Chapter 4

Radiological Environmental Surveillance

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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 2001 that covered approximately 2,000 square miles and extended up to 25 miles from the site. In conjunction with the radiological effluent monitoring program (chapter 3, "Radiological Effluent Monitoring"), the radiological environmental surveillance 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 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 2001 results for groundwater can be found in chapter 8, "Groundwater."

Detailed analytical results for 2001—as well as representative minimum detectable concentrations (MDCs) for the types of analyses being performed on the various environmental surveillance media—appear in *SRS Environmental Data for 2001* (WSRC–TR–2001–00475). Data from earlier years can be found in previous SRS environmental reports and data publications.

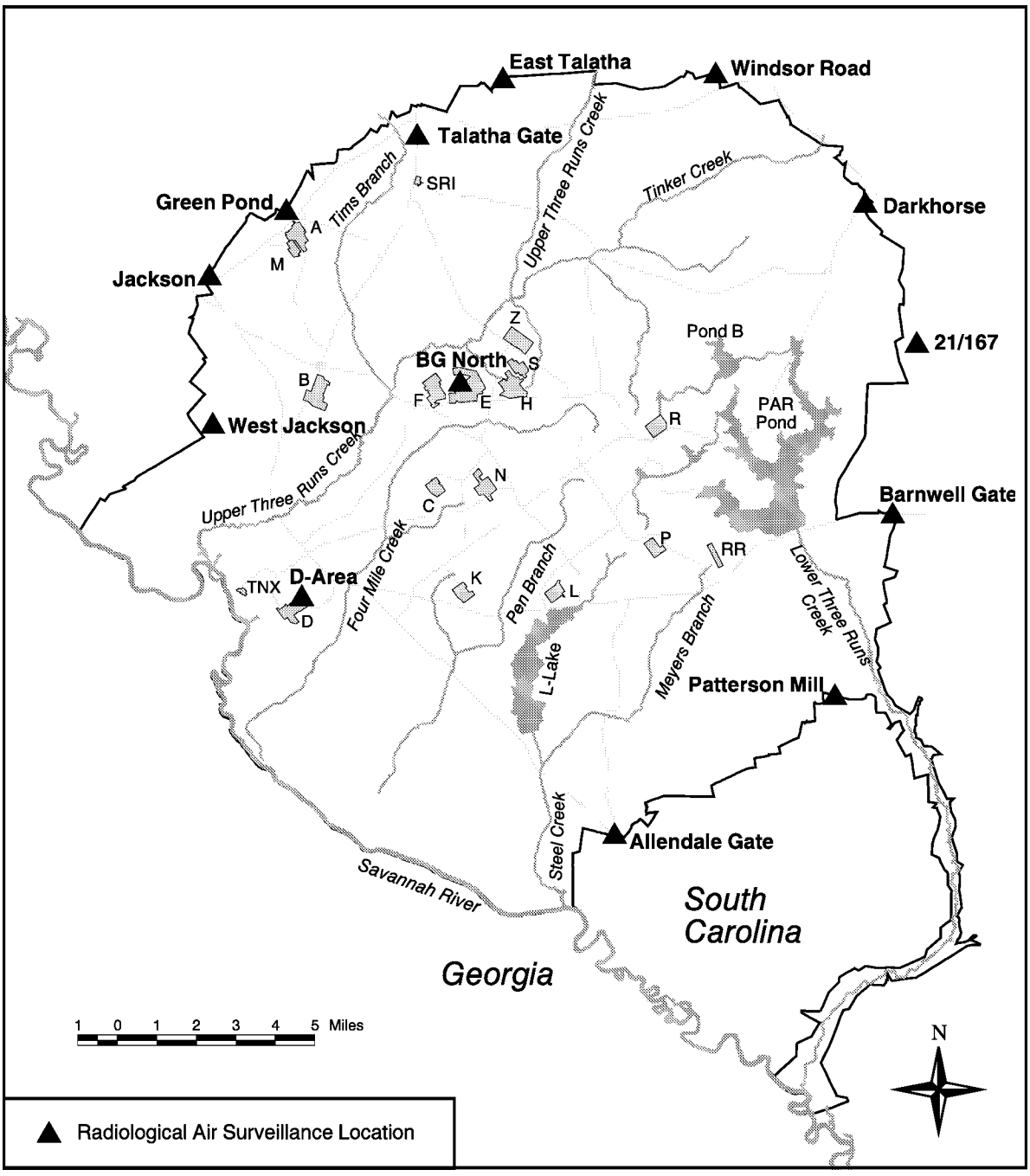
A complete description of the SRS radiological environmental surveillance program can be found in section 1105 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1 [SRS EM Program, 2001].

Air

Description of Surveillance Program

EMS maintains an extensive network of 17 sampling stations in and around SRS to monitor the concentration of radioactive materials in the air. These locations are divided into four subgroups, as follows:

- onsite



EPD/GIS Map

Figure 4–1 Radiological Air Surveillance Sampling Locations

The SRS air surveillance program consists of 13 stations located on site or along the site perimeter, as well as (not shown) three stations approximately 25 miles from the site perimeter (located near the U.S. Highway 301 Bridge over the Savannah River; the New Savannah Bluff Lock and Dam, also known as the Augusta Lock and Dam; and the Aiken airport) and one about 100 miles from the site perimeter (near Savannah, Georgia).

- site perimeter
- a control location at 25 miles
- selected major population centers at 25 and 100 miles

Figure 4–1 shows all the sampling locations except the 25- and 100-mile stations.

The air surveillance program helps determine the impact (if any) of site operations on the environment

Table 4–1
Average Gross Alpha and Gross Beta Measured in Air (pCi/m^3), 1997–2001

	Average Gross Alpha				
Locations	**1997**	**1998**	**1999**	**2000**	**2001**
On site	1.2E–03	1.1E–03	2.0E–03	1.6E–03	8.5E–04
Site perimeter	9.8E–04	1.4E–03	1.9E–03	1.7E–03	8.8E–04
25-mile radius	1.0E–03	1.5E–03	1.9E–03	1.7E–03	8.2E–04
100-mile radius	1.1E–03	[a]	2.1E–03	1.6E–03	9.0E–04
	Average Gross Beta				
Locations	**1997**	**1998**	**1999**	**2000**	**2001**
On site	1.7E–02	1.6E–02	1.9E–02	2.0E–02	1.8E–02
Site perimeter	1.5E–02	1.8E–02	1.9E–02	2.0E–02	1.8E–02
25-mile radius	1.6E–02	1.9E–02	1.9E–02	2.0E–02	1.7E–02
100-mile radius	1.1E–02	[a]	1.9E–02	1.8E–02	1.5E–02

a Could not be sampled in 1998

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.

