Regulations

THE Savannah River Site (SRS) environmental monitoring program is designed to meet state and federal regulatory requirements for radiological and nonradiological programs. These requirements are stated in U.S. Department of Energy (DOE) orders 5400.1, "General Environmental Protection Program," and 5400.5, "Radiation Protection of the Public and the Environment"; in the National Emission Standards for Hazardous Air Pollutants (NESHAP); in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA—also known as the Superfund); in the Resource Conservation and Recovery Act (RCRA); in the Clean Water Act (i.e., NPDES); and in the National Environmental Policy Act (NEPA). Compliance with these requirements is audited by regulators, including the South Carolina Department

of Health and Environmental Control (SCDHEC) and the U.S. Environmental Protection Agency (EPA), and by DOE.

The SRS environmental monitoring program's objectives incorporate recommendations of the International Commission on Radiological Protection ("Principles of Monitoring for the Radiation Protection of the Public," ICRP Publication 43), of DOE Order 5400.1, and of DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance."

More specific information about certain media is presented in the following paragraphs.

Air

DOE Order 5400.5 also establishes Derived Concentration Guides (DCGs) for radionuclides in air. DCGs, calculated by DOE using methodologies consistent with recommendations found in International Commission on Radiological Protection (ICRP) publications 26 and 30, are used as reference concentrations for conducting environmental protection programs at DOE sites and for making dose comparisons. DCGs are not considered release limits. DCGs are discussed in more detail on page 205.

In addition, radiological airborne releases are subject to EPA regulations cited in 40 CFR 61, Subpart H, NESHAP.

SCDHEC regulates nonradioactive air emissions—both criteria pollutants and toxic air pollutants—from SRS sources. Each source is permitted by SCDHEC, with specific limitations identified, as outlined in various South Carolina air pollution control regulations and standards. The applicable standards are source dependent; however, the primary standards that govern criteria air

pollutants and ambient air quality are identified in SCDHEC Air Pollution Control Regulation 61–62.5, Standard No. 2, which lists eight criteria air pollutants commonly used as indices of air quality (e.g., sulfur dioxide, nitrogen dioxide, and lead) and provides an allowable site boundary concentration for each pollutant. The standards for toxic air pollutants are identified in Regulation 61–62.5, Standard No. 8, which identifies 257 toxic air pollutants and their respective allowable site boundary concentrations. Specific permits for operating facilities are listed in appendix B, "SRS Environmental Permits."

SCDHEC airborne emission standards for each SRS permitted source may differ, based on size and type of facility, type and amount of expected emissions, and the year the facility was placed into operation. For example, for powerhouse boilers constructed before February 11, 1971, the particulate emission limit is 0.6 pounds per million BTU (British thermal unit) of boiler fuel heat input. Boilers constructed after 1971 must meet more stringent standards identified in 40 CFR 60, "New Source Performance

stacks built before February 11, 1971, the opacity standard is 40 percent. For new sources placed into operation after these dates, the opacity standard typically is 20 percent.

Compliance with the various standards is determined in several ways. At the SRS powerhouses, stack compliance tests are performed every 2 years for each boiler by airborne emission specialists under contract to SRS. The tests include

- sampling of the boiler exhaust gases to determine particulate emission rates and carbon dioxide and oxygen concentrations
- laboratory analysis of coal for sulfur content, ash content, moisture content, and BTU output

Sulfur content and BTU output are used to calculate sulfur dioxide emissions. SCDHEC also conducts visible-emissions observations during the tests to verify compliance with opacity standards. The day-to-day control of particulate matter smaller than 10 microns is demonstrated by opacity meters in all SRS powerhouse stacks.

For the package steam generating boilers in K-Area and P-Area, compliance with sulfur dioxide

standards is determined by analysis of the fuel oil being purchased from the offsite vendor. The percent of sulfur in the fuel oil must be below 0.5. Compliance with particulate emission standards was proven by mass-balance calculations rather than stack emission tests.

Compliance by SRS diesel engines and other process stacks is determined during annual compliance inspections by the local SCDHEC district air manager. These inspections include a review of operating parameters, an examination of continuous-emission monitors (where required for process stacks), and a visible-emissions observation for opacity.

Compliance by all toxic air pollutant and criteria pollutant sources is also determined by using EPA-approved air dispersion models. Air dispersion modeling is extremely conservative unless refined models are used. The Industrial Source Complex Version No. 2 model was used to predict maximum ground-level concentrations occurring at or beyond the site boundary for new sources permitted during 1994.

Liquid

DOE Order 5400.5 also establishes DCGs for radionuclides in water. DCGs were calculated by DOE using methodologies consistent with recommendations found in ICRP Publications 26 and 30 and are used

- as reference concentrations for conducting environmental protection programs at DOE sites
- as screening values for considering best available technology for treatment of liquid effluents
- for making dose comparisons

DCGs are discussed in more detail on page 205.

DOE Order 5400.5 exempts aqueous tritium releases from best available technology requirements but not from ALARA considerations.

EPA drinking water standards (40 CFR 141) for radionuclides apply at the water treatment plants serving Beaufort and Jasper counties in South Carolina and Port Wentworth in Georgia. Drinking water standards for specific radionuclides are listed in appendix D, "Drinking Water Standards."

DOE Order 5400.5, chapter II, section 3a(4), requires that settleable solids in process waste streams be tested to ensure that no buildup of

radionuclides occurs in the sediments of the receiving streams.

In 1994, SRS discharged water into site streams and the Savannah River under four NPDES permits: two for industrial wastewater (SC0000175 and SC0044903) and two for stormwater runoff—SCR000000 (industrial) and SCR100000 (construction discharge). A fifth NPDES permit—a no-discharge permit (ND0072125)—was issued to cover land application of sludge generated at onsite sanitary waste plants. Industrial permit SC0000175 expired in 1988, but because SRS has applied for a new one, discharges can continue to be made under the expired permit until the new one is issued. The South Carolina Department of Health and Environmental Control (SCDHEC) sent SRS a preliminary draft permit in May 1994, and SRS has sent its comments to SCDHEC for consideration. When the new permit is issued, it will include the discharge points covered under industrial permit SC0044903 (which expired November 30, 1995). Until then, the site is discharging industrial wastewater under permits SC0000175 and SC0044903.

Stormwater industrial permit SCR000000 covers 48 discharge locations sorted into 11 groups. A

Chart 1 South Carolina Water Quality Standards for Freshwaters

Note: This is a partial list only of water quality standards for freshwaters.

Parameters	Standards
a. Fecal coliform	Not to exceed a geometric mean of 200/100 mL, based on five consecutive samples during any 30-day period; nor shall more than 10 percent of the total samples during any 30-day period exceed 400/100 mL.
b. pH	Range between 6.0 and 8.5.
c. Temperature	Generally, shall not be increased more than 5 °F (2.8 °C) above natural temperature conditions or be permitted to exceed a maximum of 90 °F (32.2 °C) as a result of the discharge of heated liquids. For exceptions, see E-6, Regulation 61-68, State of South Carolina Water Classifications and Standards (May 28, 1993).
d. Dissolved oxygen	Daily average not less than 5.0 mg/L, with a low of 4.0 mg/L.
e. Garbage, cinders, ashes, sludge, or other refuse	None allowed.
f. Treated wastes, toxic wastes, deleterious substances, colored or other wastes, except those in (e) above.	None alone or in combination with other substances or wastes in sufficient amounts to make the waters unsafe or unsuitable for primary-contact recreation or to impair the waters for any other best usage as determined for the specific waters assigned to this class.
g. Ammonia, chlorine, and toxic pollutants listed in the federal Clean Water Act (307) and for which EPA has developed national criteria (to protect aquatic life).	See E-7 (list of water quality standards based on organoleptic data) and E-8 (water quality criteria for protection of human health), Regulation 61-68, State of South Carolina Water Classifications and Standards (May 28, 1993).

SOURCE: [SCDHEC, 1993]

representative site from each group was sampled, as required by the permit. Stormwater construction

permit SCR100000 does not require sampling.

Site Streams

SRS streams are classified as "Freshwaters" by SCDHEC. Freshwaters are defined as surface water suitable for

- primary- and secondary-contact recreation and as a drinking water source after conventional treatment in accordance with SCDHEC requirements

- fishing and survival and propagation of a balanced indigenous aquatic community of fauna and flora
- industrial and agricultural uses

Chart 1 provides some of the specific guides used in water quality surveillance, but because some of these guides are not quantifiable, they are not tracked in response form (i.e., amount of garbage found)

Savannah River

Because SCDHEC classifies the Savannah River as a Freshwater system, the river is governed by the same regulations as site streams (chart 1).

Drinking Water

SRS drinking water systems must meet the water quality criteria mandated by SCDHEC State Primary Drinking Water Regulations, R.61-68. SCDHEC implements drinking water standards which are at least as stringent as EPA standards. Drinking water standards for specific contaminants are provided in appendix D, "Drinking Water Quality Standards."

All 27 systems are monitored routinely for compliance with SCDHEC bacteriological water quality limits. The sampling frequency depends on the population served. All systems are monitored

semiannually for chlorocarbon concentrations. SRS also monitors the 13 larger systems for lead and copper concentrations according to SCDHEC requirements. SCDHEC periodically collects samples from the 13 larger systems to determine compliance with chemical, synthetic organic, and volatile organic water quality limits. The SRS annual chemical analysis program and the A-Area and M-Area chlorocarbon monitoring program were discontinued in September 1994 because they duplicated SCDHEC sampling and other site sampling programs.

Groundwater

Most groundwater constituents at SRS are compared to the final federal primary drinking water standards (DWS), because it is South Carolina policy to classify groundwater aquifers as potential drinking water sources [SCDHEC, 1985]. DWS are not, however, invariably the standards applied by regulatory agencies to those SRS waste units under their jurisdiction. For instance, standards under RCRA are DWS, groundwater protection standards, background levels, and alternate concentration limits.

The standard of 50 µg/L used for lead is the SCDHEC drinking water standard. The federal standard of 15 µg/L is an action level for drinking water at the consumer's tap and thus is inappropriate for groundwater.

Of the radionuclides discussed in this report, only gross alpha, strontium-90, and tritium are compared to true primary drinking water standards. The regulatory standards for radionuclide discharges from industrial and governmental facilities are set under the Clean Water Act, RCRA, and Nuclear Regulatory Commission and DOE regulations. The proposed drinking water maximum contaminant levels discussed in this report are only an adjunct to these release restrictions and are not used to regulate SRS groundwater.

The standard used for nonvolatile beta is a screening standard; when public drinking water exceeds this standard, the supplier is expected to analyze for individual beta and gamma emitters. A nonvolatile

beta result above the standard is an indication that one or more radioisotopes are present in quantities that would exceed the EPA's annual dose equivalent for persons consuming 2L daily. Thus, for the individual beta and gamma radioisotopes (other than strontium-90 and tritium), the standard discussed in this report is the activity per liter that would, if only that isotope were present, exceed the dose equivalent. Similarly, the standards for alpha emitters discussed are calculated to present the same risk at the same rate of ingestion.

Although radium has a current drinking water standard of 5 pCi/L for the sum of radium-226 and radium-228, the standards discussed are the Safe Drinking Water Act maximum contaminant levels of 20 pCi/L for each isotope separately, proposed by EPA in 1991. Radium-226, an alpha emitter, and radium-228, a beta emitter, cannot be analyzed by a single method.

Four other constituents without drinking water standards are discussed when their values exceed certain levels. These constituents are specific conductance at values equal to or greater than 100 µS/cm, alkalinity (as CaCO₃) at values equal to or greater than 100 mg/L, total dissolved solids (TDS) at values equal to or greater than 200 mg/L, and pH at values equal to or below 4.0 or equal to or above 8.5. The selection of these values as standards for comparison is somewhat arbitrary; however, these values exceed levels usually found in background wells at SRS. The occurrence of elevated alkalinity (as CaCO₃), specific conductance, pH, and TDS

within a single well may indicate leaching of the grouting material used in well construction rather

than degradation of the groundwater.

Potential Dose

The radiation protection standards followed by SRS are outlined in DOE Order 5400.5 and include U.S. Environmental protection Agency (EPA) regulations on the potential doses from airborne releases and treated drinking water.

The following radiation dose standards for protection of the public in the SRS vicinity are specified in DOE Order 5400.5.

Drinking Water Pathway		4 mrem per year
Airborne Pathway		10 mrem per year
All Pathways		100 mrem per year

The EPA annual dose standard of 10 mrem (0.1 mSv) for the atmospheric pathway, which is contained in "National Emission Standards for Hazardous Air Pollutants-Radionuclides (NESHAP)," 40 CFR Part 61, Subpart H, is adopted in DOE Order 5400.5.

These dose standards are based on recommendations of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP).

The DOE dose standard enforced at SRS for drinking water consumed from site drinking water systems, community drinking water systems, and downriver water treatment plants is consistent with the criteria contained in "National Interim Primary Drinking Water Regulations, 40 CFR Part 141." Under these regulations, persons consuming drinking water shall not receive an annual whole body dose—DOE Order 5400.5 interprets this dose as committed effective dose equivalent —of more than 4 mrem (0.04 mSv). Both of these dose standards are based on a consumption of 2 liters of water per day. However, some radionuclide dose conversion factors (including tritium) differ between EPA and DOE. Because SRS must use DOE-provided, ICRP-based dose conversion factors, a direct comparison of the estimated drinking water doses in chapter 7, "Potential Radiation Doses," to the EPA drinking water dose standard cannot be made. However, radionuclide concentrations found in drinking water are directly compared to the EPA drinking water concentration standards in chapter 6, "Radiological Environmental Surveillance."

Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides

Average concentrations of radionuclides in airborne emissions are calculated by dividing the yearly release total of each radionuclide from each stack by the yearly stack flow quantities. These average concentrations then can be compared to the DOE derived concentration guides (DCGs), which are found in DOE Order 5400.5 for each radionuclide.

DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs, which are based on a 100-mrem exposure, are applicable at the point of discharge (prior to dilution or dispersion) under conditions of continuous exposure (assumed to be an average inhalation rate of 8,400 cubic meters per year). This means that the DOE DCGs are based on the highly conservative assumption that a member of the public has direct access to and continuously breathes (or is immersed in) the actual air effluent 24 hours a day, 365 days a year. However, because of the large distance between most SRS operating facilities and the site boundary, and because the wind rose at SRS shows no strong prevalence (chapter 7, "Potential Radiation Doses"), this scenario is improbable.

Average annual radionuclide concentrations in SRS air effluent can be referenced to DOE DCGs as a screening method to determine if existing effluent treatment systems are proper and effective.

Comparison of Average Concentrations in Liquid Releases to DOE Derived Concentration Guides

In addition to dose standards, DOE Order 5400.5 imposes other control considerations on liquid releases. These considerations are applicable to direct discharges but not to seepage basin and Solid Waste Disposal Facility (SWDF) migration discharges. The DOE order lists DCG values for most radionuclides. DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. These DCG values are not release limits but screening values for best available technology investigations and for determining whether existing effluent treatment systems are proper and effective.

Per DOE Order 5400.5, exceedance of the DCGs at any discharge point may require an investigation of best available technology waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from best available technology requirements; however, it is not excluded from other as-low-as-reasonably-achievable (ALARA) considerations. DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detectable in the effluent is less than 1.00, based on consecutive 12-month average concentrations.

DCGs, based on a 100-mrem exposure, are applicable at the point of discharge from the effluent

conduit to the environment (prior to dilution or dispersion). They are based on the highly conservative assumption that a member of the public has continuous direct access to the actual liquid effluents and consumes 2 liters of the effluents every day, 365 days a year. However, because of security controls and the large distance between most SRS operating facilities and the site boundary, this scenario is highly improbable, if not impossible.

For each site facility that releases radioactivity, EMS compares the monthly liquid effluent concentrations and 12-month average concentrations against the DOE DCGs:

Environmental Restoration and Waste Management

SRS began its cleanup program in 1981. Two major federal statutes drive the site's environmental restoration and waste management activities: the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). RCRA addresses the management of regulated hazardous waste and requires that permits be obtained for facilities that treat, store, or dispose of hazardous or mixed waste. It also requires that DOE facilities

perform appropriate corrective action. CERCLA (also known as Superfund) addresses the uncontrolled release of hazardous substances and the cleanup of inactive waste sites. This act establishes a National Priority List of sites targeted for assessment and, if necessary, restoration. SRS was placed on this list December 21, 1989 [Fact Sheet, 1992]. SRS entered into an agreement with EPA and SCDHEC as to how SRS would be cleaned up. The agreement became effective in August 1993.

Quality Assurance/Quality Control

DOE Order 5700.6C, "Quality Assurance," sets requirements and guidelines for departmental quality assurance (QA) practices. WSRC has recently developed an implementation plan to address the order, entitled "Revised Implementation Plan: DOE Order 5700.6C". To ensure compliance with regulations and to provide overall quality requirements for site programs, WSRC has developed the *Westinghouse Savannah River Company Quality Assurance Management Plan* (WSRC-RP-92-225). The requirements of WSRC-RP-92-225 are implemented by the *Westinghouse Savannah River Company Quality Assurance Manual* (WSRC 1Q).

The *Environmental Monitoring Section Quality Assurance Plan*, Volume III (WSRC-3Q1-2), part of the EMS WSRC-3Q1 procedure series, was written to apply the QA requirements of WSRC 1Q to the environmental monitoring and surveillance program. The EMS WSRC-3Q1 procedure series includes procedures on sampling, radiochemistry, and water quality that emphasize the quality control requirements for EMS.

NESHAP defines specific QA requirements for monitoring radiological air emissions [EPA, 1989]. The EMS QA program's plan to comply with these requirements is found in WSRC-3Q1-2, Volume I, Attachment 3-1, "NESHAP QA Plan" (WSRC-IM-91-60). The Environmental Monitoring Computer Automation Project (EMCAP), a computer-based sample tracking and radiological data repository system, serves as a NESHAP-required sample tracking system for the EMS laboratory.

To ensure valid and defensible monitoring data, the records and data generated by the monitoring program are maintained according to the requirements of DOE Order 1324.2A, "Records Disposition," and of WSRC 1Q. QA records include sampling and analytical procedure manuals, logbooks, chain-of-custody forms, calibration and training records, analytical notebooks, control charts, validated laboratory data, and environmental reports. These records are maintained and stored per the requirements of WSRC-1M-93-0060, *WSRC Sitewide Records Inventory and Disposition Schedule*.

SRS Environmental Permits

Listed below are the construction and operating permits held by Savannah River Site. The permits are divided by type of permit; for each type, the permit number, permit title, and permitted source are provided.

Air Permits

Permit Number	Permit Title
0080-0041-A-CA	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; A-014 OUTFALL (GROUNDWATER REMEDIATION), 782-3M
0080-0041-A-CB	250-GPM AIR STRIPPER, A-002; CATALYTIC OXIDATION UNIT (A-001A OUTFALL); SRTC
0080-0041-CS-CA	ABRASIVE-BLAST FACILITY, UNIT A; CENTRAL SHOPS
0080-0041-CS-CA	ABRASIVE-BLAST FACILITY, UNIT B; CENTRAL SHOPS
0080-0041-CS-CB	SPRAY-PAINT BOOTH, CENTRAL SHOPS
0080-0041-G-CK	500-KW PORTABLE DIESEL-GENERATOR SET, #E-82643, ALL AREAS
0080-0041-H-CG	350-KW EMERGENCY POWER DIESEL GENERATOR (254-11H) TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261-H
0080-0041-H-CG	350-KW EMERGENCY POWER DIESEL GENERATOR (254-12H) TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261-H
0080-0041-H-CG-R1	CONSOLIDATED INCINERATION FACILITY (CIF) FOR NONRADIOACTIVE HAZARDOUS WASTE, 261-H
0080-0041-H-CH	MODIFICATION TO 0080-0041-S13; LATE-WASH FACILITY, 241-10H
0080-0041-H-CI	CONSOLIDATED INCINERATION FACILITY (CIF) CEMENT STORAGE SILO
0080-0041-H-CI	CONSOLIDATED INCINERATION FACILITY (CIF) CEMENT DAY HOPPER
0080-0041-H-CI	CONSOLIDATED INCINERATION FACILITY (CIF) ASHCRETE UNIT
0080-0041-H-CK	NEW SOLVENT STORAGE TANK FACILITY (FOUR 30,000-GALLON UNDERGROUND TANKS, NEAR CIF, 261-H)
0080-0041-M-CA	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA SEWER (GROUNDWATER REMEDIATION), 782-5M
0080-0041-M-CB	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA BASIN (GROUNDWATER REMEDIATION), 782-4M
0080-0041-M-CC	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA SOLVENT STORAGE (GROUNDWATER REMEDIATION), 782-6M
0080-0041-M-CD	SOIL VAPOR EXTRACTION/CATALYTIC OXIDATION UNIT, 782-7M
0080-0041-M-CE	MIXED-WASTE VITRIFICATION PROCESS, M-AREA

Air Permits, continued

Permit Number	Permit Title
0080-0041-M-CF-R1	CATALYTIC OXIDATION UNIT TO REDUCE VOC EMISSIONS FROM 610-GPM M-1 AIR STRIPPER, M-AREA
0080-0041-M-CG	MODIFICATION TO MIXED-WASTE VITRIFICATION PROCESS (NOx CONTROL STRATEGIES), M-AREA
0080-0041-M-CH	SOIL VAPOR EXTRACTION/CATALYTIC OXIDATION UNIT, 782-8M
0080-0041-PORT-CB	15,000-LB/HR PORTABLE PACKAGE STEAM GENERATOR #1, GENERAL SITE
0080-0042-CN	OFF-GAS COMPONENTS TEST FACILITY, 678-T
0080-0045-CI	NAVAL FUEL MATERIALS FACILITY (FMF) CEMENT & FLY-ASH SILOS & BAG-HOUSE, 247-F
0080-0045-CK	NEW SPECIAL RECOVERY PROCESS WITH CYCLONE, SCRUBBERS, & HEPA FILTERS, 221-F
0080-0046-CE	150-KW EMERGENCY POWER DIESEL GENERATOR, 241-96H
0080-0046-CH	FUEL PROCESSING FACILITY (FPF) WITH HEPA FILTERS
0080-0048-CB	800-KW EMERGENCY POWER DIESEL GENERATOR-A, 107-3P
0080-0048-CC	800-KW EMERGENCY POWER DIESEL GENERATOR-B, 107-2P
0080-0049-CB	800-KW EMERGENCY POWER DIESEL GENERATOR-A, 107-L
0080-0049-CC	800-KW EMERGENCY POWER DIESEL GENERATOR-B, 107-L
EXEMPTED	12,000-GALLON JET FUEL STORAGE TANK TO SERVE AVIATION OPERATIONS DEPARTMENT FACILITY, B-AREA
0080-0041-A01	71.7-MMBTU/HR COAL BOILER #1; CYCLONES, 784-A
0080-0041-A02	71.7-MMBTU/HR COAL BOILER #2; CYCLONES, 784-A
0080-0041-A03	600-KW EMERGENCY POWER DIESEL GENERATOR, 794-A
0080-0041-A04	400-KW EMERGENCY POWER DIESEL GENERATOR, 773-A
0080-0041-A05	150-KW EMERGENCY POWER DIESEL GENERATOR, 751-2A
0080-0041-A06	400-KW EMERGENCY POWER DIESEL GENERATOR (503-2A) TO SERVE 735-A, 735-11A, 774-A, & 773-A FEEDERS
0080-0041-A07	200-KW EMERGENCY POWER DIESEL GENERATOR, 703-A (C-WING)
0080-0041-A08	250-KW EMERGENCY POWER DIESEL GENERATOR, 754-4A
0080-0041-A09	455-KW EMERGENCY POWER DIESEL GENERATOR, 720-2A
0080-0041-A10	1250-KW EMERGENCY POWER DIESEL GENERATOR #1, 754-5A (TO SERVE 703-44A)
0080-0041-A11	1250-KW EMERGENCY POWER DIESEL GENERATOR #2, 754-5A (TO SERVE 703-44A)

Air Permits, continued

Permit Number	Permit Title
0080-0041-A12	70-GPM AIR STRIPPING COLUMN, A-001; CATALYTIC OXIDATION UNIT (A-001A OUTFALL); SRTC
0080-0041-A14	155-KW EMERGENCY POWER DIESEL GENERATOR, 737-2A (TO SERVE SREL)
0080-0041-C06	365-KW EMERGENCY POWER DIESEL GENERATOR, 183-3C
0080-0041-D01	396-MMBTU/HR COAL BOILER #1, CYCLONES; ESP, 484-D
0080-0041-D02	396-MMBTU/HR COAL BOILER #2, CYCLONES; ESP, 484-D
0080-0041-D03	396-MMBTU/HR COAL BOILER #3, CYCLONES; ESP, 484-D
0080-0041-D04	396-MMBTU/HR COAL BOILER #4, CYCLONES; ESP, 484-D
0080-0041-D05	150-KW EMERGENCY POWER DIESEL GENERATOR, 501-D
0080-0041-D06	1.1-TON/HR REJECT SYSTEM; BAGHOUSE, 484-D
0080-0041-D07	300-TON/HR COAL CRUSHER, 484-2D
0080-0041-D08	15,000-GALLON #2 FUEL OIL STORAGE TANK, 500-01; 454-D, NSPS
0080-0041-F05	URANIUM DISSOLUTION, 221-F
0080-0041-F06	200-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254-5F #1
0080-0041-F07	200-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254-5F #2
0080-0041-F08	175-KW EMERGENCY POWER DIESEL GENERATOR, 772-F #1
0080-0041-F09	175-KW EMERGENCY POWER DIESEL GENERATOR, 772-F #2
0080-0041-F10	350-KW EMERGENCY POWER DIESEL GENERATOR, 241-19F
0080-0041-F11	350-KW EMERGENCY POWER DIESEL GENERATOR, 235-F
0080-0041-F12	350-KW EMERGENCY POWER DIESEL GENERATOR, 254-4F
0080-0041-F13	250-KW EMERGENCY POWER DIESEL GENERATOR, 254-1F
0080-0041-F14	200-KW EMERGENCY POWER DIESEL GENERATOR, 241-74F
0080-0041-F15	600-KW EMERGENCY POWER DIESEL GENERATOR, 292-F
0080-0041-F16	600-KW EMERGENCY POWER DIESEL GENERATOR, 247-1F NAVAL FUEL (FMF)
0080-0041-F17	300-KW EMERGENCY POWER DIESEL GENERATOR, 254-7F
0080-0041-F18	415-KW EMERGENCY POWER DIESEL GENERATOR, 772-1F
0080-0041-F19	300-KW EMERGENCY POWER DIESEL GENERATOR, 292-2F
0080-0041-F20	300-KW EMERGENCY POWER DIESEL GENERATOR, 254-9F
0080-0041-F21	1000-KW EMERGENCY POWER DIESEL GENERATOR, 221-F

Air Permits, continued

Permit Number	Permit Title
0080-0041-F22	600-KW EMERGENCY POWER DIESEL GENERATOR, 254-10F
0080-0041-F23	350-KW EMERGENCY POWER DIESEL GENERATOR, 254-8F
0080-0041-F24	NAVAL FUEL MATERIALS FACILITY (FMF) STACK; SCRUBBERS & HEPA FILTERS, 247-F
0080-0041-F25	NAVAL FUEL MATERIALS FACILITY (FMF) WASTEWATER TREATMENT FACILITY; DEMISTER, 247-F
0080-0041-F26	NINE FINISHING VENTS, NINE SCRUBBERS, & NINE HEPA FILTERS FOR NAVAL FUEL MATERIALS FACILITY (FMF), 247-F
0080-0041-F27	455-KW EMERGENCY POWER DIESEL GENERATOR, 720-F
0080-0041-G01	WASTE PAINT SOLVENTS DISTILLATION & CONDENSATION UNIT #1; CARBON SCRUBBER, ALL AREAS
0080-0041-G02	WASTE PAINT SOLVENTS DISTILLATION & CONDENSATION UNIT #2; CARBON SCRUBBER, ALL AREAS
0080-0041-G03	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-112; ALL AREAS
0080-0041-G04	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-113; ALL AREAS
0080-0041-G05	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-114; ALL AREAS
0080-0041-G06	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-115; ALL AREAS
0080-0041-G07	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-116; ALL AREAS
0080-0041-G08	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-128; ALL AREAS
0080-0041-G09	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-129; ALL AREAS
0080-0041-G10	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-130; ALL AREAS
0080-0041-G11	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-131; ALL AREAS
0080-0041-G12	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52-132; ALL AREAS
0080-0041-G13	200-KW MOBILE EMERGENCY GENERATOR, SME 60-171; ALL AREAS
0080-0041-G14	15,000-LB/HR PORTABLE PACKAGE STEAM GENERATING BOILER #2 (NSPS), ALL AREAS
0080-0041-G15	PORTABLE NORKOT MAXIGRIND 9100 DIESEL-POWERED CHIPPER UNIT, SME 36-225; ALL AREAS
0080-0041-G16	190-KW MOBILE EMERGENCY GENERATOR, SRO #0391; ALL AREAS
0080-0041-G17	250-KW MOBILE EMERGENCY GENERATOR, SRO #7835; ALL AREAS
0080-0041-G18	PORTABLE SOIL VAPOR EXTRACTION UNIT, SRO #5957; ALL AREAS
0080-0041-G19	600-KW MOBILE EMERGENCY DIESEL GENERATOR, SRO #5422

Air Permits, continued

Permit Number	Permit Title
0080-0041-G20	300-KW MOBILE EMERGENCY DIESEL GENERATOR, SRO #5430
0080-0041-G21	300-KW MOBILE EMERGENCY DIESEL GENERATOR, SRO #6455
0080-0041-G22	260-KW MOBILE EMERGENCY GENERATOR, SRO #7850; ALL AREAS
0080-0041-G23	250-KW MOBILE EMERGENCY GENERATOR, SRO #7858; ALL AREAS
0080-0041-G24	WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #3; CARBON SCRUBBER, ALL AREAS
0080-0041-G25	WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #4; CARBON SCRUBBER, ALL AREAS
0080-0041-G26	WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #5; CARBON SCRUBBER, ALL AREAS
0080-0041-G27	1000-KW EMERGENCY POWER DIESEL GENERATOR TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), 654-G
0080-0041-G28	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #5233; ALL AREAS
0080-0041-G29	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #5248; ALL AREAS
0080-0041-G30	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #5278; ALL AREAS
0080-0041-G31	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6940; ALL AREAS
0080-0041-G32	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6941; ALL AREAS
0080-0041-G33	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6943; ALL AREAS
0080-0041-G34	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6944; ALL AREAS
0080-0041-G35	PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6945; ALL AREAS
0080-0041-H01	71.7-MMBTU/HR COAL BOILER #1; 2 CYCLONES, 784-H
0080-0041-H02	71.7-MMBTU/HR COAL BOILER #2; 2 CYCLONES, 784-H
0080-0041-H03	71.7-MMBTU/HR COAL BOILER #3; 2 CYCLONES, 784-H
0080-0041-H04	400-LB/HR TYPE "O" WASTE INCINERATOR, BAGHOUSE & HEPA FILTERS (BETA-GAMMA INCINERATOR), 230-H
0080-0041-H05	SEPARATION PROCESS, 221-H
0080-0041-H06	200-KW EMERGENCY POWER DIESEL GENERATOR, 234-4H
0080-0041-H07	200-KW EMERGENCY POWER DIESEL GENERATOR, 299-1H
0080-0041-H08	200-KW EMERGENCY POWER DIESEL GENERATOR, 241-74H
0080-0041-H09	250-KW EMERGENCY POWER DIESEL GENERATOR, 254-1H
0080-0041-H10	275-KW EMERGENCY POWER DIESEL GENERATOR, 254-3H

Air Permits, continued

Permit Number	Permit Title
0080-0041-H11	300-KW EMERGENCY POWER DIESEL GENERATOR, 221-HB
0080-0041-H12	300-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254-5H, #1
0080-0041-H13	300-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254-5H, #2
0080-0041-H14	300-KW EMERGENCY POWER DIESEL GENERATOR, 232-H
0080-0041-H15	300-KW EMERGENCY POWER DIESEL GENERATOR, 234-H
0080-0041-H16	500-KW EMERGENCY POWER DIESEL GENERATOR, 232-H, #2
0080-0041-H17	500-KW EMERGENCY POWER DIESEL GENERATOR, 254-H
0080-0041-H18	600-KW EMERGENCY POWER DIESEL GENERATOR, 292-H
0080-0041-H19	1000-KW EMERGENCY POWER DIESEL GENERATOR, 221-H
0080-0041-H20	500-KW EMERGENCY POWER DIESEL GENERATOR, 254-8H
0080-0041-H21	400-KW EMERGENCY POWER DIESEL GENERATOR, 254-9H
0080-0041-H22	765-KW EMERGENCY POWER DIESEL GENERATOR (254-10H) TO SERVE 233-H (RTF)
0080-0041-H23	2500-GPM EMERGENCY DIESEL FIRE WATER PUMP #1, 241-125H (ITP)
0080-0041-H24	2500-GPM EMERGENCY DIESEL FIRE WATER PUMP #2, 241-125H (ITP)
0080-0041-H25	455-KW EMERGENCY POWER DIESEL GENERATOR, 720-H
0080-0041-H26	IN-TANK PRECIPITATION (ITP) TANK #48; 241-948H
0080-0041-H27	IN-TANK PRECIPITATION (ITP) TANK #49; 241-949H
0080-0041-H28	IN-TANK PRECIPITATION (ITP) FILTER/STRIPPER BUILDING, 241-96H
0080-0041-H30	IN-TANK PRECIPITATION (ITP) TANK #50; 241-950H
0080-0041-H31	IN-TANK PRECIPITATION (ITP) TANK #22; 241-922H
0080-0041-H32	12,500-GALLON NO. 2 FUEL OIL STORAGE TANK TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF)
0080-0041-K01	194.5-MMBTU/HR COAL BOILER, CYCLONES; UNIT #1
0080-0041-K03	1250-KW EMERGENCY POWER DIESEL GENERATOR, 108-1K
0080-0041-K04	1250-KW EMERGENCY POWER DIESEL GENERATOR, 108-2K
0080-0041-K05	150-KW EMERGENCY POWER DIESEL GENERATOR #1, 108-4K
0080-0041-K06	150-KW EMERGENCY POWER DIESEL GENERATOR #2, 108-4K
0080-0041-K07	200-KW EMERGENCY POWER DIESEL GENERATOR, 152-7K

Air Permits, continued

Permit Number	Permit Title
0080-0041-K08	365-KW EMERGENCY POWER DIESEL GENERATOR (183-3K) TO SERVE 183-2K, 905-95K, & 905-106K
0080-0041-K09	520-BHP EMERGENCY DIESEL BOOSTER PUMP, 191-K (SERVING 105-K)
0080-0041-K10	800-KW EMERGENCY POWER DIESEL GENERATOR-A, 107-K
0080-0041-K11	800-KW EMERGENCY POWER DIESEL GENERATOR-B, 107-K
0080-0041-K12	76.8-MMBTU/HR NO. 2 FUEL OIL-FIRED BOILER (NSPS SOURCE), K-AREA
0080-0041-K13	38-MMBTU/HR NO. 2 FUEL OIL-FIRED PACKAGE STEAM GENERATOR RATED AT 30,000-LB/HR STEAM PRODUCTION (NSPS SOURCE), K-AREA
0080-0041-K14	2500-GPM (375-BHP) EMERGENCY-FIRE WATER PUMP, 192-2K
0080-0041-K15	30,000-GALLON #2 FUEL OIL STORAGE TANK, 500-02; 184-2K (NSPS SOURCE)
0080-0041-K15	30,000-GALLON #2 FUEL OIL STORAGE TANK, 500-03; 184-2K (NSPS SOURCE)
0080-0041-L01	1250-KW EMERGENCY POWER DIESEL GENERATOR, 108-1L
0080-0041-L02	1250-KW EMERGENCY POWER DIESEL GENERATOR, 108-2L
0080-0041-L03	520-BHP EMERGENCY DIESEL BOOSTER PUMP, 191-L
0080-0041-L04	150-KW EMERGENCY POWER DIESEL GENERATOR #1, 108-4L
0080-0041-L05	150-KW EMERGENCY POWER DIESEL GENERATOR #2, 108-4L
0080-0041-L06	200-KW EMERGENCY POWER DIESEL GENERATOR, 152-7L
0080-0041-L07	365-KW EMERGENCY POWER DIESEL GENERATOR, 183-3L
0080-0041-M02	ALUMINUM TUBE CLEANING WITH NITRIC ACID, 321-M
0080-0041-M03	200-KW EMERGENCY POWER DIESEL GENERATOR, 320-M (REPLACED 150-KW GENERATOR)
0080-0041-M04	610-GPM M-1 AIR STRIPPER, M-AREA
0080-0041-N01	2500-GPM (370-BHP) DIESEL FIRE PUMP, CENTRAL SHOPS (MATERIALS MANAGEMENT RECEIVING & STORAGE)
0080-0041-P02	194.5-MMBTU/HR COAL BOILER, CYCLONES, 184-P #2
0080-0041-P03	1250-KW EMERGENCY POWER DIESEL GENERATOR, 108-1P
0080-0041-P04	1250-KW EMERGENCY POWER DIESEL GENERATOR, 108-2P
0080-0041-P05	150-KW EMERGENCY POWER DIESEL GENERATOR, 108-4P, #1
0080-0041-P06	150-KW EMERGENCY POWER DIESEL GENERATOR, 108-4P, #2
0080-0041-P07	200-KW EMERGENCY POWER DIESEL GENERATOR, 152-7P
0080-0041-P08	365-KW EMERGENCY POWER DIESEL GENERATOR, 183-2P