Surveillance Results

Chapter 3 details the types and quantity of radioactive material released to the environment from SRS activities in 2001. Except for tritium, specific radionuclides were not routinely detectable at the site perimeter. Both onsite and offsite activity concentrations were similar to levels observed in previous years.

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.

A summary of the monitoring results from 1997–2001 is presented in table 4–1. Average gross alpha and beta results were slightly lower in 2001 than in 1999 and 2000. However, they are consistent with historical results, which demonstrate a long-term variability.

As in previous years, no significant difference was seen between the average concentrations measured on site near the operating facilities and the average concentrations observed at the site perimeter.

Gamma-Emitting Radionuclides

Glass fiber filters and activated charcoal canisters are collected weekly. The glass fiber filters are analyzed weekly and the activated charcoal canisters are analyzed annually. No manmade gamma-emitting radionuclides were observed in 2001. These results are consistent with historical results, which indicate only a small number of samples with detectable activity.

Tritium

Tritium-in-air analyses are conducted on biweekly silica gel samples. Tritium is released as part of routine SRS operations and becomes part of the natural environment. Monitoring ensures that there will be information available to determine whether any potential health risk to the surrounding population is created.

As detailed in the *SRS Environmental Report for 2000* (WSRC–TR–2000–00328), an unanticipated change in silica gel in early 2000 resulted in significant increases in both the variability and the concentrations of the tritium-in-air analytical results.

Research by EMS identified the cause of these increases, as well as a solution, which eliminated the problems encountered in 2000. The variability of analytical results subsequently decreased, and tritium-in-air concentrations returned to levels observed in 1999.

The 2000 report also indicated that EMS identified and implemented a correction factor for tritium-in-air measurements using silica gel. The correction factor has been used since 1999; consequently, 2001 results appear higher than those of pre-1999 years, for which no corrections have been applied.

Tritium-in-air results for 2001 were similar to those observed in 1999 (the first year in which the correction factor was utilized). Comparison to 2000 results is not possible because of the analytical problems discussed earlier. As in previous years, the Burial Ground North location showed average and maximum concentrations significantly higher than those observed at other locations. This was expected because of its proximity to SRS's tritium facilities, which are near the center of the site. Consistent with the SRS source term, tritium concentrations generally decrease with increasing distance from the tritium facilities.

Alpha-Emitting Radionuclides

The analysis of glass fiber filter paper was expanded in 1999 to include uranium isotopes (uranium-234, uranium-235, uranium-238), americium-241, and curium-244—in addition to plutonium isotopes (plutonium-238, plutonium-239). These radionuclides are released in small quantities as part of routine site operations—primarily from the separations areas.

The analysis of glass fiber filter paper for alpha-emitting radionuclides is performed on one sample per year from each location. The analyses of samples from four of the 17 locations (Talatha Gate, Aiken Airport, the U.S. Highway 301 Bridge Area, and Savannah) were not completed because of analytical difficulties in the EMS laboratory. Detectable activity, primarily U-234 and U-238, was observed at six locations: Allendale Gate, D-Area, East Talatha, Patterson Mill Road, Windsor Road, and Augusta Lock and Dam. All isotopes at the remaining locations were below detection levels; generally, these concentrations were consistent with historical results.

Strontium

Strontium analysis is performed on one sample per year from each monitoring site. As observed in previous years, none of the samples showed strontium above the lower limit of detection (LLD).

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 4–1). Ion-exchange resin columns are placed at seven of these locations. At each of the locations, rain passes through the column and into a collection bottle. Both the ion-exchange resin column and the collected liquid are returned to the laboratory for analysis. The column is analyzed weekly for gamma-emitting radionuclides, gross alpha, and gross beta and annually for plutonium-238, plutonium-239, and strontium-89,90; the rainwater is analyzed for tritium.

The rainwater collected from all other locations is analyzed for tritium only. Ion-exchange column sampling is performed monthly, while rainwater sampling is performed biweekly.

Surveillance Results

Gamma-Emitting Radionuclides

As in 2000, no detectable manmade gamma-emitting radionuclides were observed in rainwater samples during 2001.

Gross Alpha and Gross Beta

The gross alpha and gross beta results were consistent with those of 2000. Although the 2001 results generally were slightly higher than those of 2000, no long-term increasing or decreasing trend was evident. This implies that the observed values are natural background and does not indicate any contribution directly attributable to SRS.

Alpha-Emitting Radionuclides

The analysis of rain ion columns was expanded in 1999 to include uranium isotopes (uranium-234, uranium-235, uranium-238), americium-241, and curium-244—in addition to plutonium isotopes (plutonium-238 and plutonium-239). Except for U-234 and U-238 at BGN and U-234 at Savannah, all isotopes were below detection levels in 2001; generally, these concentrations were consistent with historical results.

Strontium

As in 2000, no detectable levels of strontium-89,90 were observed in rainwater samples during 2001.