Air Permits, continued

Permit Number	Permit Title
0080-0041-P09	520-BHP EMERGENCY DIESEL BOOSTER PUMP, 191-P (SERVING 105-P)
0080-0041-S05	2050-KW EMERGENCY POWER DIESEL GENERATOR #1, 292-S
0080-0041-S06	2050-KW EMERGENCY POWER DIESEL GENERATOR #2, 292-S
0080-0041-S07	261-BHP EMERGENCY FIRE WATER PUMP, 980-S
0080-0041-S08	DWPF VITRIFICATION BUILDING (PROVIDES VENTILATION FOR PERSONNEL CORRIDOR, LABORATORIES, WELD TEST, & CHEMICAL STORAGE TANKS - ZONE 2, 221-S); HEPA FILTER
0080-0041-S09	DWPF PROCESS STACK (PROVIDES VENTILATION FOR PROCESS CELLS, PROCESS VESSEL VENT, & MELTER OFF-GAS - ZONE 1, 291-S); SAND FILTER
0080-0041-S10	DWPF COLD-FEEDS FACILITY (CHEMICAL STORAGE TANKS FOR FORMIC ACID, HYDROXYLAMINE NITRATE, OXALIC ACID, NITRIC ACID, SODIUM HYDROXIDE, & A GLASS FRIT HANDLING SYSTEM WITH BAGHOUSE, 422-S)
0080-0041-S11	DWPF 150,000-GALLON ORGANIC WASTE STORAGE TANK VENT (BENZENE STORAGE, 430-S); INTERNAL FLOATING ROOF WITH PRIMARY & SECONDARY SEALS, NITROGEN BLANKET, & HEPA FILTER
0080-0041-S12	DWPF LOW-POINT PUMP PIT (TRANSFER OF RADIOACTIVE SLURRIES & SOLUTIONS, 511-S); HEPA FILTERS
0080-0041-T02	300-KW EMERGENCY POWER DIESEL GENERATOR, 673-T
0080-0041-T03	300-KW EMERGENCY POWER DIESEL GENERATOR, 672-T
0080-0041-T04	20-LB/HR SHIRCO INCINERATOR, HEPA FILTERS, 677-T
0080-0041-T05	PRECIPITATE HYDROLYSIS EXPERIMENTAL FACILITY, 682-T
0080-0041-T06	1000-KW EMERGENCY POWER DIESEL GENERATOR, 654-1T
0080-0041-T07	300-KW EMERGENCY POWER DIESEL GENERATOR (654-T) TO SERVE 678-T
0080-0041-Z01	425-KW EMERGENCY POWER DIESEL GENERATOR, 956-Z
0080-0041-Z02	SILO TO STORE CEMENT OR SLAG WITH BAGHOUSE, 205-Z
0080-0041-Z03	THREE FLY-ASH/CEMENT SILOS WITH BAGHOUSE, 205-Z
0080-0041-Z04	WEIGH HOPPER WITH BAGHOUSE, 205-Z
0080-0041-Z05	TWO PREMIX AIR BLENDERS WITH BAGHOUSE, 205-Z
0080-0041-Z06	PREMIX FEED BIN WITH BAGHOUSE, 210-Z
0080-0041-Z07	GROUT MIXER WITH BAGHOUSE, SCRUBBER, & 2 HEPA FILTERS (1 IN SERVICE, 1 STANDBY) 210-Z
0080-0041-Z08	LOW-POINT DRAIN TANK VENT WITH HEPA FILTER, 551-Z

Domestic Water Permits

The South Carolina Department of Health and Environmental Control (SCDHEC) has granted Westinghouse Savannah River Company's Environmental Protection Department the authority—under the Modified Permitting Program (MPP)—to review domestic water construction permit application packages and to issue domestic water construction and operating permits on behalf of SCDHEC. Several South Carolina municipalities have similar agreements with SCDHEC. All domestic water permits listed in this report that begin with "M" fall under the MPP.

Permit Number	Permit Title
407705M	DOMESTIC WATER LINE TO SERVE C-AREA COMBINED DOMESTIC/FIRE SYSTEM
408035M	DOMESTIC WATER LINE TO SERVE B-AREA ENGINEERING AND OPERATIONS SUPPORT FACILITY
408505M	DOMESTIC WATER SYSTEM UPGRADE – PHASE 1; D-AREA
409115M	DOMESTIC WATER SYSTEM UPGRADE – PHASE 1; B-AREA
409125M	DOMESTIC WATER SYSTEM UPGRADE – PHASE 1; A-AREA
410155M	DOMESTIC WATER SYSTEM UPGRADE – PHASE 1; N-AREA
411337	SODIUM HYPOCHLORITE SYSTEM, 780–1A
M0016	DOMESTIC WATER SYSTEM UPGRADE–PHASE 1; TNX-AREA
200092	DOMESTIC WATER DEEP WELLS, 905–104L & 904–105L, TO SERVE L-AREA
200279	DOMESTIC WATER DEEP WELL, 905–120P, TO SERVE P-AREA
201715	DOMESTIC WATER DEEP WELL, 905–107G, TO SERVE RAILROAD CLASSIFICATION YARD
202822	DOMESTIC WATER SYSTEM (TEST WELL #1, "DIVISION A") TO SERVE D-AREA
202822A1	DOMESTIC WATER SYSTEM (PUMP, PIPING, TREATMENT, STORAGE TANK) TO SERVE D-AREA
202915	DOMESTIC WATER WELL & DISTRIBUTION SYSTEM TO SERVE CONSTRUCTION SUPPORT AREA, S-AREA
203427	SODIUM HYPOCHLORITE SYSTEM, 280–F
203467	SODIUM HYPOCHLORITE SYSTEM, 280–H
203590	DOMESTIC WATER WELL, 905–126G, TO SERVE 100-AREA FIRE STATION, 709–1G (INTERSECTION OF ROAD C & ROAD 7)
203628	DOMESTIC WATER WELL, 905–118G, TO SERVE PISTOL RANGE (REPLACED WELL 905–11G)
203638	DOMESTIC WATER WELL, 905–117G, TO SERVE ALLENDALE BARRICADE (REPLACED WELL 905–6G)
203786	DOMESTIC WATER WELL, 905–114G, TO SERVE RIVER WATER PUMPING STATION, 681–3G (REPLACED WELL 905–4G)
204138	DOMESTIC WATER DEEP WELL, 905–106K, TO SERVE K-AREA (REPLACED WELL 905–94K)

Domestic Water Permits, continued

Permit Number	Permit Title
204198	DOMESTIC WATER DEEP WELL, 905-119H, TO SERVE H-AREA (REPLACED WELL 905-66H)
205142	POLYPHOSPHATE SYSTEMS, 200-F-AREA
205217	UPGRADE INSTRUMENTATION 280-1H (CAUSTIC FEED SYSTEM); (F-Area also covered under this permit)
205217	UPGRADE INSTRUMENTATION 280-1F (CAUSTIC FEED SYSTEM); (H-Area also covered under this permit)
205702	POLYPHOSPHATE SYSTEMS, 200-H-AREA
205877	DOMESTIC WATER WELL, 905-116G, PIPING & STORAGE TANK TO SERVE AUGUSTA BARRICADE, 701-6G (REPLACED WELL 905-10G)
206474	DOMESTIC WATER TEST WELL, 905-136G, TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF)
206474A1	DOMESTIC WATER SYSTEM (PUMP, WELLHEAD PIPING, TREATMENT, TANK & DISTRIBUTION SYSTEM) TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF)
206501	DOMESTIC WATER DEEP WELL, 905-125B (TEST WELL) TO SERVE B-AREA (REPLACES WELL 905-59B)
206501A1	DOMESTIC WATER DEEP WELL, 905-125B, (PUMP/PIPING/TREATMENT) TO SERVE B-AREA
206575	DOMESTIC WATER DEEP WELLS, 905-112G & 905-113G, TO SERVE A-AREA & M-AREA
207853	DOMESTIC WATER SYSTEM (BACKUP TEST WELL) TO SERVE D-AREA
207853A1	DOMESTIC WATER SYSTEM (BACKUP PUMP, PIPING, TREATMENT, STORAGE TANK) TO SERVE D-AREA
208425	DOMESTIC WATER TEST WELL, 905-108G, TO SERVE ADVANCED TACTICAL TRAINING ACADEMY (ATTA), 617-G
208425A1	DOMESTIC WATER SYSTEM (PUMP, PIPING, TREATMENT, TANK) TO SERVE ADVANCED TACTICAL TRAINING ACADEMY (ATTA), 617-G
208434	DOMESTIC WATER SYSTEMS (WELLS/PIPING/TREATMENT) TO SERVE ROAD 2 BARRICADE 701-8G (WELL 905-111G), ROAD 3 BARRICADE 701-12G (WELL 905-110G), & ROAD 6 BARRICADE 701-13G (WELL 905-109G)
208866	DOMESTIC WATER WELL, 905-115G, TO SERVE AIKEN BARRICADE, 701-5G (REPLACED WELL 905-69G)
209191	DOMESTIC WATER TEST WELL, 905-131G, TO SERVE SREL PAR POND LABORATORY, 737-G
209191A1	DOMESTIC WATER SYSTEM (PUMP, PIPING, TREATMENT, STORAGE TANK) TO SERVE SREL PAR POND LABORATORY, 737-G
209454	DOMESTIC WATER WELLS, 905-96G & 905-97G, TO SERVE TNX-AREA

Domestic Water Permits, continued

Permit Number	Permit Title
210657	DOMESTIC WATER DEEP WELL, 905-103F, & DISTRIBUTION SYSTEM TO SERVE F-AREA (REPLACED WELL 905-39F)
212745	DOMESTIC WATER DEEP WELLS, 905-1 & 905-2, TO SERVE S-AREA
304134	TNX-AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS
400203	TNX-AREA HYDROPNEUMATIC DOMESTIC WATER STORAGE TANK
400347	DOMESTIC WATER HEADERS, TNX-AREA
400737	DOMESTIC WATER SYSTEM (PUMP, PIPING, STORAGE TANK) TO SERVE, Z-AREA
401118	DOMESTIC WATER LINE TO SERVE NEW WASTE TRANSFER FACILITY (NWTF), 241-102H
401354	250,000-GALLON DOMESTIC WATER STORAGE TANK, A-AREA
401446	DOMESTIC WATER LINE TO SERVE PRODUCTION CONTROL FACILITY, 772-1F
401654	B-AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS
402186	DOMESTIC WATER LINES TO SERVE S-AREA
402343	H-AREA BACKUP BOOSTER PUMP ("AS BUILT")
402874	SEGREGATED DOMESTIC WATER SUPPLY, 300/700 AREA, PHASE I
402925-RI	DOMESTIC WATER LINES TO SERVE TEMPORARY CONSTRUCTION BUILDINGS, S-AREA
403434	SEGREGATED DOMESTIC WATER SUPPLY, 300/700 AREA, PHASE II
404608	DOMESTIC WATER LINE TO SERVE 717-K
404618	DOMESTIC WATER LINE TO SERVE 705-C
405184	DOMESTIC WATER LINE TO SERVE 773-41A & 773-42A
405556	DOMESTIC WATER LINES TO SERVE H-AREA
405566	UPGRADE DOMESTIC WATER SYSTEM, 200-F
406137	DOMESTIC WATER LINE TO SERVE INTERIM STORAGE & REDRUMMING FACILITY, 645-1N & 645-2N (FORMERLY 709-1G & 709-2G)
406871E1	DOMESTIC WATER LINE TO SERVE B-AREA ENGINEERING CENTER, 730-B
407830	DOMESTIC WATER LINE TO SERVE N-AREA MATERIAL MANAGEMENT RECEIVING & STORAGE FACILITIES (MMRSF), 731-N THROUGH 731-4N
408221	K-AREA DOMESTIC WATER TREATMENT & DISTRIBUTION SYSTEM UPGRADE
408285	DOMESTIC WATER LINE TO SERVE TNX-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607-41T
408552	K-AREA FILTER BACKWASH SYSTEM

Domestic Water Permits, continued

Permit Number	Permit Title
408595	DOMESTIC WATER LINE TO SERVE CONSTRUCTION OFFICE BUILDING, 305-1M
409484	DOMESTIC WATER LINE TO SERVE REACTOR SIMULATOR FACILITY, 707-C
409955	DOMESTIC WATER & FIRE PROTECTION LINES TO SERVE HELICOPTER FACILITY, 703-5G & 703-6G
410406	DOMESTIC WATER LINE TO SERVE VEHICLE PROTECTION SHELTER SAFETY SHOWER & EYE WASH STATION, 777-A
411357	DOMESTIC WATER LINE TO SERVE THREE SAFETY SHOWERS AT ETF-H LIFT STATION
411995	DOMESTIC WATER LINE TO SERVE 340-M & 341-M
412255	DOMESTIC WATER LINE FROM DOMESTIC WATER DEEP WELLS (905-112G & 905-113G) TO SERVE A-AREA & M-AREA
412917	DOMESTIC WATER LINE TO SERVE F/H ETF CONTROL BUILDING, 241-84H & F/H ETF TREATMENT BUILDING, 241-81H
510255	MODIFICATION TO D-AREA DOMESTIC WATER SYSTEM (SODIUM ALUMINATE FEED SYSTEM)
603505	FORESTRY AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS (SODA ASH FEED SYSTEM)
LS-1-W	DOMESTIC WATER LINE TO SERVE TRITIUM FACILITIES SUPPORT BUILDING, 235-H
LS-106-W	DOMESTIC WATER LINE TO SERVE CONSTRUCTION SUPPORT FACILITIES AT DWPF AUXILIARY PUMP PIT, S-AREA
LS-11-W	DOMESTIC WATER LINE TO SERVE NAVAL FUEL MATERIAL FACILITY (FMF), 247-F
LS-115-W	DOMESTIC WATER LINE TO SERVE CENTRAL SHOPS ADMINISTRATION BUILDING (CSAB), 704-3N
LS-118-W	DOMESTIC WATER LINE TO SERVE 719-4A
LS-119-W	DOMESTIC WATER LINE TO SERVE 730-M
LS-139-W	DOMESTIC WATER LINE TO SERVE REPLACEMENT TRITIUM FACILITY (RTF), 233-H & 249-H
LS-168-W	DOMESTIC WATER LINE TO SERVE SUPPORT SERVICES BUILDING, 716-2A
LS-178-W	DOMESTIC WATER LINE TO SERVE COMPUTER REPAIR BUILDING, 722-5A
LS-185-W	DOMESTIC WATER LINE TO SERVE 703-41A
LS-187-W	DOMESTIC WATER LINE TO SERVE THREE SAFETY SHOWERS AT THE ETF-F LIFT STATION

Domestic Water Permits, continued

Permit Number	Permit Title
LS-232-W	TEMPORARY DOMESTIC WATER LINE TO SERVE TOILET TRAILER, 704-47S, & OFFICES 704-44S, 704-45S, & 704-46S (Formerly FPF Construction Engineers' Offices 225-1H, 225-2H, & 225-3H) & TOILET TRAILER, 704-47H, & OFFICES 704-27H, 704-32H, 704-37H, & 704-42H
LS-233-W	TEMPORARY DOMESTIC WATER LINE TO SERVE F/H ETF TOILET TRAILER, 704-46H
LS-238-W	DOMESTIC WATER LINE TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701-3H, & CENTRAL ALARM STATION (CAS), 720-H
LS-25-W	DOMESTIC WATER LINE TO SERVE C-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607-9C
LS-264-W	DOMESTIC WATER LINE TO SERVE CONSTRUCTION QUALITY ASSURANCE OFFICE BUILDING, 704-1N
LS-265-W	DOMESTIC WATER LINE TO SERVE EQUIPMENT STORAGE & HEALTH PROTECTION (HP) FACILITY, 221-25F
LS-4-W	DOMESTIC WATER LINE TO SERVE OFFICE BUILDING, 703-41A
LS-43-W	"AS BUILT" DOMESTIC WATER LINE TO SERVE 773-A, 773-41A, & 773-42A
LS-55-W	DOMESTIC WATER LINE TO SERVE N-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607-38N
LS-56-W	DOMESTIC WATER LINE TO SERVE H-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607-20H
LS-57-W	DOMESTIC WATER LINE TO SERVE RADIOLOGICAL & ENVIRONMENTAL SUPPORT FACILITY, 735-11A
LS-60-W	DOMESTIC WATER LINE TO SERVE 704-S ADMINISTRATION BUILDING
LS-61-W	DOMESTIC WATER LINE TO SERVE S-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 980-S
LS-7-W	DOMESTIC WATER LINE TO SERVE NAVAL FUEL MATERIAL FACILITY (FMF), 221-17F, & 221-18F
LS-8-W	DOMESTIC WATER LINE TO SERVE 703-4A, 703-6A, & 703-34A
LS-81-W	DOMESTIC WATER LINE TO SERVE CONSTRUCTION ADMINISTRATION OFFICE BUILDING, 704-6C
LS-82-W	DOMESTIC WATER LINE TO SERVE B-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607-2B
LS-91009	DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 245-F THROUGH 245-12F
LS89002	DOMESTIC WATER & FIRE PROTECTION LINES TO SERVE TEMPORARY MODULAR OF FICES 706-8C THROUGH 706-19C & 703-1C THROUGH 703-28C
LS89008	EXPANSION OF DOMESTIC WATER & FIRE PROTECTION TO SERVE MODULAR OF FICES, B-AREA

Domestic Water Permits, continued

Permit Number	Permit Title
LS89016	RELOCATION OF DOMESTIC WATER LINE AT L-AREA SANITARY FLOW EQUALIZATION BASIN
LS89017	DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICE TRAILERS, 707-7K THROUGH 707-19K
LS89020	INSTALL BLOCK VALVE ON 200-F AREA DOMESTIC WATER WELL HEADER
LS89028	DOMESTIC WATER LINE TO SERVE GENERAL PHYSICS OFFICE, 777-18A
LS89029	DOMESTIC WATER LINE TO SERVE MATERIAL MANAGEMENT, RECEIVING & STORAGE FACILITIES (MMRSF) FIRE WATER STORAGE TANK MAKEUP WATER SYSTEM, 681-17N, & 681-18N
LS91001	DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 773-62A THROUGH 773-70A
LS91005	DOMESTIC WATER LINE TO FILL IN-TANK PRECIPITATION (ITP) FIRE TANK, 241-20H
LS91006	DOMESTIC WATER LINE TO FILL IN-TANK PRECIPITATION (ITP) FIRE TANK, 241-21H
LS91007	DOMESTIC WATER LINE REROUTE TO SERVE SAFETY SHOWER/EYEWASH STATIONS AT THE REPLACEMENT HIGH-LEVEL EVAPORATOR, H-AREA
LS91010	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, B-AREA
LS91011	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, 3/700 AREA
LS91012	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, C-AREA
LS91013	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, N-AREA
LS91014	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, D-AREA
LS91015	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, FORESTRY AREA
LS91016	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, L-AREA
LS91017	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, P-AREA
LS91018	UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, RAILROAD YARD
M0015	DOMESTIC WATER LINE TO SERVE 284-H CHANGE ROOM
M0025R2	DOMESTIC WATER LINE TO SERVE DWPF LATE-WASH FACILITY
M0035	DOMESTIC WATER SYSTEM UPGRADE - PHASE 1; FORESTRY AREA
M0045	DOMESTIC WATER LINE TO SERVE 704-8T
M0054E1	DOMESTIC WATER LINE TO SERVE B-AREA UTILITIES UPGRADE; 735-4B & 735-2B
M0055	DOMESTIC WATER LINE TO SERVE SRFS EDUCATION TRAILER RESTROOMS, 760-22G

Domestic Water Permits, continued

Permit Number	Permit Title
M0064E1	DOMESTIC WATER LINE TO SERVE COMPRESSED-GAS STORAGE FACILITY, 731-6N
M0065	K-AREA DOMESTIC WATER LOOP COMPLETION
M0073E1	DOMESTIC WATER LINE TO SERVE SAFEGUARDS & HEALTH PROTECTION SHOP, 228-H
M0075	DOMESTIC WATER LINE TO SERVE WASTE MANAGEMENT OFFICE AND STORAGE BUILDING, 241-102H
M0084E1	241-2H CONTROL BUILDING, TYPE III TANK SALT REMOVAL
M0085	DOMESTIC WATER LINE TO SERVE FORESTRY SERVICE BUILDING, 760-15G
M0103E1	DOMESTIC WATER LINE TO SERVE DRINKING WATER FOUNTAIN, 740-4A
M0012E2	DOMESTIC WATER LINE TO SERVE B-AREA FIRE PROTECTION SUPPLY SYSTEM
M0013	DOMESTIC WATER LINE TO SERVE NITRIC TANK SAFETY SHOWER/EYE WASH STATION, 221-S
M0014E1	DOMESTIC WATER LINE TO SERVE TRAINING CENTER, 766-H (FORMERLY 225-H)
M0022	DOMESTIC WATER LINE TO SERVE PORTABLE BOILER INSTALLATION, 183-2P,
M0023E1	DOMESTIC WATER LINE TO SERVE CONSOLIDATED INCINERATION FACILITY, 261-H
M0024	DOMESTIC WATER LINE TO SERVE ESSENTIAL-MATERIALS WAREHOUSE RE-ROUTE, 315-M
M0032	DOMESTIC WATER LINE TO SERVE PORTABLE BOILER INSTALLATION, 183-2K
M0033E1	DOMESTIC WATER LINE TO SERVE F-AREA & E ROAD FIRE PROTECTION SUPPLY
M0034	DOMESTIC WATER LINE TO SERVE RESTROOM TRAILER, 760-21G; FORESTRY AREA
M0042E1	DOMESTIC WATER LINE TO SERVE LUNCHROOM TRAILER, 773-72A
M0043	DOMESTIC WATER LINE TO SERVE OPERATION SUPPORT BUILDING, 704-2H
M0044	DOMESTIC WATER LINE TO SERVE 412-D & 413-D ASBESTOS ABATEMENT SHOWERS
M0052	DOMESTIC WATER LINE TO SERVE LUNCHROOM TRAILER, 740-16A
M0053	DOMESTIC WATER LINE TO SERVE 221-S LAB TRAILERS SAFETY SHOWER/EYE WASH STATION
M0063R1	DOMESTIC WATER LINE TO SERVE ADMINISTRATIVE SUPPORT BUILDING, 708-1B
M0072E2	DOMESTIC WATER LINE TO SERVE FLAMMABLE-STORAGE FACILITY, 731-5N

Domestic Water Permits, continued

Permit Number	Permit Title
M0074R1	DOMESTIC WATER LINE TO SERVE SAFETY SHOWER/EYEWASH STATION, 421-6D
M0082	DOMESTIC WATER LINE TO SERVE CENTRAL SERVICES WORKS ENGINEERING (CSWE) FACILITY, 717-11A
M0083	DOMESTIC WATER LINE TO SERVE RESTROOM TRAILER, 704-11K
M0092	DOMESTIC WATER LINE TO SERVE ENGINEERING SUPPORT BUILDING, 707-7F
M0093	D-AREA BACKUP WELL CONNECTOR
M0102	DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICES, 233-20H & 233-21H,
M0112	DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICES, 742-G & 742-1G THROUGH 742-14G,
M0113	DOMESTIC WATER LINE TO SERVE 704-11K, 704-12K, & 705-K SUPPLY LINE
M0122	DOMESTIC WATER LINE TO SERVE SRTC MODULAR RESTROOM UNIT, 773-71A
M0123E1	DOMESTIC WATER LINE TO SERVE 673-T, 678-T, & 679-8T SAFETY SHOWERS

Industrial Wastewater Permits

Permit Number	Permit Title
12888	METALLURGICAL LABORATORY NEUTRALIZATION FACILITY, 723-A
14214	MODIFICATIONS TO NAVAL FUEL (FMF) WASTEWATER TREATMENT FACILITY; BATCH MIXER SYSTEM
16119	F/H ETF PERMANENT pH ADJUSTMENT SYSTEM
17587-IW	TNX-AREA CROSS-FLOW FILTER TEST FACILITY
17596-IW	DWPF PRECIPITATE-FEED LATE-WASH FACILITY
17614-IW	250-GPM AIR STRIPPER (A-002), SRTC
17617-IW	OIL/WATER SEPARATOR TO SERVE 701-3H VEHICLE BARRIER
17618-IW	OIL/WATER SEPARATOR TO SERVE 701-4F VEHICLE BARRIER
17763-IW	SKID-MOUNTED ION-EXCHANGE DEMONSTRATION FACILITY, TNX-AREA
17816-IW	MODIFICATION TO 735-11A LAB BUILDING PROCESS SEWER SYSTEM NEUTRALIZATION FACILITY, 607-17A
17903-IW	TEMPORARY BOILER BLOWDOWN TRANSFER SYSTEM, 784-A
17911-IW	F-AREA SEEPAGE BASINS GROUNDWATER REMEDIATION (EXTRACTION/ INJECTION PIPING NETWORK)
17912-IW	H-AREA SEEPAGE BASINS GROUNDWATER REMEDIATION (EXTRACTION/ INJECTION PIPING NETWORK)

Industrial Wastewater Permits, continued

Permit Number	Permit Title
LOA-7/10/95	M-AREA PROCESS WASTE INTERIM TREATMENT/STORAGE FACILITY (PWIT/SF) SLUDGE VENDOR TREATMENT PROCESS; MODIFICATION TO M-AREA LIQUID EFFLUENT TREATMENT FACILITY (LETF)
10253	M-AREA 610-GPM AIR STRIPPER
10287	LIQUID EFFLUENT TREATMENT FACILITIES (LETF), 300-M
10349	672-T TNX-AREA PROCESS SEWER TO OUTFALL X-008
10358	S-AREA OIL/WATER SEPARATOR
10389	M-AREA DRAIN LINE
10475	NONCONTACT COOLING WATER DIVERSION, 300-M AREA
10696	INTERIM SLUDGE STORAGE TANK, M-AREA
10765	WASTEWATER NEUTRALIZATION FACILITY, 704-B
10920	SREL WASTEWATER DISINFECTION FACILITY
10949	TRADE WASTE FLOW EQUALIZATION TANK, 607-18A FOR 703-43A SILVER RECOVERY
10955	DWPF CONCRETE BATCH PLANT WASTEWATER TREATMENT POND, S-AREA
11406	FIRE BRIGADE TRAINING FACILITIES OIL/WATER SEPARATOR, 411-D
11411	DWPF TREATED EFFLUENT LINE, S-AREA
11413	DWPF CHEMICAL TREATMENT FACILITY, S-AREA
11497	PRODUCTION CONTROL FACILITY SANITARY/PROCESS SEWER, 772-1F
11498	FLOW-MONITORING STATION FOR NPDES OUTFALL L-007
11588	POWERHOUSE EFFLUENT DIVERSION TO ASH BASINS; 200-D (H-Area also covered under this permit)
11588	POWERHOUSE EFFLUENT DIVERSION TO ASH BASINS; 200-H (D-Area also covered under this permit)
11589	POWERHOUSE EFFLUENT DIVERSION TO ASH BASIN, 184-P (184-K also covered under this permit)
12622	ORGANICS REMOVAL FACILITY (ORF), TNX-AREA
12633	TNX-AREA EFFLUENT TREATMENT PLANT (ETP)
12683	INDUSTRIAL WASTEWATER TREATMENT FACILITY TO SERVE Z-AREA SALTSTONE MANUFACTURING FACILITY
12782	REPLACEMENT TRITIUM FACILITY (RTF) PROCESS SEWER
12870	F/H EFFLUENT TREATMENT FACILITY (ETF), 241-81H

Industrial Wastewater Permits, continued

Permit Number	Permit Title
12894	FILTRATE HOLD-TANK COVERS, M-AREA
12922	MODIFICATIONS TO NAVAL FUEL (FMF) WASTEWATER TREATMENT FACILITY (PIPING MOD.)
12973	P-AREA NEUTRALIZATION FACILITY, 183-2P
13105	F/H ETF PROCESS SEWER LINES, F-AREA (H-Area also included under this permit)
13105	F/H ETF PROCESS SEWER LINES, H-AREA (F-Area also included under this permit)
13154	FLOW MEASUREMENT DEVICE, L-AREA
13354	D-AREA NEUTRALIZATION FACILITY, 483-1D
13355	F-AREA NEUTRALIZATION FACILITY, 280-1F
13356	H-AREA NEUTRALIZATION FACILITY, 280-H
13357	K-AREA NEUTRALIZATION FACILITY, 183-2K
13431	FLUME AT M-004 OUTFALL
13735	INDUSTRIAL WASTEWATER pH CONTROL SYSTEM, 211-F
13978	TNX-AREA ION-EXCHANGE FACILITY
14020	MERCURY & ORGANIC REMOVAL FACILITY FOR F/H ETF
14100	REPAIR ASH BASIN DIKE 488-1D
14218	NPDES OUTFALL STRUCTURES F-012 & F-013 (FLOW-MONITORING WEIR BOX STRUCTURES)
14219	NPDES OUTFALL STRUCTURES H-017 & H-018 (MONITORING WEIR BOX STRUCTURES)
14338	"AS BUILT" H-Z INTERAREA SALT SOLUTION TRANSFER LINE
14379	UPPER THREE RUNS CREEK DIFFUSER FOR F/H ETF OUTFALL, H-016
14520	"AS BUILT" F/H ETF TANK 50
14624	EXISTING F/H ETF AREA PROCESS SEWER LINES, F-AREA (H-Area also included under this permit)
14624	EXISTING F/H ETF AREA PROCESS SEWER LINES, H-AREA (F-Area also included under this permit)
14832	MODIFICATION TO M-AREA LIQUID EFFLUENT TREATMENT FACILITIES (LETf); SUPERNATANT TRANSFER & POLYMER ADDITION SYSTEMS
15256	EVAPORATOR RECYCLE LINE FOR F/H ETF
15467	UPGRADE PROCESS SEWERS, 211-F/H ETF, F-AREA (H-Area also included under this permit)

Industrial Wastewater Permits, continued

Permit Number	Permit Title
15467	UPGRADE PROCESS SEWERS, 211-F/H ETF, H-AREA (F-Area also included under this permit)
15892	F/H ETF INTERIM pH ADJUSTMENT SYSTEM (CAUSTIC & ACID SUPPLY)
16449	K-REACTOR EMERGENCY RETENTION BASIN PERCOLATION DRAIN FIELD
16478	FOUNDATIONS & SUPPORTING STRUCTURE SURROUNDING CWST; K-AREA RETENTION BASIN
16614	K-REACTOR EMERGENCY RETENTION BASIN LINER & COVER
16783	"AS BUILT" DWPF INDUSTRIAL WASTEWATER TREATMENT FACILITY, S-AREA
16785	K-AREA NATURAL DRAFT COOLING TOWER THERMAL MITIGATION
16797	(70-GPM AIR STRIPPER) PROTOTYPE AIR STRIPPER COLUMN RELOCATION & RECOVERY WELL INSTALLATION
16938	K-REACTOR RETENTION BASIN UMBRELLA TOP STRUCTURE
17022	UPGRADE D-AREA NEUTRALIZATION FACILITY, 483-1D
17424-IW	"AS BUILT" F-AREA HIGH-LEVEL RADIOACTIVE WASTE TANK FARM (H-Area also covered under this permit)
17424-IW	"AS BUILT" H-AREA HIGH-LEVEL RADIOACTIVE WASTE TANK FARM (F-Area also covered under this permit)
17434-IW	TNX-AREA TRICKLE-FLOW BIOREACTOR UNIT
17588-IW	MOBILE TRICKLE-FLOW BIOREACTOR SYSTEM
17765-IW	INVESTIGATION-DERIVED WASTE (IDW) TRANSFER STATION AT F/H EFFLUENT TREATMENT FACILITY (ETF)
7289	"AS BUILT" WASTEWATER TREATMENT FACILITIES, A-AREA (M-Area also covered under this permit)
7289	"AS BUILT" WASTEWATER TREATMENT FACILITIES, M-AREA (A-Area also covered under this permit)
7290	"AS BUILT" WASTEWATER TREATMENT FACILITIES, F-AREA
7291	"AS BUILT" WASTEWATER TREATMENT FACILITIES, H-AREA
7292	"AS BUILT" WASTEWATER TREATMENT FACILITIES, P-AREA
7293	"AS BUILT" WASTEWATER TREATMENT FACILITIES, K-AREA
7294	"AS BUILT" WASTEWATER TREATMENT FACILITIES, C-AREA
7295	"AS BUILT" WASTEWATER TREATMENT FACILITIES, D-AREA
7296	"AS BUILT" WASTEWATER TREATMENT FACILITIES, N-AREA
9974	DWPF CONCRETE BATCH PLANT WASTEWATER TREATMENT POND DECANT STRUCTURE, S-AREA

Industrial Wastewater Permits, continued

Permit Number	Permit Title
LS-112-S	FIRE-TRAINING FACILITY PROCESS SEWER, 904-D
LS-42-S	INERT L-FACILITY LOADING DOCK SEWER RELOCATION, 234-H

NPDES – Discharge Permits

Permit Number	Permit Title
SC0000175	76 OUTFALLS AT SAVANNAH RIVER SITE
SC0044903	SEVEN OUTFALLS AT SAVANNAH RIVER SITE

NPDES – No-Discharge Permit

Permit Number	Permit Title
ND0072125	SRS SANITARY SLUDGE LAND APPLICATION SITE, FORESTS (SLUDGE FROM ALL SWTPs)

NPDES – Stormwater Permits

Permit Number	Permit Title
SCR000000	48 INDUSTRIAL STORMWATER OUTFALLS AT SAVANNAH RIVER SITE
SCR100000	10 NPDES-PERMITTED CONSTRUCTION STORMWATER SITES AT SAVANNAH RIVER SITE

RCRA Permit

Permit Number	Permit Title
SCI80008989	SEVEN PERMITTED RCRA FACILITIES AT SAVANNAH RIVER SITE

Sanitary Wastewater Permits

Permit Number	Permit Title
02-91040041	SEPTIC TANK & TILE FIELD TO SERVE OFFICE BUILDING, 704-56H (A.K.A. 5002-H)
02-92080098	SEPTIC TANK & TILE FIELD TO SERVE SREL PAR POND LABORATORY, 737-G
10132-P	SEPTIC TANK & TILE FIELD TO SERVE TOILET TRAILER, 704-47S, & OFFICES 704-44S, 704-45S, & 704-46S (FORMERLY FPF CONSTRUCTION ENGINEERS' OFFICES 225-1H, 225-2H, & 225-3H)
10236	SANITARY SEWER SYSTEM (LIFT STATION & SEWER LINE) TO SERVE CHANGE STATION FACILITY, 241-58H
10314	DWPF CONSTRUCTION SITE SANITARY SEWER SYSTEM, S-AREA
10499	SANITARY SEWER TO SERVE DWPF, 200-S
10521	CHEMICAL FEED FACILITY (607-16A) FOR A-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7-1A, 607-7-2A, & 607-23A

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
10522	CHEMICAL FEED FACILITY (607-19F) FOR F-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7F & 607-21F
10523	CHEMICAL FEED FACILITY (607-20H) FOR H-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7H & 607-21H
10524	CHEMICAL FEED FACILITY (607-22P) FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7P & 607-23P
10525	CHEMICAL FEED FACILITY (607-38N) FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-18N & 607-42N
10526	CHEMICAL FEED FACILITY (607-14D) FOR D-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-15D
10530	TNX-AREA 20,000-GALLON SANITARY WASTEWATER TREATMENT PLANT, 607-40T
10533	SEPTIC TANK & TILE FIELD (607-54G) TO SERVE DEER HUNT BUILDING, 760-12G
10825	SANITARY SEWER LIFT STATION (607-19A) TO SERVE 730-A
11407	SANITARY SEWER LIFT STATION TO SERVE 321-M CHANGE ROOM
11442	SANITARY SEWER SYSTEM (LIFT STATION & SEWER LINE) TO SERVE ECR/ICR CONTROL HOUSE, 241-82H
11687	SEPTIC TANK & TILE FIELD TO SERVE WACKENHUT HELICOPTER FACILITY, 703-5B
11755	SEPTIC TANK & TILE FIELD TO SERVE 100-AREA FIRE STATION, 709-1G (INTERSECTION OF ROAD C & ROAD 7)
11847	EFFLUENT WEIR FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-40T
12386	SANITARY SEWER TO SERVE 730-M
12695	SANITARY SEWER TO SERVE REPLACEMENT TRITIUM FACILITY (RTF), 233-H
12725	45,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607-18F) FOR SANITARY WASTEWATER TREATMENT PLANTS, 607-7F & 607-21F (PHASE III)
12910	H-AREA 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-21H
13155	NAVAL FUEL (FMF) FLOW MEASUREMENT DEVICE; OUTFALL F-003(A)
13156	SANITARY SEWER TO SERVE 716-2A
13157	SANITARY SEWER TO SERVE COMPUTER REPAIR BUILDING, 722-5A
13175	97,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607-22A) FOR SANITARY WASTEWATER TREATMENT PLANTS, 607-7-1A, 607-7-2A, & 607-23A
13291	SEPTIC TANK & TILE FIELD TO SERVE AUXILIARY PUMP PIT
13430	F-AREA 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-21F

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
13538	SEPTIC TANK & TILE FIELD TO SERVE K-AREA COOLING TOWER CONSTRUCTION TRAILER
13539	SEPTIC TANK & TILE FIELD TO SERVE K-AREA COOLING TOWER ECR/ICR BUILDING, 153-1K
13717	SEPTIC TANK (831-1Z) & TILE FIELD (831-2Z) TO SERVE Z-AREA
14311	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR C-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-7C
14312	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR K-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-17K
14313	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR L-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-16L
14314	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7P & 607-23P
14315	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR F-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7F & 607-21F
14316	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR H-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7H & 607-21H
14317	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR S-AREA SANITARY WASTEWATER TREATMENT PLANTS, 831-1S & 831-2S
14318	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR D-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-15D
14320	INTERIM SODIUM HYPOCHLORITE DISINFECTION SYSTEM (607-8A) FOR A-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7-1A, 607-7-2A, & 607-23A
14321	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR SREL WASTEWATER DISINFECTION FACILITY, 737-21A
14322	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-18N & 607-42N
14323	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR NAVAL FUEL (FMF) SANITARY WASTEWATER TREATMENT PLANT, 607-17F
14324	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-40T
14407	D-AREA 20,000-GPD SANITARY WASTEWATER TREATMENT PLANT EXPANSION, 607-15D
14443	SEPTIC TANK & TILE FIELD TO SERVE 241-102H
15005	A-AREA 65,000-GPD SANITARY WASTEWATER TREATMENT PLANT EXPANSION, 607-23A
15049	35,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607-19G) FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-18G & 607-42G