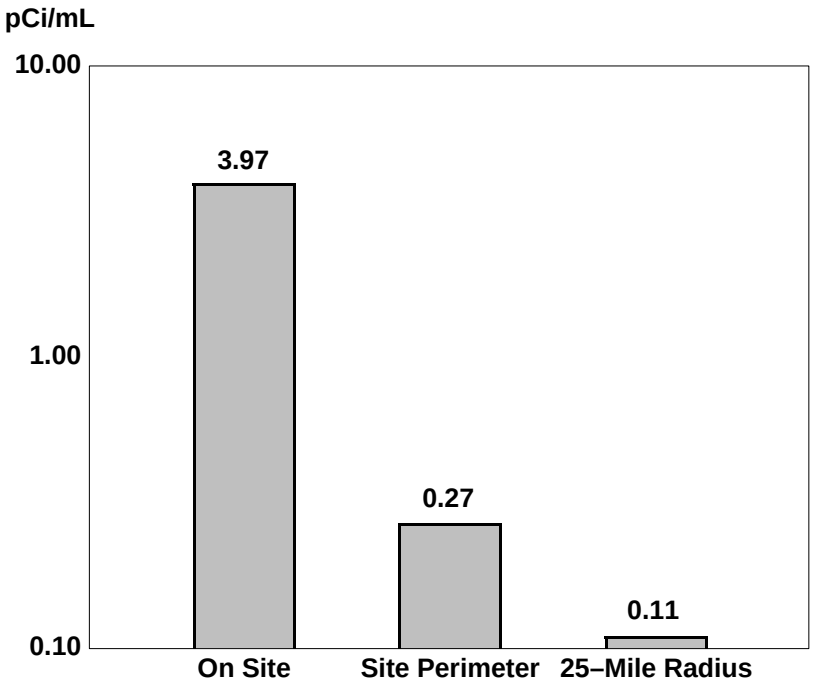


Figure 4–2 Average Concentration of Tritium in Rainwater, 2001

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

Ileaf Graphic

Tritium

As in previous years, tritium-in-rain values were highest near the center of the site. This is consistent with the H-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 4–2); 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 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 four subprograms, as follows: site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor potential exposures from Georgia Power's Vogtle Electric Generating Plant). All TLDs are exchanged quarterly.

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, but only limited monitoring is conducted beyond this distance and at the 25- and 100-mile air surveillance stations.

Surveillance Results

In general, the 2001 ambient gamma radiation monitoring results indicated gamma exposure rates slightly lower than those observed at the same locations in 2000. However, these results generally are consistent with previously published historical results, as indicated in figure 4–3.

Exposures at all TLD monitoring locations show some variation based on normal site-to-site and year-to-year differences in the components of natural ambient gamma exposure levels. Generally, this

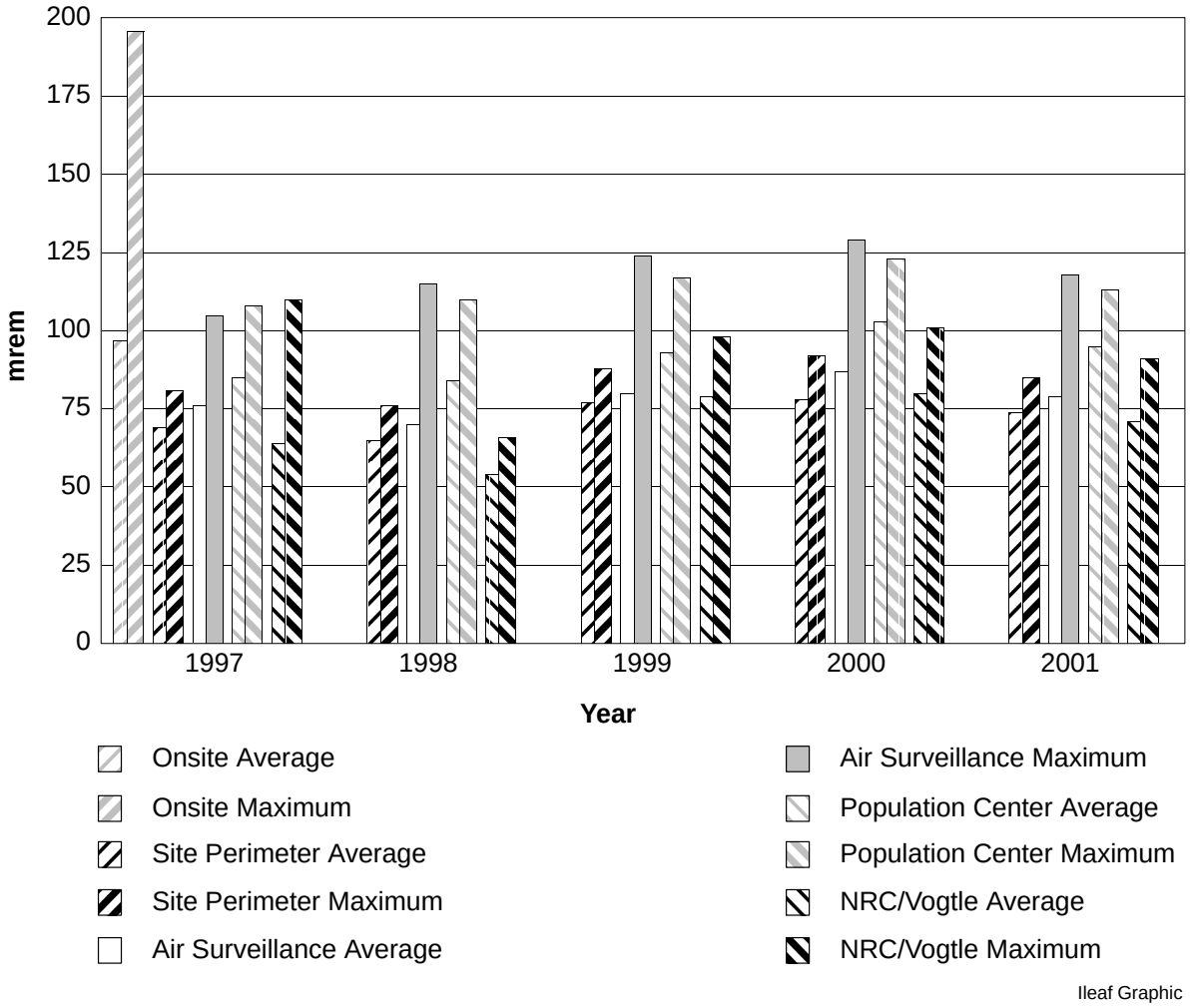


Figure 4–3 Annual Average/Maximum Gamma Exposure Grouped by Program Element, 1997–2001

Natural background gamma exposure levels remain fairly constant with time. With the exception of a few locations, onsite gamma exposure levels at SRS are similar to regional background levels.

Table 4–2
TLD Surveillance Results Summary for 2001

Monitoring Subprogram	Mean Exposure (mrem per year)	Maximum Exposure (mrem per year)	Maximum-Exposure Location
Site perimeter	74	85	Perimeter #65-D
Air surveillance	79	118	Burial Ground North
Population centers	95	113	Williston, SC
NRC/Vogtle	71	91	NRC #5

phenomena is observed at both onsite and offsite locations. Table 4–2 summarizes the 2001 surveillance results, which—except for the population center results—show no significant differences in average gamma exposure rates from one monitoring network to another. During the past 4 years, the highest exposure rate consistently has been at the burial ground.

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 seepage basins was discontinued in 1988, but stormwater accumulating in the basins continues to be monitored by EMS because of potential contamination from the basin soil.

Description of Surveillance Program

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

Surveillance Results

Because of dry conditions, no samples were obtained from the E–06 location in 2001. Locations E–01, E–02, E–04, and E–05 were sampled monthly, and E–03 was sampled once. Because there are no active discharges to site seepage basins, the primary contributor to seepage basin water is from rainwater. As a result, there has been little variation in seepage basin results in recent years. In 2001, the highest mean tritium concentration, (6.66 ± 3.57)E+05 pCi/L, was found in E–02. This represents an increase from the highest 2000 mean concentration, (7.54 ± 1.08)E+03 pCi/L, found at E–02. The high mean tritium concentration at E–05 is the result of three tritium spikes that were caused by equipment failure and resulting drainage from the nearby Four Mile Creek phytoremediation project. The sampler at E–05 was relocated in late 2001, which should eliminate the possibility of concentration influence from the phytoremediation project. Mean cobalt-60, cesium-137, and gross alpha concentrations all were below their representative MDCs for rainwater.

Site Streams

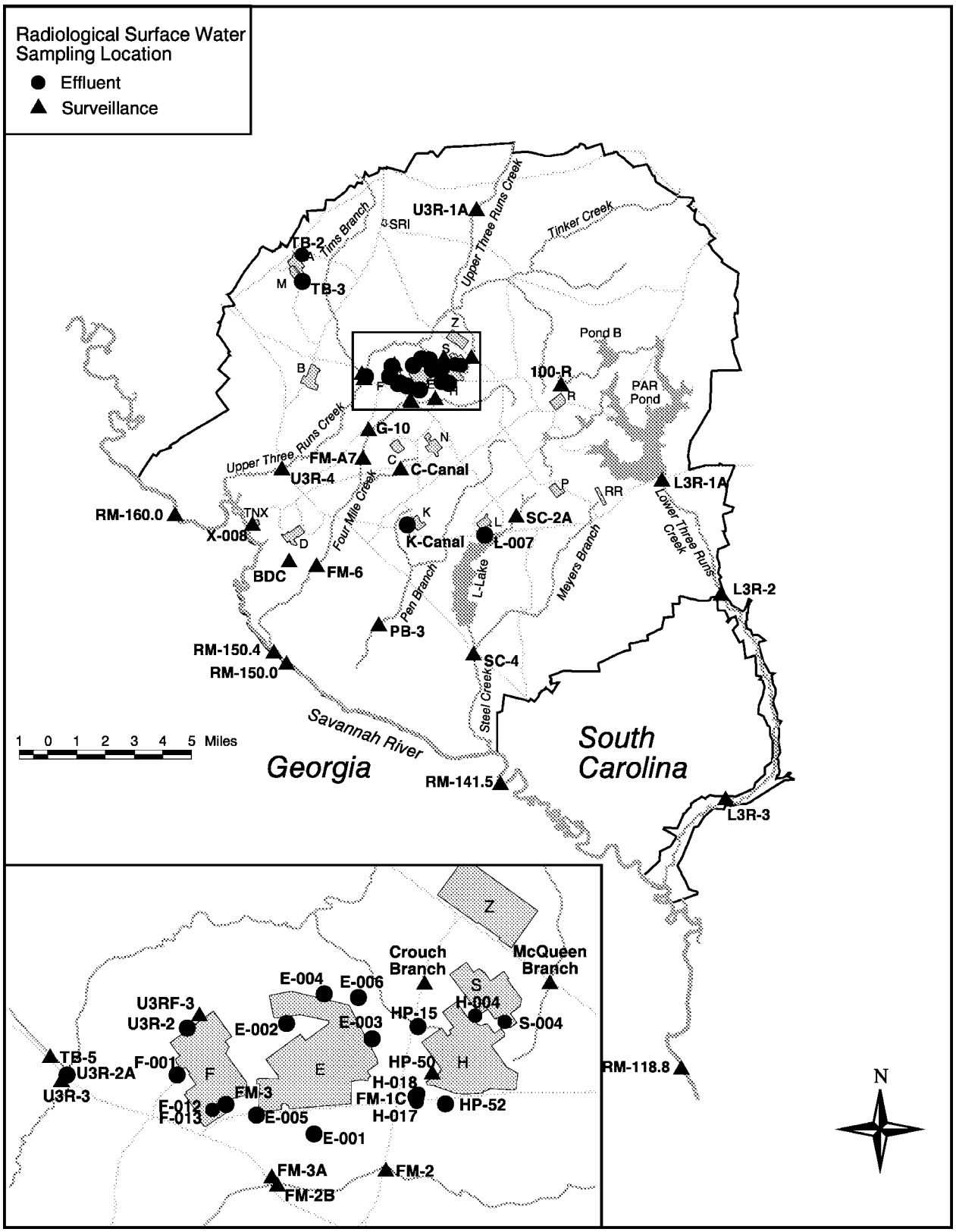
Continuous surveillance is used on several SRS streams (figure 4–4), including Tims Branch, Upper Three Runs, Four Mile Creek (also known as Fourmile Branch), Pen Branch, Steel Creek, and Lower Three Runs. Stream water sampling locations that monitor below process areas serve to detect and quantify levels of radioactivity in liquid effluents that are being transported to the Savannah River. In 2001, 23 such locations on SRS streams served as environmental surveillance points.

Description of Surveillance Program

The site's stream surveillance program monitors six streams—Tims Branch, Upper Three Runs, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs.