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
15416	12,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607-16K) FOR SANITARY WASTEWATER TREATMENT PLANT, 607-17K
15417	11,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607-24P) FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607-7P & 607-23P
15418	17,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607-15L) FOR SANITARY WASTEWATER TREATMENT PLANT, 607-16L
15419	SANITARY SEWER LIFT STATION TO SERVE REPLACEMENT TRITIUM FACILITY (RTF)
15444	SANITARY SEWER LIFT STATION TO SERVE 341-M
15506	15,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607-22F) FOR NAVAL FUEL (FMF) SANITARY WASTEWATER TREATMENT PLANT, 607-17F
15530	27,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607-4C) FOR SANITARY WASTEWATER TREATMENT PLANT, 607-7C
15740	SANITARY SEWER SYSTEM EXPANSION (TWO LIFT STATIONS & SEWER LINE) TO SERVE C-AREA
16477	SANITARY SEWER TO SERVE N-AREA MATERIAL MANAGEMENT RECEIVING & STORAGE FACILITIES (MMRSF), 731-N THROUGH 731-4N
16784	TNX-AREA SANITARY WASTEWATER TREATMENT PLANT (607-40T) EFFLUENT REROUTE FROM OUTFALL X-013 TO X-008A
16961	SANITARY SEWER LINE FROM MATERIAL MANAGEMENT RECEIVING & STORAGE FACILITIES (MMRSF) TO N-AREA SANITARY WASTEWATER TREATMENT PLANT
17057	B-AREA 80,000-GPD SANITARY WASTEWATER TREATMENT PLANT UPGRADE, 607-4B (INCLUDES 40,000-GALLON FLOW EQUALIZATION BASIN)
17059	SANITARY SEWER TO SERVE B-AREA ENGINEERING CENTER, 730-B
17156	FLOW CONTROL BOXES FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT, 607-40T
17157	FLOW CONTROL BOXES FOR H-AREA SANITARY WASTEWATER TREATMENT FACILITIES, 607-7H & 607-21H
17232	SANITARY SEWER TO SERVE 705-3C
17273-IW	SANITARY SEWER TO SERVE 704-49S OFFICE BUILDING
17278-IW	SANITARY SEWER TO SERVE 730-1M OFFICE BUILDING
17279-IW	SANITARY SEWER TO SERVE 705-K OFFICE BUILDING
17383-IW	SANITARY SEWER TO SERVE REPLACEMENT TRITIUM FACILITY (RTF) TRAILERS, 233-20H & 233-21H
17419-IW	SANITARY SEWER TO SERVE H-AREA TRAILERS, 742-10G THROUGH 742-12G
17499-IW	SANITARY SEWER & LIFT STATION TO SERVE 704-2H

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
17528-IW	SANITARY SEWER TO SERVE ENGINEERING SUPPORT FACILITY, 730-1B, & OPERATIONS SUPPORT FACILITIES, 730-2B & 730-4B
17604-IW	SANITARY SEWER TO SERVE SITE TRAINING BUILDING, 766-H (FORMERLY 225-H)
17643-IW	COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 1A (FROM C ROAD [INCLUDING LS-3000A] TO CSWTF)
17646-IW	COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 1A (FROM LS-4000C TO LS-3000A)
17656-IW	SANITARY SEWER TO SERVE HEALTH PROTECTION INSTRUMENT CALIBRATION FACILITY, 735-2B, & NEW WHOLE BODY COUNTER FACILITY, 735-4B
17676-IW	SANITARY SEWER TO SERVE 241-2H
17679-IW	1,050,000-GPD CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF) TO SERVE A-AREA, B-AREA, C-AREA, F-AREA, H-AREA, N-AREA, & S-AREA
17682-IW	SANITARY SEWER REROUTE TO SERVE SREL LIBRARY ADDITION, 737-A
17683-IW	COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 1B (B-AREA, F-AREA, H-AREA, & S-AREA)
17690-IW	COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 2 (A-AREA, C-AREA, & N-AREA)
17715-IW	UV DISINFECTION SYSTEM FOR D-AREA SANITARY WASTEWATER TREATMENT PLANT
17719-IW	UV DISINFECTION SYSTEM FOR P-AREA SANITARY WASTEWATER TREATMENT PLANT
17721-IW	UV DISINFECTION SYSTEM FOR K-AREA SANITARY WASTEWATER TREATMENT PLANT
17722-IW	UV DISINFECTION SYSTEM FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT
17726-IW	UV DISINFECTION SYSTEM FOR L-AREA SANITARY WASTEWATER TREATMENT PLANT
17842-IW	SANITARY SEWER AND LIFT STATION TO SERVE SREL ANIMAL-HOLDING FACILITIES
1995020076	SEPTIC TANK AND TILE FIELD TO SERVE CENTRAL STAGING AREA, 704-13G
1995020100	SEPTIC TANK AND TILE FIELD TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261-H
7947	L-AREA 35,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-16L
8611-P	SEPTIC TANK & TILE FIELD TO SERVE INTERIM STORAGE & REDRUMMING FACILITY, 645-1N (FORMERLY 709-1G), N-AREA
8670	K-AREA 24,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-17K

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
8928	NAVAL FUEL (FMF) 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-17F
9256P	SEPTIC TANK & TILE FIELD TO SERVE LANDFILL MONITORING BUILDING, 642-E
9326	H-AREA 60,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-7H (F-Area, N-Area, & P-Area also included under this permit)
9326	P-AREA 10,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-23P (F-Area, H-Area, & N-Area also included under this permit)
9326	N-AREA 30,000-GPD (607-18G) & 40,000-GPD (607-42G) SANITARY WASTEWATER TREATMENT PLANTS (F-Area, H-Area, & P-Area also included under this permit)
9326	F-AREA 60,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-7F (H-Area, N-Area, & P-Area also included under this permit)
9694	SANITARY SEWER SYSTEM (LIFT STATION & SEWER LINE) TO SERVE 773-41A & 773-42A
9888	S-AREA, TWO 12,000-GPD SANITARY WASTEWATER TREATMENT PLANTS, 831-1S & 831-2S
9940	SANITARY SEWER TO SERVE REACTOR SIMULATOR FACILITY, 707-C
9983	C-AREA, 55,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607-7C
9998	SEPTIC TANK & TILE FIELD TO SERVE F/H ETF CONTROL BUILDING, 241-84H
LS-10-S	SANITARY SEWER TO SERVE NAVAL FUEL MATERIAL FACILITY (FMF), 247-F & 248-F
LS-129-S	SANITARY SEWER TO SERVE 719-4A
LS-134-S	DWPF SANITARY SEWER LINE MODIFICATION, S-AREA
LS-149-S	SANITARY SEWER TO SERVE TNX-AREA EFFLUENT TREATMENT PLANT, 904-T
LS-158-S	SANITARY SEWER TO SERVE 3/700 CONSTRUCTION FACILITY
LS-2-S	SANITARY SEWER TO SERVE TRITIUM FACILITY SUPPORT BUILDING, 235-H
LS-206-S	SEWER PIPE & MANHOLE, 704-1T
LS-227-S	SANITARY SEWER TO SERVE 705-C
LS-228-S	SANITARY SEWER TO SERVE 717-K
LS-239-S	SANITARY SEWER TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701-4F, & CENTRAL ALARM STATION (CAS), 720-F
LS-240-S	SANITARY SEWER TO SERVE 720-2A (3/700 AREA SECURITY UPGRADE, PACAS FACILITY)
LS-244-S	SANITARY SEWER TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701-3H, & CENTRAL ALARM STATION (CAS), 720-H
LS-256-S	MACERATOR FOR F-AREA SANITARY FLOW EQUALIZATION BASIN, 607-18F

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
LS-275-S	SANITARY SEWER TO SERVE EQUIPMENT STORAGE & HEALTH PROTECTION FACILITY, 221-25F
LS-3-S	SANITARY SEWER TO SERVE 703-41A
LS-32-S	SANITARY SEWER TO SERVE WACKENHUT BUILDINGS 703-B & 703-1B
LS-335-S	SANITARY SEWER TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 704-7K THROUGH 704-19K
LS-336-S	"AS BUILT" OIL/WATER SEPARATOR, 716-A
LS-337-S	"AS BUILT" OIL/WATER SEPARATOR, 722-4A
LS-35-S	SANITARY SEWER RELOCATION TO SERVE 735-11A
LS-351-S	SANITARY SEWER TO SERVE TEMPORARY MODULAR OFFICE TRAILERS, 245-F THROUGH 245-12F
LS-352-S	SANITARY SEWER TO SERVE N-AREA NEW EMPLOYEE PROCESSING CENTER
LS-354-S	SANITARY SEWER TO SERVE TO SERVE GENERAL PHYSICS OFFICE, 777-18A
LS-52-S	SANITARY SEWER TO SERVE 707-H
LS-53-S	SANITARY SEWER TO SERVE CONSTRUCTION OFFICE BUILDING, M-AREA
LS-62-S	SANITARY SEWER RELOCATION TO SERVE 717-F
LS-78-S	SANITARY SEWER TO SERVE CONSTRUCTION ADMINISTRATION BUILDING, C-AREA
LS-79-S	SANITARY SEWER TO SERVE N-AREA ELECTRICAL OFFICE BUILDING
LS-80-S	SANITARY SEWER TO SERVE N-AREA RECEIVING & STORES WAREHOUSE

SCWRC 401 (Water Quality) Permit

Permit Number	Permit Title
SC 88-D-005	F/H ETF DIFFUSER

Solid Waste Permits

Permit Number	Permit Title
025500-1120	SANITARY LANDFILL
025500-1601	D-F STEAM-LINE INDUSTRIAL SOLID WASTE LANDFILL (ASBESTOS)
025500-1602	F-AREA INERT-MATERIALS LANDFILL (RAILROAD TIE PILE)
CWP-030	BURMA ROAD INERT-MATERIALS LANDFILL

Solid Waste Permits, continued

Permit Number	Permit Title
IWP-211	H-AREA INERT-MATERIALS LANDFILL
IWP-217	Z-AREA SALTSTONE DISPOSAL FACILITY

Underground Injection Control Permits

Permit Number	Permit Title
126	TNX-AREA TRACER TEST
211	F-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION
215	GROUNDWATER OPERABLE UNIT (GOU) RECIRCULATION WELL, TNX-AREA
216	TRACER TEST AT THE M-AREA SETTLING BASIN
223	H-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION
225	IN-SITU BIOREMEDIATION
118	F-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION
119	H-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION
119M	H-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION (MCBEAN TEST)
139	F-AREA SEEPAGE BASIN INFILTRATION GALLERIES GROUNDWATER REMEDIATION (H-Area also covered under this permit)
139	H-AREA SEEPAGE BASIN INFILTRATION GALLERIES GROUNDWATER REMEDIATION (F-Area also covered under this permit)
194	BIOREMEDIATION OPTIMIZATION TEST AT THE SANITARY LANDFILL, 740-G
201	PURGE-WATER MANAGEMENT SYSTEM DEMONSTRATION, TNX-AREA

Underground Storage Tank Permits

Permit Number	Permit Title
P-02-GF-09467	FORESTRY AREA 2000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 620-G (A)
P-02-GF-09467	FORESTRY AREA 2000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 620-G (B)
P-02-GF-10838	H-AREA 10,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-2G (A-Area, C-Area, K-Area, L-Area, N-Area, & P-Area also included)
P-02-GF-10838	L-Area 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-L (A-Area, C-Area, H-Area, K-Area, N-Area, & P-Area also included)
P-02-GF-10838	C-Area 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-C (A-Area, H-Area, K-Area, L-Area, N-Area, & P-Area also included)
P-02-GF-10838	K-Area 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-K (A-Area, C-Area, H-Area, L-Area, N-Area, & P-Area also included)

Underground Storage Tank Permits, continued

Permit Number	Permit Title
P-02-GF-10838	P-Area 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-P (A-Area, C-Area, H-Area, K-Area, L-Area, & N-Area also included)
P-02-GF-10838	A-Area 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-AA (C-Area, H-Area, K-Area, L-Area, N-Area, & P-Area also included)
P-02-GF-10838	A-Area 5000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 715-AB (C-Area, H-Area, K-Area, L-Area, N-Area, & P-Area also included)
P-02-GF-10838	A-Area 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-AC (C-Area, H-Area, K-Area, L-Area, N-Area, & P-Area also included)
P-02-GF-10838	N-Area 10,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715-N #1 (A-Area, C-Area, H-Area, K-Area, L-Area, & P-Area also included)
P-02-GF-10838	N-Area 10,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 715-N #2 (A-Area, C-Area, H-Area, K-Area, L-Area, & P-Area also included)
P-02-GF-12476	A-Area 5000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 754-6A

Radionuclide and Chemical Nomenclature

Nomenclature and Half-life for Radionuclides

Radionuclide	Symbol	Half-Life ^{a,b}	Radionuclide	Symbol	Half-Life ^{a,b}
Americium-241	Am-241	432.7 y	Osmium-185	Os-185	93.6 d
Americium-243	Am-243	7.37E3 y	Phosphorus-32	P-32	14.28 d
Antimony-125	Sb-125	2.758 y	Polonium-210	Po-210	138.38 d
Argon-41	Ar-41	1.82 h	Plutonium-238	Pu-238	87.7 y
Beryllium-7	Be-7	53.28 d	Plutonium-239	Pu-239	2.41E4 y
Californium-252	Cf-252	2.638 y	Potassium-40	K-40	1.28E9 y
Carbon-14	C-14	5,730 y	Promethium-147	Pm-147	2.6234 y
Cerium-141	Ce-141	32.50 d	Ruthenium-103	Ru-103	39.27 d
Cerium-144	Ce-144	284.6 d	Ruthenium-106	Ru-106	1.020 y
Cesium-134	Cs-134	2.065 y	Selenium-75	Se-75	119.78 d
Cesium-137	Cs-137	30.17 y	Strontium-89	Sr-89	50.52 d
Cobalt-58	Co-58	70.88 d	Strontium-90	Sr-90	29.1 y
Cobalt-60	Co-60	5.271 y	Technetium-99	Tc-99	2.13E5 y
Curium-242	Cm-242	162.8 d	Tritium	H-3	12.3 y
Curium-244	Cm-244	18.1 y	Uranium-235	U-235	7.04E8 y
Iodine-129	I-129	1.57E7 y	Uranium-238	U-238	4.47E9 y
Iodine-131	I-131	8.04 d	Xenon-133	Xe-133	5.243 d
Krypton-85	Kr-85	10.73 y	Xenon-135	Xe-135	9.10 h
Krypton-88	Kr-88	2.84 h	Yttrium-90	Y-90	64.08 h
Manganese-54	Mn-54	312.2 d	Zirconium-95	Zr-95	64.02 d
Niobium-95	Nb-95	34.97 d			

Nomenclature for Common Chemical Analyses

Analysis	Symbol	Analysis	Symbol
Biochemical Oxygen Demand	BOD	Total Organic Carbon	TOC
Chemical Oxygen Demand	COD	Total Organic Halogens	TOH
Dissolved Oxygen	DO	Total Phosphates	TPO ₄
Particulate Matter <10 microns	PM ₁₀	Total Solids	TS
Polychlorinated Biphenyl	PCB	Total Suspended Solids	TSS
Perchloroethylene	PCE	Volatile Organic Compound	VOC
Tetrachloroethylene	TCE		
Total Dissolved Solids	TDS		

^a h = hour; d = day; y = year

^b Reference: Chart of the Nuclides, 14th edition, revised to April 1988, General Electric Company

Nomenclature for Elements and Chemical Constituents

Constituent	Symbol	Constituent	Symbol
Aluminum	Al	Mercury	Hg
Ammonia	NH ₃	Nickel	Ni
Antimony	Sb	Nitrogen	N
Arsenic	As	Nitrate	NO ₃
Barium	Ba	Nitrite	NO ₂
Beryllium	Be	Oxygen	O
Cadmium	Cd	Ozone	O ₃
Calcium	Ca	Phosphorus	P
Calcium Carbonate	CaCO ₃	Phosphate	PO ₄
Carbon	C	Potassium	K
Chlorine	Cl	Radium	Ra
Chromium	Cr	Rhenium	Re
Cobalt	Co	Selenium	Se
Copper	Cu	Silver	Ag
Fluorine	F	Sodium	Na
Iron	Fe	Sulfate	SO ₄
Lead	Pb	Sulfur Dioxide	SO ₂
Lithium	Li	Thallium	Tl
Magnesium	Mg	Uranium	U
Manganese	Mn	Vanadium	V
		Zinc	Zn

Appendix D

Drinking Water Standards

Analyte	Level ^a	Units	Status	Reference ^b
Note: "ede" denotes "calculated effective dose equivalent."				
Alachlor	0.002	mg/L	final	CFR, 1993
Aldicarb	0.003	mg/L	final	CFR, 1993
Aldicarb sulfone	0.002	mg/L	final	CFR, 1993
Aldicarb sulfoxide	0.004	mg/L	final	CFR, 1993
Antimony	0.006	mg/L	final	CFR, 1993
Antimony-125	3.E+02	pCi/L	interim final	EPA, 1977
Arsenic	0.05	mg/L	final	CFR, 1993
Asbestos	7,000,000	fibers/L ^c	final	CFR, 1993
Atrazine	0.003	mg/L	final	CFR, 1993
Barium	2.0	mg/L	final	CFR, 1993
Barium-140	9.E+01	pCi/L	interim final	EPA, 1977
Benzene	0.005	mg/L	final	CFR, 1993
Benzo[a]pyrene	0.0002	mg/L	final	SDWA, 1992
Beryllium	0.004	mg/L	final	CFR, 1993
Beryllium-7	6.E+03	pCi/L	interim final	EPA, 1977
2-sec-Butyl-4, 6-dinitrophenol (Dinoseb)	0.007	mg/L	final	CFR, 1993
Cadmium	0.005	mg/L	final	CFR, 1993
Carbofuran	0.04	mg/L	final	CFR, 1993
Carbon-14	2.E+03	pCi/L	interim final	EPA, 1977
Carbon tetrachloride	0.005	mg/L	final	CFR, 1993
Cerium-141	3.E+02	pCi/L	interim final	EPA, 1977
Cesium-137	2.E+02	pCi/L	interim final	EPA, 1977
Chlordane	0.002	mg/L	final	CFR, 1993
Chlorobenzene (monochlorobenzene)	0.1	mg/L	final	CFR, 1993
Chloroethene (Vinyl chloride)	0.002	mg/L	final	CFR, 1993
Chloroform ^d	0.1	mg/L	final	CFR, 1993

a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].

b References are found on page 241.

c Longer than 10 μ m

d The level for total trihalomethanes is set at 0.1 mg/L. Because bromated methanes are rarely detected in SRS groundwater, the Environmental Protection Department (EPD) presumes that most of the trihalomethanes present in site groundwater are chloroform.

Analyte	Level ^a	Units	Status	Reference ^b
Chromium	0.1	mg/L	final	CFR, 1993
Chromium-51	6.E+03	pCi/L	interim final	EPA, 1977
Cobalt-58	9.E+03	pCi/L	interim final	EPA, 1977
Cobalt-60	1.E+02	pCi/L	interim final	EPA, 1977
Cyanide	0.2	mg/L	final	CFR, 1993
Dalapon	0.2	mg/L	final	CFR, 1993
Dibromochloropropane	0.0002	mg/L	final	CFR, 1993
Di (2-ethylhexyl) adipate (Deha)	0.4	mg/L	final	CFR, 1993
Di (2-ethylhexyl) phthalate	0.006	mg/L	final	SDWA, 1992
1,2-Dichlorobenzene	0.6	mg/L	final	CFR, 1993
1,4-Dichlorobenzene (p-Dichlorobenzene)	0.075	mg/L	final	CFR, 1993
1,2-Dichloroethane	0.005	mg/L	final	CFR, 1993
cis-1,2-Dichloroethylene	0.07	mg/L	final	CFR, 1993
trans-1,2-Dichloroethylene	0.1	mg/L	final	CFR, 1993
1,1-Dichloroethylene	0.007	mg/L	final	CFR, 1993
Dichloromethane (Methylene chloride)	0.005	mg/L	final	CFR, 1993
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.07	mg/L	final	CFR, 1993
1,2-Dichloropropane	0.005	mg/L	final	CFR, 1993
Dioxin (2,3,7,8-TCDD)	3.00E-08	mg/L	final	CFR, 1993
Diquat	0.02	mg/L	final	CFR, 1993
Endrin	0.002	mg/L	final	CFR, 1993
Endothall	0.1	mg/L	final	CFR, 1993
Ethylbenzene	0.7	mg/L	final	CFR, 1993
Ethylene dibromide	0.00005	mg/L	final	CFR, 1993
Europium-154	2.E+02	pCi/L	interim final	EPA, 1977
Europium-155	6.E+02	pCi/L	interim final	EPA, 1977
Fluoride	4	mg/L	final	CFR, 1993
Glyphosate	0.7	mg/L	final	CFR, 1993
Gross alpha	15	pCi/L	final	CFR, 1993
Heptachlor	0.0004	mg/L	final	CFR, 1993
Heptachlor epoxide	0.0002	mg/L	final	CFR, 1993
Hexachlorobenzene	0.001	mg/L	final	CFR, 1993

^a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].

^b References are found on page 241.

Analyte	Level ^a	Units	Status	Reference ^b
Hexachlorocyclopentadiene	0.05	mg/L	final	CFR, 1993
Iodine-129	1.E+00	pCi/L	interim final	EPA, 1977
Iodine-131	3.E+00	pCi/L	interim final	EPA, 1977
Iron-55	2.E+03	pCi/L	interim final	EPA, 1977
Iron-59	2.E+02	pCi/L	interim final	EPA, 1977
Lanthanum-140	6.E+01	pCi/L	interim final	EPA, 1977
Lindane	0.0002	mg/L	final	CFR, 1993
Manganese-54	3.E+02	pCi/L	interim final	EPA, 1977
Mercury	0.002	mg/L	final	CFR, 1993
Methoxychlor	0.04	mg/L	final	CFR, 1993
Nickel	0.1	mg/L	final	CFR, 1993
Nickel-59	3.E+02	pCi/L	interim final	EPA, 1977
Nickel-63	5.E+01	pCi/L	interim final	EPA, 1977
Niobium-95	3.E+02	pCi/L	interim final	EPA, 1977
Nitrate + Nitrite (As N)	10	mg/L	final	CFR, 1993
Nitrate (as N)	10	mg/L	final	CFR, 1993
Nitrite (as N)	1	mg/L	final	CFR, 1993
Nonvolatile beta	4	mrem/yr	final	CFR, 1993
Oxamyl (Vydate)	0.2	mg/L	final	CFR, 1993
PCBs	0.0005	mg/L	final	CFR, 1993
Pentachlorophenol	0.001	mg/L	final	CFR, 1993
Picloram	0.5	mg/L	final	SDWA, 1992
Radium-226/228 (Total)	5	pCi/L	final	CFR, 1993
Ruthenium-103	2.E+02	pCi/L	interim final	EPA, 1977
Ruthenium-106	3.E+01	pCi/L	interim final	EPA, 1977
Selenium	0.05	mg/L	final	CFR, 1993
Simazine	0.004	mg/L	final	CFR, 1993
Strontium-89	2.E+01	pCi/L	interim final	EPA, 1977
Strontium-89/90	4.20E+01 ^c	pCi/L	final	CFR, 1993
Strontium-90	8.E+00	pCi/L	final	CFR, 1993
Styrene	0.1	mg/L	final	CFR, 1993
Technetium-99	9.E+02	pCi/L	interim final	EPA, 1977
Tetrachloroethylene	0.005	mg/L	final	CFR, 1993
Thallium	0.002 ^d	mg/L	final	CFR, 1993
Tin-113	3.E+02	pCi/L	interim final	EPA, 1977

^a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].

^b References are found on page 241.

^c For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

^d This is the lower of two proposed levels.

Analyte	Level ^a	Units	Status	Reference ^b
Toluene	1.0	mg/L	final	CFR, 1993
Total radium	5	pCi/L	final	CFR, 1993
Toxaphene	0.003	mg/L	final	CFR, 1993
2,4,5-TP (Silvex)	0.05	mg/L	final	CFR, 1993
1,2,4-Trichlorobenzene	0.07	mg/L	final	CFR, 1993
1,1,1-Trichloroethane	0.2	mg/L	final	CFR, 1993
1,1,2-Trichloroethane	0.005	mg/L	final	CFR, 1993
Trichloroethylene	0.005	mg/L	final	CFR, 1993
Total trihalomethanes ^c (includes bromodichloro- methane, bromoform, chloro- form, and dibromochloro- methane)	0.1	mg/L	final	CFR, 1993
Tritium	2.E+01	pCi/mL	final	CFR, 1993
Xylenes	10	mg/L	final	CFR, 1993
Zinc-65	3.E+02	pCi/L	interim final	EPA. 1977
Zirconium-95	2.E+02	pCi/L	interim final	EPA. 1977
Zirconium/Niobium-95 ^d	2.E+02	pCi/L	interim final	EPA. 1977

^a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].

^b References are found on page 241.

^c EMS does not test for total trihalomethanes, but each of these analytes is tested separately.

^d For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

References

CFR (Code of Federal Regulations), 1993. "National Primary Drinking Water Regulations," 40 CFR, Part 141, pp. 592-731, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1977. *National Interim Primary Drinking Water Regulations*, EPA-570/9-76-003. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986. "Water Pollution Control; National Primary Drinking Water Regulations, Radionuclides (Proposed)," *Federal Register*, September, 1986, pp. 34835-34862. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1990. "National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals; Proposed Rule," *Federal Register*, July 25, 1990, pp. 30369-30448, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1991. "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule," *Federal Register*, July 18, 1991, pp. 33052-33127, Washington, D.C.

SDWA (Safe Drinking Water Act—Phase V Rule, Synthetic Organic Chemicals and Inorganic Chemicals), 1992. "National Primary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals; Final Rule," *Federal Register*, July 17, 1992, 57:138:31776, Washington, D.C.

Environmental Monitoring Reports

Reports of the routine environmental monitoring program at Savannah River Site (SRS) have been prepared periodically since before construction of the site in 1951. The monitoring report numbering system and titles have been changed several times to reflect the evolving progress in the concepts of environmental monitoring. The amount of detailed information contained in the reports also varies from time to time and probably reflects the relative importance and emphasis given to topics by different authors.

Except for July–December 1953, reports were issued semiannually from 1951 to 1962, then annually beginning in 1963. Attempts to find a report for July–December 1953 have been unsuccessful. The onsite report was discontinued in 1985, when the onsite and offsite reports were merged into a single publication.

Some of the monitoring reports originally contained secret information, primarily radioactive release values that could be related to production rates. The secret information in these reports was deleted in the mid-1970s, and a deleted version (DEL) of the report was issued.

Onsite Reports

Natural Radioactivity Content of the Savannah River Plant

DP27 Jun 1951–Jan 1953

Works Technical Department Data Record, Health Physics Site Survey Data

DPSPU 54–11–12 Jan–Jul 1953 No report Jul–Dec 1953

Radioactivity in the Environment of the Savannah River Plant

DP92 Jan–Jul 1954

Semiannual Progress Report–Regional

DPSP 55–25–34 Jul–Dec 1954 DPSP 56–25–13 Jan–Jun 1955

Health Physics Regional Monitoring

DPSP 56–25–54 (DEL)	Jul–Dec 1955	DPSPU 60–11–9	Jul–Dec 1959
DPSP 56–25–4 (DEL)	Jan–Jun 1956	DPSP 60–25–26 (DEL)	Jan–Jun 1960
DPSP 57–25–15 (DEL)	Jul–Dec 1956	DPSP 61–25–4 (DEL)	Jul–Dec 1960
DPSP 57–25–43 (DEL)	Jan–Jun 1957	DPSP 62–25–2 (DEL)	Jan–Jun 1961
DPSP 58–25–17 (DEL)	Jul–Dec 1957	DPSP 62–25–9 (DEL)	Jul–Dec 1961
DPSP 58–25–38 (DEL)	Jan–Jun 1958	DPSP 63–25–3 (DEL)	Jan–Jun 1962
DPSPU 59–11–23	Jul–Dec 1958	DPSP 63–25–10 (DEL)	Jul–Dec 1962
DPSPU 59–11–30	Jan–Jun 1959		

Environmental Monitoring at the Savannah River Plant

DPSPU 64–11–12	Jan–Dec 1963	DPST 71–302	Jan–Dec 1970
DPST 65–302	Jan–Dec 1964	DPSPU 72–302	Jan–Dec 1971
DPST 66–302	Jan–Dec 1965	DPSPU 73–302	Jan–Dec 1972
DPST 67–302	Jan–Dec 1966	DPSPU 74–302	Jan–Dec 1973
DPST 68–302	Jan–Dec 1967	DPSPU 75–302	Jan–Dec 1974
DPST 69–302	Jan–Dec 1968	DPSPU 76–302	Jan–Dec 1975
DPST 70–302	Jan–Dec 1969	DPSPU 77–302	Jan–Dec 1976

Environmental Monitoring at the Savannah River Plant (cont.)

DPSPU 78-302	Jan-Dec 1977	DPSPU 82-302	Jan-Dec 1981
DPSPU 79-302	Jan-Dec 1978	DPSPU 83-302	Jan-Dec 1982
DPSPU 80-302	Jan-Dec 1979	DPSPU 84-302	Jan-Dec 1983
DPSPU 81-302	Jan-Dec 1980	DPSPU 85-302	Jan-Dec 1984

Offsite Reports

Results of the environmental monitoring program that affected the offsite environment have been reported to the public since 1959. These reports contained data from the site boundary and beyond. The offsite report was discontinued in 1985, when the on- and offsite reports were merged into a single publication. A listing of the offsite reports follows.

The Effect of the Savannah River Plant on Environmental Radioactivity

No document number	Jan-Mar 1960	DPST 65-30-2	Jan-Jun 1965
No document number	Apr-Jun 1960	DPST 66-30-1	Jul-Dec 1965
No document number	Jul-Sep 1960	DPST 66-30-2	Jan-Jun 1966
No document number	Oct-Dec 1960	DPST 67-30-1	Jul-Dec 1966
No document number	Jan-Mar 1961	DPST 67-30-2	Jan-Jun 1967
No document number	Apr-Jun 1961	DPST 68-30-1	Jul-Dec 1967
No document number	Jul-Sep 1961	DPST 68-30-2	Jan-Jun 1968
DPSPU 62-30-11	Oct-Dec 1961	DPST 69-30-1	Jul-Dec 1968
DPSPU 62-30-24	Jan-Jun 1962	DPST 69-30-2	Jan-Jun 1969
DPSPU 63-30-12	Jul-Dec 1962	DPST 70-30-1	Jul-Dec 1969
DPSPU 63-30-1	Jan-Jun 1963	DPST 70-30-2	Jan-Jun 1970
DPSPU 64-30-1	Jul-Dec 1963	DPST 71-30-1	Jul-Dec 1970
DPSPU 64-30-2	Jan-Jun 1964	DPST 71-30-16	Jan-Jun 1971
DPSPU 65-30-1	Jul-Dec 1964		

Environmental Monitoring in the Vicinity of the Savannah River Plant

DPSPU 72-30-1	Jan-Dec 1971	DPSPU 79-30-1	Jan-Dec 1978
DPSPU 73-30-1	Jan-Dec 1972	DPSPU 80-30-1	Jan-Dec 1979
DPSPU 74-30-1	Jan-Dec 1973	DPSPU 81-30-1	Jan-Dec 1980
DPSPU 75-30-1	Jan-Dec 1974	DPSPU 82-30-1	Jan-Dec 1981
DPSPU 76-30-1	Jan-Dec 1975	DPSPU 83-30-1	Jan-Dec 1982
DPSPU 77-30-1	Jan-Dec 1976	DPSPU 84-30-1	Jan-Dec 1983
DPSPU 78-30-1	Jan-Dec 1977		

Savannah River Plant Environmental Report

DPSPU 85-30-1	Jan-Dec 1984
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Combined Onsite and Offsite Reports

In 1985, the onsite and offsite environmental monitoring reports were merged into a single publication. A listing of these reports follows.

Savannah River Site Environmental Report

DPSPU 86-30-1	Jan-Dec 1985	WSRC-IM-91-28	Jan-Dec 1990
DPSPU 87-30-1	Jan-Dec 1986	WSRC-TR-92-186	Jan-Dec 1991
DPSPU 88-30-1	Jan-Dec 1987	WSRC-TR-93-075	Jan-Dec 1992
WSRC-RP-89-59-1a	Jan-Dec 1988	WSRC-TR-94-075	Jan-Dec 1993
WSRC-IM-90-60	Jan-Dec 1989	WSRC-TR-95-075	Jan-Dec 1994

Savannah River Site Environmental Data

WSRC-TR-93-077	Jan-Dec 1992	WSRC-TR-95-077	Jan-Dec 1994
WSRC-TR-94-077	Jan-Dec 1993		

Errata from 1994 Report

The following information was reported incorrectly in the Savannah River Site Environmental Report for 1994 (WSRC-TR-95-075):

Page 15, table 2-2, fourth-column header: Methyl Ethel Ketone should have been Methyl *Ethyl* Ketone.

Page 19, right column, second paragraph, last line: The number of inactive outfalls should have been six, not 16.

Page 20, right column, second bullet: The number of existing NPDES permits should have been two, not five.

Page 25, right column, third full paragraph: The number of CERCLA releases reported to regulatory agencies should have been two, not three.

Page 56, right column, first paragraph: The reference to "12-month average tritium concentrations during 1993" should have been to "12-month average tritium concentrations during 1994."

Page 57, left column, first paragraph: The value for the total quantity of tritium migrating from the seepage basins and SWDF should have been 7,500 Ci ($2.8\text{E}+14$ Bq), not 7,600 Ci ($2.8\text{E}+13$ Bq).

Glossary

A

absorption – Process by which the number and energy of particles or photons entering a body of matter is reduced by interaction with the matter.

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

activity – See radioactivity.

adsorption – Surface retention of solid, liquid, or gas molecules, atoms, or ions by a solid or liquid, as opposed to absorption, the penetration of substances into the bulk of the solid or liquid.

air flow – Rate of flow, measured by mass or volume per unit of time.

air stripping – Process used to decontaminate groundwater by pumping the water to the surface, “stripping” or evaporating the chemicals in a specially-designed tower, and pumping the cleansed water back to the environment.

aliquot – Quantity of sample being used for analysis.

alkalinity – Alkalinity is a measure of the buffering capacity of water, and since pH has a direct effect on organisms as well as an indirect effect on the toxicity of certain other pollutants in the water, the buffering capacity is important to water quality.

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 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.

anion – Negatively charged ion.

anomaly – Deviation beyond normal variations.

Appendix IX – List of constituents specified by Appendix IX of the Code of Federal Regulations, Title 40, Part 264. Analyses for Appendix IX constituents are required by the Resource Conservation and Recovery Act under specified conditions.

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

aquitard – Geologic unit that inhibits the flow of water.

atom – Smallest particle of an element capable of entering into a chemical reaction.

Atomic Energy Commission – 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 (now part of the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission).

B

bailer – Container lowered into a well to remove water. The bailer is allowed to fill with water and then is removed from the well.

best available demonstrated technology – One or more specified treatment technologies or treatment to meet certain concentration limits for hazardous constituents (required by Resource Conservation and Recovery Act Land Disposal Restrictions treatment standards).

best available technology – Technology that is the best available at the time to treat waste. See best available demonstrated technology.

best management practices – Sound engineering practices that are not, however, 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.

blank – Control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. In such cases, the measured value or signal for the substance being analyzed is believed to be due to artifacts. Under certain circumstances, that value may be subtracted from the measured value to give a net result reflecting the amount of the substance in the sample. The Environmental Protection Agency does not permit the subtraction of blank results in Environmental Protection Agency-regulated analyses.

blind blank – Sample container of deionized water sent to a laboratory under an alias name as a quality control check.

blind replicate – In the Environmental Monitoring Section groundwater monitoring program, a second sample taken from the same well at the same time as the primary sample, assigned an alias well name, and sent to a laboratory for analysis (as an unknown to the analyst).

blind sample – Control sample of known concentration in which the expected values of the constituent are unknown to the analyst.

borrow pit – Excavation dug to provide material such as sand and gravel (borrow) to be used as fill elsewhere.

Brailsford pump – Surface water sampling device which is stationed on a stand above a stream. The device, which continuously samples stream water, consists of an all-plastic valveless piston driven by a Brailsford small electric motor. The variable pump speed is set normally at 0.75 gallons/day.

C

calibration – Determination of variance from a standard of accuracy of a measuring instrument to ascertain necessary correction factors.

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.

cation – Positively charged ion.

Central Savannah River Area (CSRA) – 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.

chain-of-custody – Form that documents sample collection, transport, analysis, and disposal.

chemical oxygen demand – Indicates the quantity of oxidizable materials present in a water and varies with water composition, concentrations of reagent, temperature, period of contact, and other factors.

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 – Blending of more than one portion to make a sample for analysis.

comprehensive analyses – Group of analyses that forms the core of the Environmental Monitoring Section groundwater monitoring program each quarter.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – This act addresses the cleanup of hazardous substances and establishes a National Priorities List of sites targeted for assessment and, if necessary, restoration (commonly known as "Superfund").

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-reportable release – Release to the environment that exceeds reportable quantities as defined by the Comprehensive Environmental Response, Compensation, and Liability Act.