- Tims Branch is a tributary of Upper Three Runs, receiving effluents from M-Area and SRTC and stormwater runoff from A-Area and M-Area. The surveillance point on Tims Branch, TB–5, is located downstream of all release points and before entry into Upper Three Runs.
- Upper Three Runs receives discharges from the Effluent Treatment Facility (ETF) and S-Area; flow from Tims Branch; stormwater runoff from F-Area, H-Area, Z-Area, and S-Area; and water that has migrated from E-Area and is outcropping into the stream. Tritium, the predominant radionuclide detected in Upper Three Runs, is discharged primarily from the ETF.
- Four Mile Creek receives effluents from F-Area, H-Area, and the Central Sanitary Wastewater Treatment Facility (CSWTF); stormwater runoff from E-Area, C-Area, F-Area, and H-Area; and water that has migrated from seepage basins and E-Area and is outcropping into the stream.
- Pen Branch receives discharges and stormwater runoff from K-Area. Because K-Reactor has not operated since 1992, tritium detected in Pen Branch is attributed to groundwater seepage. PB–3 monitoring location tritium migration sources include the K-Area percolation field and seepage basins.
- Lower Three Runs receives overflow from PAR Pond, a manmade pond that receives seepage from R-Area basins and stormwater runoff from P-Area and R-Area.
- Steel Creek receives releases from L-Area effluents, tritium migration from P-Area seepage basins, and stormwater runoff from P-Area and L-Area.

For all locations except U3R–1A (the control location), which is sampled weekly, sampling for gross alpha and gross beta, tritium, and gamma is performed on a biweekly composite. Actinide analyses are performed annually on grab samples from all locations, while strontium-89,90 and—beginning in mid-2001—technetium-99 analyses are performed annually on grab samples from all except four locations on Four Mile Creek—FM–A7, FMC–2B, FMC–2, and FMC–3A. Strontium and technetium analyses at these locations are performed on biweekly composite samples. Outfall G–10, the discharge point for the CSWTF,



EPD/GIS Map

Figure 4–4 Radiological Surface Water Sampling Locations

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

establishes a baseline for monitoring radiological effluents to sanitary sewers. Sampling for gross alpha, gross beta, tritium, gamma, actinides, and strontium-89,90 is performed on a weekly composite at G–10. Outfall TNX–008 was added as a surveillance location in 2001 to monitor discharges from TNX-Area, which will be shut down in 2002.

Surveillance Results

The average gross alpha, gross beta, and tritium concentrations for 2001 at downstream locations near the creek mouths are presented in table 4–3. Figure 4–5 is a graph showing the average tritium concentration over a 10-year period in the five major site streams. 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 control location U3R–1A (above process effluents and runoff locations on Upper Three Runs) are listed for comparison purposes in table 4–3. Five-year trend charts showing gross alpha, gross beta, and cesium-137 concentrations for each major site stream appear in figure 4–6. The results in each chart are from the monitoring point nearest the stream's discharge to the Savannah River.

The gross alpha mean concentration at the control location (U3R–1A) doubled in 2001—from (4.04 ± 0.28)E+00 to (8.41 ± 0.85)E+00. A laboratory process investigation indicated no systematic errors. It is believed that this increase was the result of offsite activities; an investigation will be conducted in 2002.

The highest gross alpha mean concentration in 2001, found at TB–5, was (2.97 ± 0.62)E+00 pCi/L.

Mean gross beta concentrations were consistent with historical data. Strontium-89,90 and cesium-137 are contributors to gross beta activity. The newly initiated A Tc-99 measurement program begun in 2001 is still in the development stages in terms of establishing historical Tc-99 levels. During 2001, Tc-99 was detected at FM–2, FM–2B, and FM–A7.

Mean tritium concentrations at downstream locations were consistent with historical values.

Seepage Basin and Solid Waste Disposal Facility Radionuclide Migration

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 Solid Waste Disposal Facility (SWDF) as part of its stream surveillance program. During 2001, tritium, strontium-89,90, and cesium-137 were detected in migration releases. As noted in chapter 3 ("Radiological Effluent Monitoring"), measured iodine-129 results were not available from EMS and the value measured in 1996 was used for dose calculation. This value is reported in table 3–2 in chapter 3.

Figure 4–7 is a graphical representation of releases of tritium via migration to site streams for the years

Table 4–3
Average 2001 Concentration of Radioactivity in SRS Streams (pCi/L)

Location[a]	Gross Alpha	Gross Beta	Tritium
Onsite Downstream Locations			
Tims Branch (TB–5)	(2.97 ± 0.62)E+00	(1.38 ± 0.25)E+00	(6.46 ± 0.90)E+02
Lower Three Runs (L3R–3)	(2.01 ± 0.46)E+00	(1.90 ± 0.28)E+00	(1.36 ± 0.11)E+03
Steel Creek (SC–4)	(5.10 ± 1.02)E–01	(1.00 ± 0.11)E+00	(6.54 ± 0.40)E+03
Pen Branch (PB–3)	(4.09 ± 0.78)E–01	(9.85 ± 1.69)E–01	(1.06 ± 0.05)E+05
Four Mile Creek (FM–6)	(1.03 ± 0.19)E+00	(4.93 ± 0.67)E+00	(7.74 ± 0.23)E+04
Upper Three Runs (U3R–4)	(1.43 ± 0.17)E+00	(9.02 ± 1.28)E–01	(1.47 ± 0.16)E+04
Onsite Control Location (for comparison purposes)			
Upper Three Runs (U3R–1A)	(8.41 ± 0.85)E+00	(4.09 ± 0.44)E+00	(2.31 ± 0.53)E+02

a Site surveillance locations are near mouths of streams.