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 a water and the temperature at which the measurement is made.

confined aquifer – Fully saturated aquifer with an aquitard lying above it.

contamination – Deposition of unwanted material on the surfaces of structures, areas, objects, or personnel.

cosmic radiation – Ionizing radiation with very high energies, originating outside the earth's atmosphere. Cosmic radiation is one source contributing to natural background radiation.

count – Signal that announces an ionization event within a counter; a measure of the radiation from an object or device.

counter – General designation applied to radiation detection instruments or survey meters that detect and measure radiation.

counting geometry – Well-defined sample size and shape for which a counting system has been calibrated.

criteria pollutant – any of the pollutants commonly used as indices for air quality that can have a serious effect on human health and the environment, including sulfur dioxide, nitrogen dioxide, total suspended particulates, PM₁₀, carbon monoxide, ozone, gaseous fluorides, and lead.

criticality – Condition in which a nuclear reactor is just self-sustaining.

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.

decay time – Time taken by a quantity to decay to a stated fraction of its initial value.

decontamination and decommissioning – See environmental restoration.

derived concentration guide – 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) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and lens of the eye. The guides for radionuclides in air and water are given in Department of Energy Order 5400.5.

desorption – Process of removing a sorbed substance by the reverse of adsorption or absorption.

detector – Material or device (instrument) that is sensitive to radiation and can produce a signal suitable for measurement or analysis.

diatometer – Diatom collection equipment consisting of a series of microscope slides in a holder that is used to determine the amount of algae in a water system.

diatoms – Unicellular or colonial algae of the class Bacillariophyceae, having siliceous cell walls with two overlapping, symmetrical parts. Diatoms represent the predominant periphyton (attached algae) in most water bodies and have been shown to be reliable indicators of water quality.

disintegration (nuclear) – Spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom.

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.

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).

dose equivalent – Product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem=0.01 sievert).

committed dose equivalent – Calculated total dose equivalent to a tissue or organ over a 50-year period after known intake of a radionuclide into the body. Contributions from external dose are not included. Committed dose equivalent is expressed in units of rem (or sievert).

committed effective dose equivalent – Sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).

effective dose equivalent – Sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body.

collective dose equivalent/collective effective dose equivalent – Sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within a 50-mile (80-km) radius, and expressed in units of person-rem (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 50-mile distance

is measured from a point located centrally with respect to major facilities or DOE program activities.

dosimeter – Portable detection device for measuring the total accumulated exposure to ionizing radiation.

dosimetry – Theory and application of principles and techniques involved in the measurement and recording of radiation doses. Its practical aspect is concerned with using various types of radiation instruments to make measurements.

downgradient – In the direction of decreasing hydrostatic head.

downgradient well – Well that is installed hydraulically downgradient of a site and may be capable of detecting migration of contaminants from a site.

drinking water standards – Federal primary drinking water standards, both proposed and final, as set forth by EPA.

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 – Liquid or gaseous waste discharge to the environment.

effluent monitoring – Collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying the release of contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.

environmental monitoring – Program at Savannah River Site that includes effluent monitoring and environmental surveillance with 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 restoration – Department of Energy program that directs the assessment and cleanup of its sites (remediation) and facilities (decontamination and decommissioning) contaminated with waste as a result of nuclear-related activities.

environmental surveillance – Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from Department of Energy sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

equipment blank – Sample container of deionized water that has been pumped through or has filled a sampling device (e.g., well pump bailer). Laboratory analysis of the blank can identify potential contaminants in water, sample container, or analytical equipment.

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 upper 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 that exposure to ionizing radiation which takes place during a person's working hours. Population exposure is the exposure to the total number of persons who inhabit an area.

external radiation – Exposure to ionizing radiation when the radiation source is located outside the body.

F

fecal coliform – Coliform group comprises all of the aerobic, nonspore-forming, rod-shaped bacteria. The test determines the presence or absence of coliform organisms.

Federal Facility Agreement (FFA) – Agreement negotiated among the Department of Energy, the 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 the Savannah River Site waste units identified for evaluation and, if necessary, clean-up.

feral hog – Hog that has reverted to the wild state from domestication.

field blank – Sample container of deionized water generated by filling the sample container at the sample location and treated as a groundwater sample.

food web – Series of organisms related by predator-prey and consumer-resource interactions; the entirety of interrelated food chains in an ecological community.

formation – Mappable unit of consolidated or unconsolidated geologic material of a characteristic lithology or assemblage of lithologies.

frit – Fused or partially fused materials used in glass-making.

G

gamma ray – High-energy, short wavelength electromagnetic radiation emitted from the nucleus of an excited atom. Gamma rays are identical to X-rays except for the source of the emission.

gamma-emitting radionuclide – Radionuclide that emits gamma rays.

gamma spectrometry – System consisting of a detector, associated electronics, and a multichannel analyzer that is used to analyze samples for gamma-emitting radionuclides.

gas chromatographic volatile organic analyses (GC VOA) – Analytical technique detecting and quantifying volatile organic compounds in a sample by gas chromatography.

Gaussian puff/plume model – Computer simulated atmospheric dispersion of a release using a Gaussian (normal) statistical distribution to determine concentrations in air.

Geiger-Mueller counter – Highly sensitive, gas-filled radiation detector, which operates at voltages sufficiently high to produce ionization. The counter is used primarily in the detection of gamma radiation and beta emission. It is named for Hans Geiger and W. Mueller, who invented it in 1928.

genotoxicology – Study of the effects of chemicals or radioactive contaminants on the genetics of individual animals or plants.

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).

groundwater (unconfined) – Groundwater exposed to the unsaturated zone.

H

half-life (biological) – Time required for a biological system, such as that of a human, to eliminate by natural processes half the amount of a substance (such as a radioactive material) that has entered it.

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.

head reversal – Hydrologic phenomenon in which a deeper formation has a higher water pressure than a more shallow formation in the same location. This condition results in a tendency for groundwater to flow upward from the deeper media to the more shallow formation.

heavy water – Water in which the molecules contain oxygen and deuterium, an isotope of hydrogen that is heavier than ordinary hydrogen.

herbaceous – Having little or no woody tissue.

herbicides/pesticides – Suite of analyses consisting of 2,4-dichlorophenoxyacetic acid, endrin, lindane, methoxychlor, toxaphene, and 2,4,5-TP (silvex).

hydraulic gradient – Difference in hydraulic head over a specified distance.

hydraulic head – Elevation of the water in a well or piezometer.

hydrogeology – Hydrologic aspects of site geology.

hydrology – Science that treats the occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment.

I

in situ – In its original place. Field measurements taken without removing the sample from its origin; remediation performed while groundwater remains below the surface.

inorganic – Involving matter other than plant or animal.

internal dose factor – Factor used to convert intakes of radionuclides to dose equivalents.

internal radiation – Internal radiation occurs when natural radionuclides enter the body by ingestion of foods, milk, and water, and by inhalation. Radon is the major contributor to the annual dose equivalent for internal radionuclides.

ion – Atom or compound that carries an electrical charge.

ion exchange – Process in which a solution containing soluble ions is passed over a solid ion exchange column that removes the soluble ions by exchanging them with labile ions from the surface of the column. The process is reversible so that the trapped ions are removed (eluted) from the column and the column is regenerated.

irradiation – Exposure to radiation.

Isco sampler – Portable, microprocessor-controlled water sampler that utilizes a peristaltic pump for sample collection. The sampler may be used with a flowmeter to obtain a flow-proportional sample or without a flowmeter to obtain a time-proportional sample.

isotopes – Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons.

long-lived isotope – Radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years).

short-lived isotope – Radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

L

laboratory blank – Deionized water sample generated by the laboratory; a laboratory blank is analyzed with each batch of samples as an in-house check of analytical procedures. Also called an internal blank.

layup – To put in condition for possible future use.

liquid scintillation cocktail – Solution combined with a radioactive sample which converts the energy of the particle emitted during radioactive decay into light, which is detected by a liquid scintillation counter.

liquid scintillation counter – Combination of phosphor, photomultiplier tube, and associated circuits for counting light emissions produced in the phosphors.

lower limit of detection (LLD) – Smallest concentration/amount of analyte that can be reliably detected in a sample at a 95 percent confidence level.

M

macroinvertebrates – Size-based classification used for a variety of insects and other small invertebrates; as defined by the Environmental Protection Agency, those organisms that are retained by a No. 30 (590 micron) U.S. Standard Sieve.

macrophyte – A plant that can be observed with the naked eye.

manmade radiation – Radiation sources such as consumer products, medical procedures, and nuclear industry.

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.

mean relative difference (MRD) – 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.

microbes – Microscopic organisms.

migration – Transfer or movement of a material through the air, soil, or groundwater.

milliroentgen (mR) – Measure of X-ray or gamma radiation. The unit is one-thousandth of a roentgen.

minimum detectable concentration (MDC) – 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.

monitoring – Process whereby the quantity and quality of factors that can affect the environment and/or human health are measured periodically in order to regulate and control potential impacts.

N

natural radiation – Radiation arising from cosmic and other naturally occurring radionuclide (such as radon) sources present in the environment.

nonpoint source – any source that does not meet the definition for point source (National Emission Standards for Hazardous Air Pollutants radionuclide program).

nonroutine radioactive release – Unplanned or non-scheduled 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 – Point of discharge (e.g., drain or pipe) of wastewater or other effluents into a ditch, pond, or river.

P

paddlewheel sampler – Water sampling device, constructed of a Lexan® wheel, suspended on two pontoons and anchored in streams and rivers.

parameter – Analytical constituent; chemical compound(s) or property for which an analytical request may be submitted.

parts per million (ppm) – Unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L.

percolation – Slow movement of a liquid through a porous material.

permeability – Physical property that describes the ease with which water may move through the pore spaces and cracks in a solid.

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 have a pH from 0–6, basic solutions have a pH > 7, and neutral solutions have a pH = 7.

piezometer – Instrument used to measure the potentiometric surface of the groundwater. Also, a well designed for this purpose.

plume – Volume of contaminated air or water originating at a point-source emission (e.g., a smokestack) or a waste source (e.g., a hazardous waste disposal site).

point of compliance – Vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units.

point source – stack or vent (National Emission Standards for Hazardous Air Pollutants radionuclide program).

population dose commitment – See collective dose equivalent under dose.

priority pollutants – Group of approximately 130 chemicals (about 110 are organics) that appear on an Environmental Protection Agency list because they are toxic and relatively common in industrial discharges.

process sewer – Pipe or drain, generally located underground, used to carry off process water and/or waste matter.

process water – Water used within a system process.

purge – To remove water prior to sampling, generally by pumping or bailing.

purge water – Water that has been removed prior to sampling; water that has been released to seepage basins to allow a significant part of tritium to decay before the water outcrops to surface streams and flows to the Savannah River.

Q

quality assurance (QA) – Any action in environmental monitoring to assure the reliability of monitoring and measurement data.

quality control (QC) – In environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes.

R

rad – Unit of absorbed dose deposited in a volume of material.

radiation detection instruments – Devices that detect and record the characteristics of ionizing radiation.

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.

real-time instrumentation – Operation in which programmed responses to an event are essentially simultaneous with the event itself.

reforestation – Process of planting new trees on land once forested.

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 × the radiation quality factor). Dose equivalent is frequently reported in units of millirem (mrem) which is one-thousandth of a rem.

remediation – Assessment and cleanup of Department of Energy sites contaminated with waste as a result of past activities. See environmental restoration.

replicate – In the Environmental Monitoring Section groundwater monitoring program, a second sample from the same well taken at the same time as the primary sample and sent to the same laboratory for analysis.

replicate result – Analytical result of a blind replicate sample. See blind replicate.

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.

Resource Conservation and Recovery Act (RCRA) closure certification – Certification prepared within 60 days of closure by the owner or operator of an individual waste disposal unit at a facility or an incinerator, tank, or container storage facility, and a qualified, independent, registered professional engineer. The document certifies that the facility or unit was closed in accordance with the approved facility closure plan.

Resource Conservation and Recovery Act (RCRA) interim status – Statutorily conferred authorization for a hazardous waste management unit to operate pending issuance or denial of its Resource Conservation and Recovery Act permit. Interim status provisions, contained in 40 CFR Part 265, allow a facility to operate legally. The facility is considered to be operating under a permit until the Environmental Protection Agency takes final administrative action on that facility's permit application.

Resource Conservation and Recovery Act (RCRA) site – Solid waste management unit under Resource Conservation and Recovery Act regulation. See Resource Conservation and Recovery Act.

retention basin – Unlined basin used for emergency, temporary storage of potentially contaminated cooling water from chemical separations activities.

RFI Program – RCRA Facility Investigation Program; Environmental Protection Agency-regulated investigation of a solid waste management unit with regard to its potential impact on the environment.

RFI/RI – RCRA Facility Investigation/Remedial Investigation. See RFI/RI Program.

RFI/RI Program – RCRA Facility Investigation/Remedial Investigation Program. At the Savannah River Site, the expansion of the RFI Program to include Comprehensive Environmental Response, Compensation, and Liability Act and hazardous substance regulations.

roentgen – Unit of exposure from X- or gamma rays. One roentgen equals 2.58×10^{-4} coulombs per kilogram of air.

routine radioactive release – Planned or scheduled release of radioactivity to the environment.

S

screen zone – In well construction, the section of a formation that contains the screen, or perforated pipe that allows water to enter the well.

seep – Area, generally small, where water percolates slowly to the land surface.

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 analyte.

set-aside areas – Thirty areas covering 14,288 acres set aside to protect rare, threatened, and endangered biota, as well as unique habitats.

settleable solids – Material settling out of suspension within a defined period.

settling basin – Temporary holding basin (excavation) that receives wastewater which is subsequently discharged.

sidegradient well – Well that intercepts groundwater flowing next to a site; a sidegradient well is located neither upgradient nor downgradient to the monitored site.

Sievert (Sv) – SI (International System of Units) unit of dose equivalent, 1 Sv=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.

Solid Waste Disposal Facility – Place for burying unwanted radioactive material to prevent escape of radioactivity. The surrounding water acts as a shield. Such material is placed in watertight, noncorrosive containers so that it cannot leach out and invade underground water.

source – Point or object from which radiation or contamination emanates.

source check – Radioactive source with a known amount of radioactivity used to check the performance of the radiation detector instrument.

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.

specific conductance – Ability of water to conduct electricity; this ability varies in proportion to the amount of ionized minerals in the water.

spike – Addition of a known amount of reference material containing the analyte of interest to a blank sample.

split sample – Two samples from the same well, taken at the same time, and sent to two different laboratories for analysis.

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.

stormwater runoff – Surface streams that appear after precipitation.

strata – Beds, layers, or zones of rocks.

substrate – Substance, base, surface, or medium in which an organism lives and grows.

Superfund – see Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

supernatant – Portion of a liquid above settled materials in a tank or other vessel.

surface water – All water on the surface of the earth, as distinguished from groundwater.

T

tank farm – Installation of interconnected underground tanks 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 radiation – Ionizing radiation emitted from radioactive materials, primarily potassium-40, thorium, and uranium, in the earth's soils. Terrestrial radiation contributes to natural background radiation.

thermoluminescent dosimeter (TLD) – Device used to measure external gamma radiation.

total activity – Total quantity of radioactive decay particles that are emitted from a sample.

total dissolved solids – Dissolved solids and total dissolved solids are terms generally associated with freshwater systems and consist of inorganic salts, small amounts of organic matter and dissolved materials.

total organic halogens – Measure of the total concentration of organic compounds that have one or more halogen atoms.

total phosphorus – When concentrations exceed 25 mg/L at the time of the spring turnover on a volume-weighted basis in lakes or reservoirs, it may occasionally stimulate excessive or nuisance growths of algae and other aquatic plants.

total solids – Sum of total dissolved solids and suspended solids.

total suspended particulates – Refers to the concentration of particulates in suspension in the air irrespective of the nature, source, or size of the particulates.

transmissive zone – Zone of sediments sufficiently porous and permeable to allow the flow of groundwater through the zone.

transuranic waste – Solid radioactive waste containing primarily alpha-emitting elements heavier than uranium.

turbidity – Measure of the concentration of sediment or suspended particles in solution.

U

upgradient – In the direction of increasing hydrostatic head.

V

vadose zone – Soil zone located above the water table.

vitrification – Process of changing into glass.

volatile organic compounds – Broad range of organic compounds, commonly halogenated, that vaporize at ambient, or relatively low, temperatures (e.g., acetone, benzene, chloroform, and methyl alcohol).

W

waste unit – Inactive area that is known to have received contamination or had a release to the environment.

water table – Planar, underground surface beneath which earth materials, as soil or rock, are saturated with water.

watershed – Region draining into a river, river system, or body of 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 contributed to that particular tissue. The weighting factors used in this report are recommended by the International Commission on Radiological Protection (Publication 26).

wetlands – Lowland area, such as a marsh or swamp, inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted for life in saturated soils.

wind rose – Diagram in which statistical information concerning direction and speed of the wind at a location is summarized.

worldwide fallout – Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

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Index

A

A-Area and M-Area, groundwater monitoring results, 149

Academy of Natural Sciences of Philadelphia river quality surveys, 191

algae and aquatic macrophyte studies progress report, 194

chemistry and bacteriology studies progress report, 198

diatometer monitoring progress report, 193

fish studies progress report, 196

insect studies progress report, 196

noninsect macroinvertebrate studies progress report, 195

protozoa studies progress report, 195

sampling sites for, 192

acid/caustic basins, groundwater monitoring results, 137

Affirmative Procurement Plan, 42

Aiken Plateau, 131

air, radiological surveillance of, 70

sampling stations for, 71

air dispersion modeling, 114, 119

air emissions inventory, 27

airborne emissions

- nonradiological monitoring of, 111
- radiological monitoring of, 55
- comparison of average concentrations to Derived Concentration Guides, 57
- diffuse and fugitive sources, 56
- results of, 57

algae and aquatic macrophyte studies by Academy of Natural Sciences of Philadelphia, 194

A-Line groundwater monitoring results, uranium recovery facility, 147

ambient air quality, 114, 119

appraisals and surveillances of environmental program, 31

aquatic food products. *See* fish, marine fish, shellfish

as low as reasonably achievable concept, 55

asbestos removal program, 26

ash basins, groundwater monitoring results, 140

Atomic Energy Commission, 1

B

bald eagle, 29

B-Area gas station, groundwater monitoring results, 155

Baseline Risk Assessment, 16

beavers, radiological surveillance of, 87

beef. *See* food products

Bentonite Mat, 46

blind sample program, for quality assurance, 178

Bridging Amendment, 14

burial grounds, groundwater monitoring results, 151

burning/rubble pits, groundwater monitoring results, 138–140

C

caddisflies, 11

canyons, 7

CAP88, 96

Cassini mission (NASA), 7

Catherwood Diatometers, 193

Center for Vitrification Research, 10

Central Sanitary Wastewater Treatment Facility, 24

Central Savannah River Area Radiological Environmental Monitoring Program, 43

Chemical Commodity Management Center, 42

chemical, metals, and pesticides pits, groundwater monitoring results, 155

chemistry and bacteriology studies by Academy of Natural Sciences of Philadelphia, 198

Citizens Advisory Board, 12

recommendations of, 52

Clean Air Act, 25
 compliance with National Emissions Standards of Hazardous Air Pollutants, 105
 Notice of Violation, 28