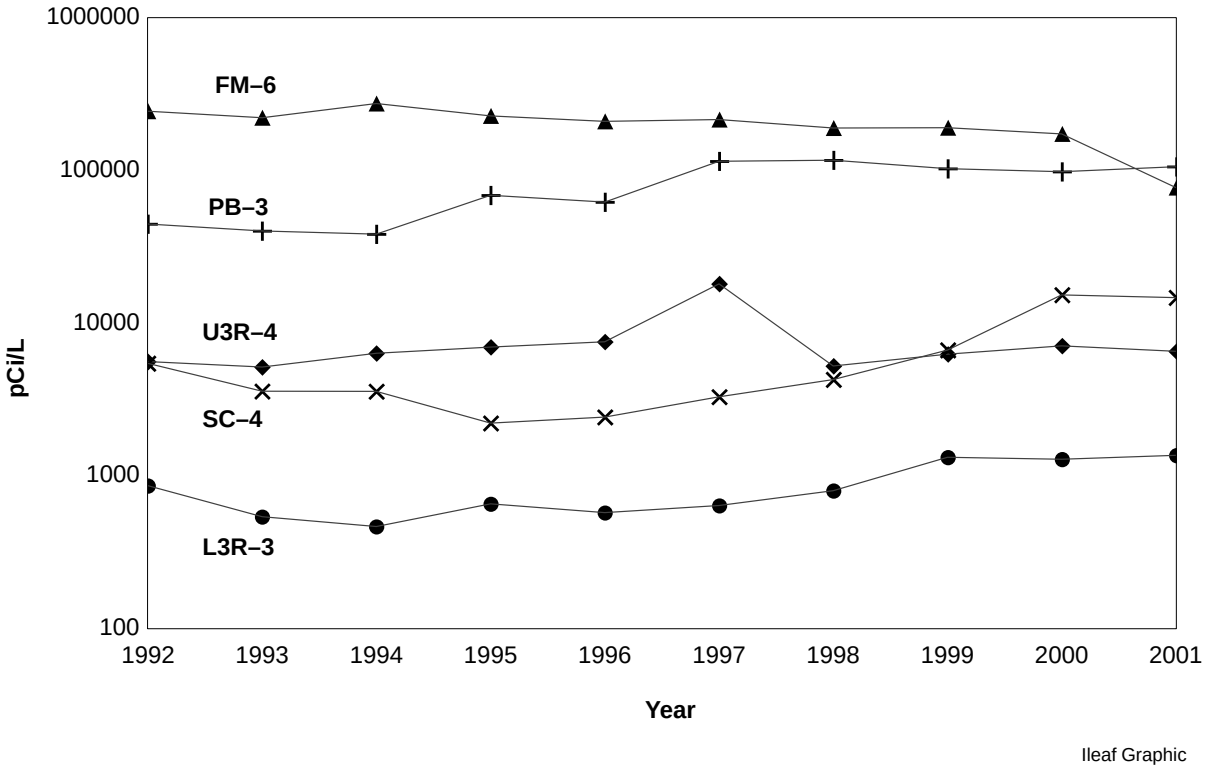


Figure 4–5 Average Tritium Concentrations in Major SRS Streams, 1992–2001

1992–2001. During 2001, the total quantity of tritium migrating from the seepage basins and SWDF was about 2,675 Ci, compared to 4,200 Ci in 2000. The decline is attributed to (1) the success of the Four Mile Creek phytoremediation project, which began in late 2000 with the installation of a dam on the creek, and (2) the subsequent startup in early 2001 of the project's irrigation system.

The total combined tritium releases in 2001 (direct discharges and migration from seepage basins and SWDF) were 4,423 Ci, compared to 5,995 Ci in 2000. Figure 4–8 shows 1992–2001 total combined tritium releases.

F-Area and H-Area Seepage Basins and SWDF

Radioactivity previously deposited in the F-Area and H-Area seepage basins and SWDF continues to migrate via the groundwater and to outcrop into Four Mile Creek and into Upper Three Runs.

Groundwater migration from the F-Area seepage basins enters Four Mile Creek between sampling locations FM–3A, FM–2B, and FM–A7. 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 part of 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. Four Mile Creek sampling locations are shown in figure 4–4.

Measured migration of tritium from F-Area seepage basins was 284 Ci in 2001. This is a 20-percent decrease from the 2000 total of 353 Ci. The measured migration from H-Area seepage basin 4 and SWDF was 411 Ci, a 400-percent decrease from the 2000 total of 1,920 Ci. Most of the decrease is believed to be attributable to the Four Mile Creek phytoremediation project. The measured migration from H-Area seepage basins 1, 2, and 3 was 161 Ci, a 16-percent increase from the 2000 total of 139 Ci. Figure 4–9 shows 1992–2001 tritium migration releases from the F-Area and H-Area seepage basins and from the SWDF.

Generally, 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 [Looney, 1993]. Tritium migration from SWDF has fluctuated between 2,000 and 5,000 Ci during the past 9 years. Based on recent assessments of the operational history of SWDF and the geology and hydrology of the site, it is anticipated that, with

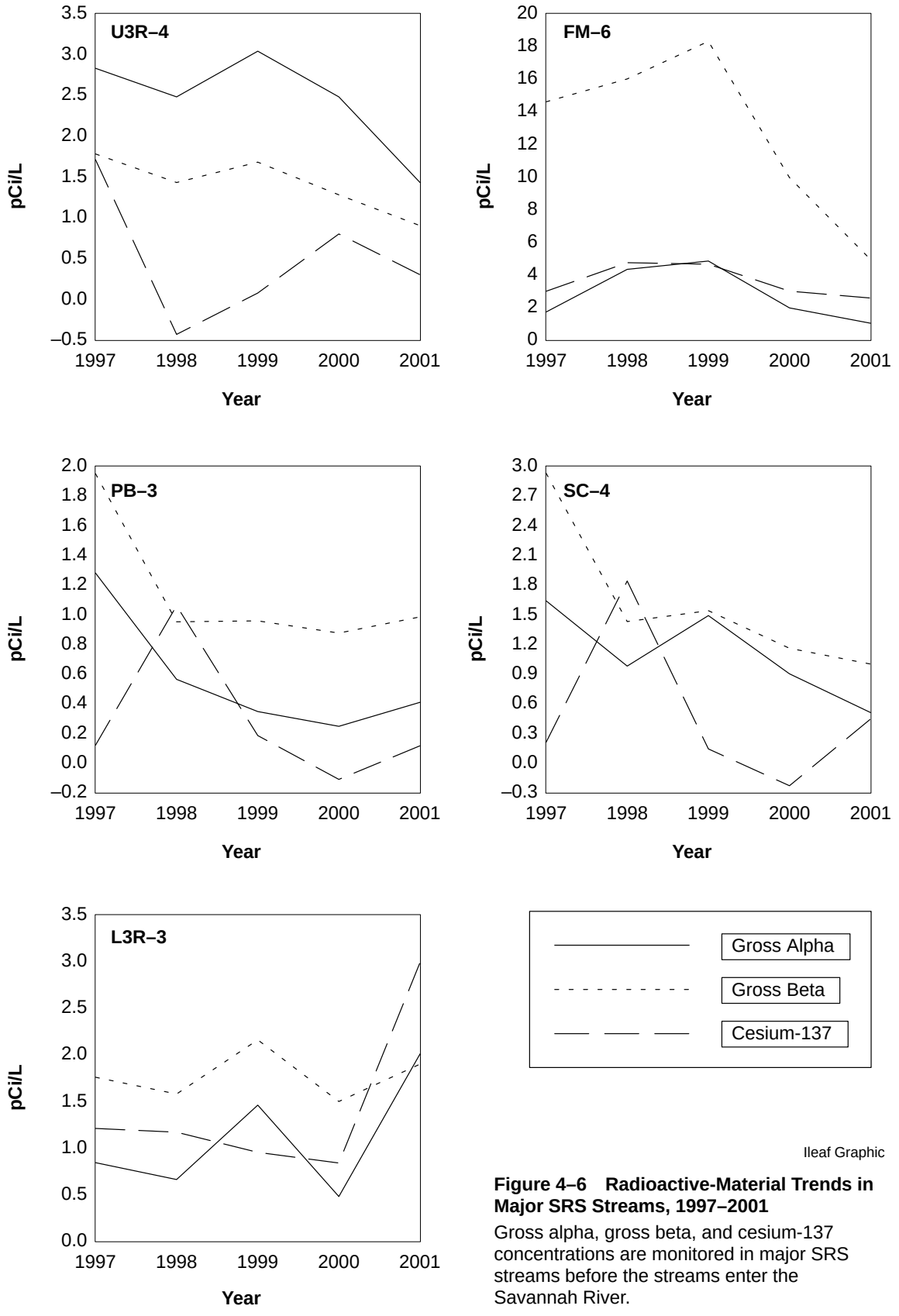


Figure 4–6 Radioactive-Material Trends in Major SRS Streams, 1997–2001

Gross alpha, gross beta, and cesium-137 concentrations are monitored in major SRS streams before the streams enter the Savannah River.

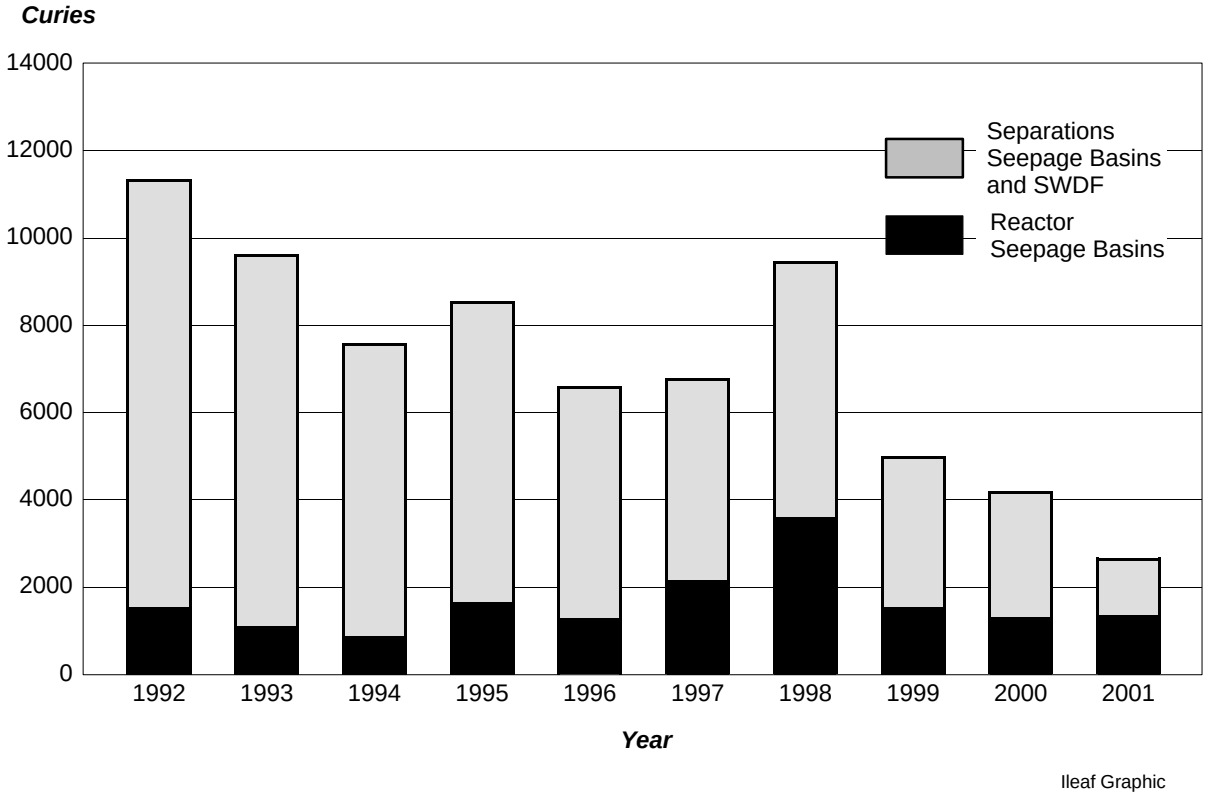


Figure 4–7 Tritium Migration from Seepage Basins and SWDF to SRS Streams, 1992–2001

no corrective actions, SWDF tritium migration into Four Mile Creek will continue, but slowly decrease for the next 20 to 25 years [Flach, 1996]. However, implementation of the Four Mile Creek phytoremediation project should accelerate this decrease.

The measured migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2001 was 470 Ci, a 3-percent decrease from the 2000 total of 483 Ci. (The GSA is in the central part of SRS and contains all waste disposal facilities, chemical separations facilities, associated high-level waste storage facilities, and numerous other sources of radioactive material.)

A 10-year history of tritium migration releases into Upper Three Runs is shown in figure 4–10.Tritium migration into Upper Three Runs has remained between 150 and 500 Ci per year. A computer-modeled groundwater migration study predicts increased tritium migration to Upper Three Runs during the next 20 years [Cook, 1997]. This analysis assumes all current and future tritium inventories will migrate relatively fast without considering past migration releases or potential corrective actions; these assumptions are considered to be conservative. A complete and thorough assessment of tritium migration into Upper Three Runs that is based on measured groundwater concentrations and movement has not yet been performed.

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 2001. 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 (such as the Four Mile Creek phytoremediation project) are under consideration, or are currently being implemented, as components of SWDF remediation. Remediation is discussed in chapter 2, “Environmental Management.”

The total amount of strontium-89,90 entering Four Mile Creek from the GSA seepage basins and SWDF during 2001 was estimated to be 20 mCi. This was a 62-percent decrease from the 2000 level of 53 mCi. The decrease was attributed to the success of the Four Mile Creek phytoremediation project (figure 4–6).