Clean Water Act, 24
 reportable occurrences, 30

cleanup, definition of term, 8, 45

coal piles, groundwater monitoring results, 140

coal-fired boilers
 capacities of, 112
 nonradiological airborne emissions standards for, 112
 stack test results of, 113

compensatory mitigation, 191

Comprehensive Environmental Response, Compensation, and Liability Act, 16
 reportable occurrences, 30, 31

confined aquifer, 130

Congaree-Fourmile zone, 132

Consolidated Incineration Facility, 50

construction and operating permits, 33

continuous monitoring, 56

cooperative research and development agreements, 9

criteria pollutant air emissions (1994), 113

critical pathways analysis, 39

CRITR, 110

D

D-Area groundwater monitoring results, oil disposal basin, 155

data validation, and quality assurance, 179

decontamination and decommissioning, definition of terms, 8

deer
 dose from consumption of, 106
 radiological surveillance of, 86

Defense Waste Processing Facility, 8, 17, 51

Department of Energy Quality Assurance Program, 179

Derived Concentration Guides, 57, 60

diatometer studies by Academy of Natural Sciences of Philadelphia, 193

noninsect macroinvertebrate studies by Academy of Natural Sciences of Philadelphia, 195

protozoa studies by Academy of Natural Sciences of Philadelphia, 195

diffuse and fugitive sources, radioactive releases from, 56

disassembly basins, groundwater monitoring results, 141

dose
 calculating by Savannah River Site, 96
 calculating for children, 96
 calculation models, 96
 contributions to average individual, 106
 definition of in this report, 95
 to maximally exposed individual, 95
 uncertainty in calculation of, 99

dose calculation results
 air pathway, 102
 atmospheric concentrations, 102
 atmospheric source terms, 102
 collective dose (population dose), 104
 maximally exposed individual, 103, 104
 National Emissions Standards for Hazardous Air Pollutants compliance, 105
 all-pathway, 105
 comparison of, to standard, 107
 deer and hog consumption pathway, 106
 dose to aquatic animal organisms, 109
 drinking water pathway, 101
 fish consumption pathway, 107
 liquid pathway, 99
 collective effective dose equivalent (population dose), 101
 irrigation, 102
 liquid release source terms, 99
 maximally exposed individual, 101
 maximally exposed individual, (sector-specific), 104
 sportsman dose, 106
 deer and hog consumption pathway, 106
 fish consumption pathway, 107

Dose Reconstruction Study, 40

drinking water
 nonradiological surveillance of, 120
 radiological surveillance of, 82
 offsite sampling locations for, 82
 site systems, 23

Du Pont, 1

E

E.I. du Pont de Nemours and Company, 1

Education, Research and Development Association of Georgia Universities, 12

educational outreach, 12

effluent monitoring, definition of, 36

Emergency Planning and Community Right-to-Know Act, 17

endangered and threatened species, 5

Endangered Species Act, 29

Environmental Advisory Committee, 43

environmental awareness program, 42

Environmental Bulletin, 44

environmental compliance

- 33/50 Pollution Prevention Program, 17
- appraisals and surveillances of programs, 31
- Clean Air Act, 25
 - Notice of Violation, 28
- Clean Water Act
 - National Pollutant Discharge Elimination System program, 24
 - reportable occurrences, 30
- Comprehensive Environmental Response, Compensation, and Liability Act, 16
 - reportable occurrences, 30, 31
- Emergency Planning and Community Right-to-Know Act, 17
- Endangered Species Act, 29
- Executive Order 12856, 18
- Federal Facility Agreement, 16
- Federal Facility Compliance Act, 14
- Federal Insecticide, Fungicide, and Rodenticide Act, 25
- floodplain management (Executive Order 11988), 29
- key regulations for, 15
- land disposal restrictions, 14
- National Emission Standards for Hazardous Air Pollutants, 25
- National Environmental Policy Act, 18
- National Historic Preservation Act, 29
- PAR Pond repair/refill, 34
- permits, 33
- protection of wetlands (Executive Order 11990), 30
- Resource Conservation and Recovery Act, 13
 - 300-3004(u) Program, 16
 - Notice of Violation, 16
- Safe Drinking Water Act, 23

Site Item Reportability and Issues Management Program, 31

- summary of 33/50 chemical exceedances, 20
- toxic chemical releases, 18, 19

Toxic Substances Control Act, 28

training, 34

tritium migration, 34

underground storage tanks, 15

Waste Minimization Program, 16

environmental monitoring program, 35

- 1995 changes, 40
- environmental regulations for, 38
- measurement capabilities as factors in, 39
- nonradioactive materials, 37
- objectives of, 38
- policy for, 37
- public concerns about releases, 39
- radioactive contaminants, 36
- rationale for, 38

Environmental Outreach and Education Program, 44

Environmental Protection Agency quality assurance program, (Quality Assurance Division), 180

environmental release response and reporting, 30

environmental restoration

- 1995 achievements, 46
- definition of term, 7, 45
- description of program, 46
 - graphic, 47
- regulations for, 45

environmental surveillance, definition of, 36

Environmental Transport Group and air quality modeling, 114

F

F-Area, groundwater monitoring results

- canyon building, 147
- effluent treatment cooling water basin, 148

FB-Line, description of operations, 7

Federal Facility Agreement, 16

Federal Facility Compliance Act, 14

Federal Insecticide, Fungicide, and Rodenticide Act, 25

fish

- dose from consumption of, 107
- nonradiological surveillance of, 122
- radiological surveillance of, 84
- sampling locations for, 85

risk from consumption of, 109
fish studies by Academy of Natural Sciences of Philadelphia, 196
floodplain management (Executive Order 11988), 29
flow rate measurements, 56, 59
food products, radiological surveillance of, 83
freshwater fish. *See* fish, radiological surveillance of
Freshwaters, definition of, 119
fruit. *See* food products

G

gamma radiation, radiological surveillance of, 73
 offsite sampling locations for, 76
geological setting at Savannah River Site, 131
grains. *See* food products
Green Building Program, 42
"Green Clay" aquitard, 132
greens. *See* food products
groundwater
 and quality assurance, 182
 and trans-river flow, 186
 description of monitoring program for, 133–137
 1995 changes, 135
 hydrology, 127
 monitoring well network, 128
 movement of, 127
 overview of well network, 158
 plume monitoring, 149–151
 quality control of, 135
 uses in Savannah River Site vicinity, 132
groundwater monitoring results, 137–161
 A-Line uranium recovery facility, 147
 acid/caustic basins, 137
 B-Area gas station, 155
 burial grounds, 151
 burning/rubble, rubble, and metals burning pits, 138–140
 chemicals, metals, and pesticides pits, 155
 coal pile runoff containment basins, ash basins, and coal piles, 140
 D-Area oil disposal basin, 155
 disassembly basins, 141
 F-Area
 canyon building, 147

 effluent treatment cooling water basin, 148
H-Area
 auxiliary pump pit, 148
 canyon building, 148
 effluent treatment cooling water basin, 148
K-Area
 diesel tank spill, 156
 tritium sump, 148
L-Area acid/caustic basin and oil and chemical basin, 156
miscellaneous chemical basin, 156
motor shop oil basin, 156
N-Area
 diesel spill, 156
 fire department training facility, 157
 hazardous waste storage facility, 148
 hydrofluoric acid spill, 157
radioactive waste storage and disposal facilities, 151–153
Road A (Baxley Road) chemical basin, 157
S-Area
 facilities, 148
 low-point pump pit, 148
 vitrification building, 149
sanitary landfill, 153
seepage and retention basins, 142–147
Silverton Road waste site, 157
sludge application sites, 154
T-Area (TNX), 150
tank farms, 152
TNX burying ground, 157
Z-Area
 low-point drain tank, 149
 saltstone manufacturing and disposal facility, 149

H

H-Area, groundwater monitoring results
 auxiliary pump pit, 148
 canyon building, 148
 effluent treatment cooling water basin, 148
hazardous waste, 48
HB-Line, description of operations, 7
high-level waste, 51
hogs
 dose from consumption of, 106
 radiological surveillance of, 86
hydrogeological setting at Savannah River Site, 131

I

In-Tank Precipitation Facility, 51
information exchange, 43
inorganic contaminants, in sediment, 122
insect studies by Academy of Natural Sciences of Philadelphia, 196
Integrated Demonstration Site, 8
Interim Sanitary Landfill, 48
interlaboratory comparison
 Department of Energy Quality Assurance Program, 179
 Environmental Protection Agency Quality Assurance Division, 180
 for National Pollutant Discharge Elimination System, 181
intralaboratory comparison, for National Pollutant Discharge Elimination System, 181

K

K-Area, groundwater monitoring results
 diesel tank spill, 156
 tritium sump, 148
key regulations for environmental compliance, 15

L

L-Lake, construction of, 3
L-Area, groundwater monitoring results
 acid/caustic basin, 156
 oil and chemical basin, 156
laboratory data record reviews, and quality assurance, 184
LADTAPII, 96
land disposal restrictions, 14
liquid discharges
 nonradiological monitoring of, 114
 radiological monitoring of, 58
 comparison of average concentrations to Derived Concentration Guides, 60
 results of, 59
liquid effluents, direct discharges of, 60
low-level waste, 48

M

marine fish. *See* fish, radiological surveillance of
MAXIGASP, 96
mercury, in fish, 122
metals burning pits, groundwater monitoring results, 138–140
metals pits, groundwater monitoring results, 155
meteorological data, as input for dose calculations, 96
miscellaneous chemical basin, groundwater monitoring results, 156
mitigation, compensatory, 191
Mitigation Action Plan for Pen Branch Reforestation, 189
mixed waste, 49
motor shop oil basin, groundwater monitoring results, 156

N

N-Area, groundwater monitoring results
 diesel spill, 156
 fire department training facility, 157
 hazardous waste storage facility, 148
 hydrofluoric acid spill, 157
National Emissions Standards for Hazardous Air Pollutants, 25
 compliance with for dose calculation, 105
National Environmental Policy Act, 18
 documentation activities, 22
 types of activities, 21
National Environmental Research Park
 designation of Savannah River Site as, 4
 program overview, 10
National Historic Preservation Act, 29
National Pollutant Discharge Elimination System, 24
 1995 exceedances, 117
 and quality assurance, 180
 Environmental Protection Agency control sample program, 181
 history of exceedances, 116
 permits, 114
 program results, 115
National Priority List, 16, 46
Natural Resources Environmental Education Program, 11, 44

New Waste Transfer Facility, 51
 Nonradioactive Disposal Facility (Sanitary Landfill), 46
 nonradiological monitoring and surveillance. *See* individual medium
 nonroutine occurrence, 58
 Notice of Violation
 Clean Air Act, 28
 Resource Conservation and Recovery Act, 16

O

Oil Pollution Prevention, 24
 ozone-depleting substances, 25, 27, 42

P

PAR Pond
 construction of, 3
 repair/refill, 34
 patents and licenses, 9
 pathways
 examples of exposure, 39
 surveillance of as part of radiological surveillance program, 69
 Pen Branch reforestation
 by natural succession, 189
 by planting, 190
 permits for environmental compliance, 33
 construction and operating, 33
 pesticides and herbicides, in sediment, 122
 pesticides pits, groundwater monitoring results, 155
 pesticides, herbicides, and volatile organic compounds, SCDHEC sampling locations for, 121
 pipe crawlers, 9
 plume monitoring
 in A-Area and M-Area, 149
 in separations and waste management areas, 150
 in T-Area (TNX), 150
 pollution prevention, 40
 33/50 Pollution Prevention Program, 17
 summary of exceedances, 20
 Executive Order 12856, 18
 Pollution Prevention Act of 1990, 17

POPGASP, 96
 population database and distribution, as input for dose calculations, 97
 public
 concerns about releases, 39
 involvement of stakeholders, 52
 outreach, 43
 Public Involvement Program, 52
 purple coneflower, 29

Q

quality assurance
 definition of terms, 179, 183
 external program, 179
 for Environmental Monitoring Section laboratories, 177
 for groundwater analyses, 182
 for National Pollutant Discharge Elimination System analyses, 180
 for soil and sediment analyses, 184
 for stream and river water analyses, 182
 for subcontracted laboratories, 180
 internal program, 178
 relevant guidance documents for, 178
 Quality Assurance Division (Environmental Protection Agency), 180
 Quality Assurance Program (Department of Energy), 179
 quality control practices for groundwater, 135

R

Radiation Assessment Program, 110
 radioactive waste storage and disposal facilities, groundwater monitoring results, 151–153
 radiological monitoring and surveillance. *See* individual medium
 rainwater, radiological surveillance of, 72
 reactors, 5
 real-time monitoring, 55
 Receiving Basin for Offsite Fuels, 7
 recycling, of solid waste, 41
 red-cockaded woodpecker, 29
 Replacement Tritium Facility, 5
 reportable occurrences for environmental compliance, 30

Comprehensive Emergency Response,
Compensation, and Liability Act, 31
reporting, of environmental releases, 30
Resource Conservation and Recovery Act, 13
300-4(u) Program, 16
Notice of Violation, 16
retention basins, groundwater monitoring results,
142-147
river flow rate data, as input for dose calculations,
97
Road A (Baxley Road) chemical basin,
groundwater monitoring results, 157
robotic technology, 8
rubble pits, groundwater monitoring results,
138-140

S

S-Area, groundwater monitoring results
facilities, 148
low-point pump pit, 148
vitrification building, 149
Safe Drinking Water Act, 23
Saltstone Facility, 52
sampling locations
nonradiological
Savannah River water, 121
sediment, 123
stream water quality, 121
radiological
air, 71
drinking water (offsite), 82
fish, 85
gamma radiation (offsite), 76
sediment, 90
soil, 88
surface water (seepage basins, streams, Savan-
nah River), 77
vegetation (inside Solid Waste Disposal Facili-
ty), 94
vegetation (onsite quarterly and outside-Solid
Waste Disposal Facility locations), 91
sanitary landfill, groundwater monitoring results,
153
sanitary waste, 48
Savannah River
nonradiological surveillance of, 120
sampling locations for, 121
radiological surveillance of, 79
sampling locations for, 77
tritium release transport, 81
Savannah River Archaeological Research
Program, 11
Savannah River Ecology Laboratory, 10
Savannah River Forest Station, 4, 11
Savannah River Research Campus, 10
Savannah River Site
areas, 6
as South Carolina's largest single employer, 12
changing mission, 5
construction, 1
geological setting, 131
history, 1
hydrogeological setting, 131
location, 3
map of areas, 6
policy of the 1990s, 12
tours, 43
Savannah River Swamp Survey, 185
Savannah River Technology Center, 8
sediment
nonradiological surveillance of, 122
sampling locations for, 123
radiological surveillance of, 89
sampling locations for, 90
seepage basins
groundwater monitoring results, 142-147
migration results, 61
radiological surveillance of, 74
sampling locations for, 77
separations and waste management areas,
groundwater monitoring results, 150
settleable solids, radiological monitoring of, 63
shellfish. *See* fish, radiological surveillance of
shortnose sturgeon, 29
Silverton Road waste site, groundwater
monitoring results, 157
Site Item Reportability and Issues Management
Program, 31
unusual occurrences reported through, 32
Site Treatment Plan for Mixed Wastes, 50
sludge application sites, groundwater monitoring
results, 154
soil, radiological surveillance of, 88
sampling locations for, 88
solid waste, 48
reduction of, 41
Solid Waste Disposal Facility, 48

migration results, 61
 radiological results of vegetation samples at, 94
 South Carolina Universities Research and Education Foundation, 12
 Speakers Bureau, 43
 spent nuclear fuel, 7
 SRS Domestic Water Consolidation Preliminary Engineering Report, 23
 SRS Environmental Bulletin, 12
 stakeholder involvement, 52
 steam boilers, capacities of, 113
 stormwater discharges, 24
 stratospheric ozone protection, 27
 streams
 nonradiological surveillance of, 119
 sampling locations for, 121
 radiological surveillance of, 76
 sampling locations for, 77
 tritium release transport, 81
 subcontracted laboratories, 180
 Superfund Amendments and Reauthorization Act, 16
 Superfund List. *See* Comprehensive Environmental Response, Compensation, and Liability Act
 Supplier Environmental and Waste Management Information Exchange, and vendor partnership achievements, 50
 surface water. *See* seepage basins, streams, Savannah River

T

T-Area (TNX), groundwater monitoring results, 150
 "Tan Clay" layer, 132
 tank farms
 evaporator facilities, 51
 groundwater monitoring results, 152
 technology transfer, 9
 terrestrial food products. *See* food products
 terrestrial vegetation. *See* vegetation
 thermoluminescent dosimeter program
 and public concern, 39
 locations of offsite surveillance stations, 76
 Tier II Inventory Report, 17

Title V operating program, 27
 TNX burying ground, groundwater monitoring results, 157
 tours of Savannah River Site, 43
 toxic air pollutant air sources, stack test results of, 114
 Toxic Chemical Release Inventory, 17, 18
 decline in reportable release quantities, 41
 toxic chemicals, releases of, 18, 19
 Toxic Substances Control Act, 28
 Tracking Radioactive Atmospheric Contaminants (TRAC), 11
 training
 for environmental awareness, 43
 for environmental compliance, 34
 for quality assurance, 177
 trans-river flow, definition of, 186
 Trans-River Flow Project, 185
 and base-flow studies, 188
 and water quality, 187
 transuranic waste, 48
 Traveling Lecturers Program, 43
 tritium
 options for production of, 5
 unplanned release of, 58
 tritium migration, 34, 185
 tritium release transport in streams and Savannah River, 81
 turkeys, radiological surveillance of, 87

U

underground storage tanks, 15
 unplanned releases, response to, 30
 Upper Atlantic Coastal Plain, 131

V

vegetation, radiological surveillance of, 89
 results of quarterly samples, 91
 results of seepage and retention basin samples, 93
 results of Solid Waste Disposal samples, 94
 sampling locations for (inside Solid Waste Disposal Facility), 94
 sampling locations for (quarterly onsite locations and outside-Solid Waste Disposal Facility locations), 91

Visitors Program, 43

vitrification, 8

W

waste

hazardous, 48

low-level, 48

mixed, 49

sanitary, 48

transuranic, 48

waste certification, 49

waste management

definition of term, 8, 45

high-level, 51

1995 accomplishments of, 51

regulations for, 45

solid, 48

waste minimization, 16, 41, 49

water buffaloes, 48

water quality, and quality assurance, 182

Weather Information and Display, 11

wetlands, protection of, 30

wind rose for Savannah River Site, 98

wood stork, 29, 41

Z

Z-Area, groundwater monitoring results

low-point drain tank, 149

saltstone manufacturing and disposal facility,
149

Units of Radiation Measure		
Current System	<i>Système International</i>	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

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					
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-U.S.	0.946	L	L	1.057	liq qt-U.S.
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}	μ Ci	μ Ci	10^6	pCi
pCi/L (water)	10^{-9}	μ Ci/mL (water)	μ Ci/mL (water)	10^9	pCi/L (water)
pCi/m ³ (air)	10^{-12}	μ Ci/mL (air)	μ Ci/mL (air)	10^{12}	pCi/m ³ (air)

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