In addition, a total of 37.5 mCi of cesium-137 was estimated to have migrated from the GSA seepage basins and SWDF in 2001. As discussed previously, iodine-129 was not measured in Four Mile Creek water samples during 2001. It was assumed that 78.2 mCi migrated from the GSA seepage basins in 2001. This was the amount last measured (during 1996).

A total of 45.6 mCi of technetium-99 was estimated to have migrated from the F-Area and H-Area seepage basins from the beginning of this analysis in mid-2001 until the end of the year.

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. From 1960 until 1992, purges from the K-Area disassembly basin were discharged to a percolation field below the K-Area retention basin.

Tritium migration from the seepage basin and the percolation field is measured in Pen Branch. The 2001 migration total of 1,040 Ci represents no change from the 1,040 Ci recorded in 2000.

P-Area, C-Area, and L-Area Seepage Basins

Liquid purges from the P-Area, L-Area, and C-Area disassembly basins were released periodically to their respective seepage basins from the 1950s until 1970. Purge water was released to the reactor seepage basins to allow a significant part of the tritium to decay before the water outcropped to surface streams and flowed into the Savannah River. The delaying action of the basins reduced the dose that users of water from downriver water treatment plants received from SRS tritium releases. Between 1970 and 1978, disassembly basin purge water was released directly to SRS streams. However, 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 C-Area, L-Area, and P-Area, and the periodic release of liquid purges to the seepage basins was resumed. The operation of the C-Area, L-Area, and P-Area seepage basins was terminated in 1988 because of mission changes at the site.

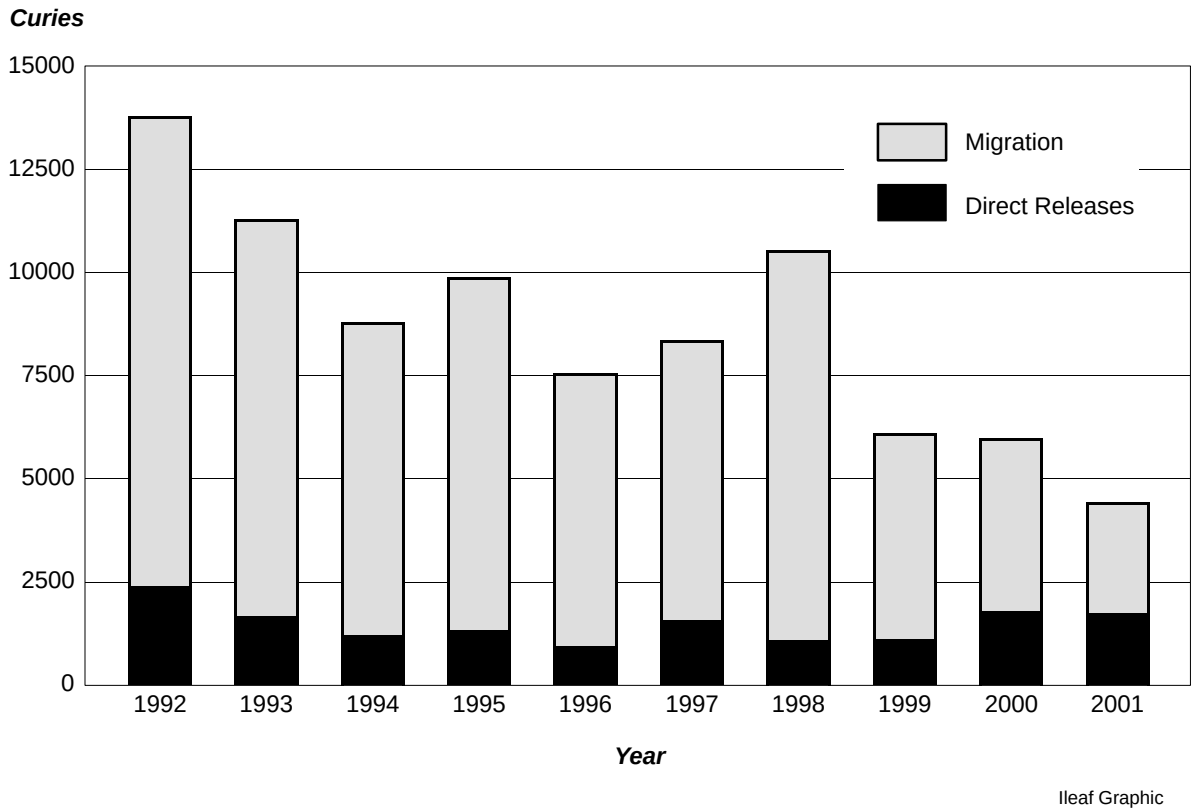


Figure 4–8 Total Tritium Releases to SRS Streams (Direct Discharges and Migration), 1992–2001, Based on Point-of-Release Concentrations and Flow Rates

No radionuclide migration was attributed to the C-Area seepage basin in 2001. 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 309 Ci of tritium migrated from the P-Area seepage basin during 2001, 17 percent more than the 265 Ci of tritium in 2000. No migration of radionuclides from the L-Area seepage basin was detected in site streams.

Transport of Actinides in Streams

In 1996, a new and more sensitive analytical method for actinides was implemented for the analysis of uranium, plutonium, americium, and curium. As a result of the increased sensitivity, trace amounts of uranium and plutonium were detected at the stream transport locations FM–6, PB–3, L3R–2, and U3R–4. Uranium was in most stream samples at approximately natural uranium-234/uranium-238 ratios. Plutonium-238, plutonium-239, americium-241, and curium-244 were found at low concentrations at HP–50. A few other samples had some of these radionuclides at barely detectable levels. Because the levels remained relatively low from 1996 through 1999, analysis of biweekly samples from these four locations was discontinued in 2000. Uranium, plutonium, americium, and curium now are analyzed on an annual grab sample from each stream location. Values for 2001 were consistent with historical data.

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 river.

Description of Surveillance Program

Five locations along the river continued to serve as environmental surveillance points in 2001. River sampling locations are shown in figure 4–4. Composite samples are collected weekly at the five river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides. An annual grab sample is obtained at each location and analyzed for strontium-89,90 and actinides. Grab samples are obtained annually—and analyzed for

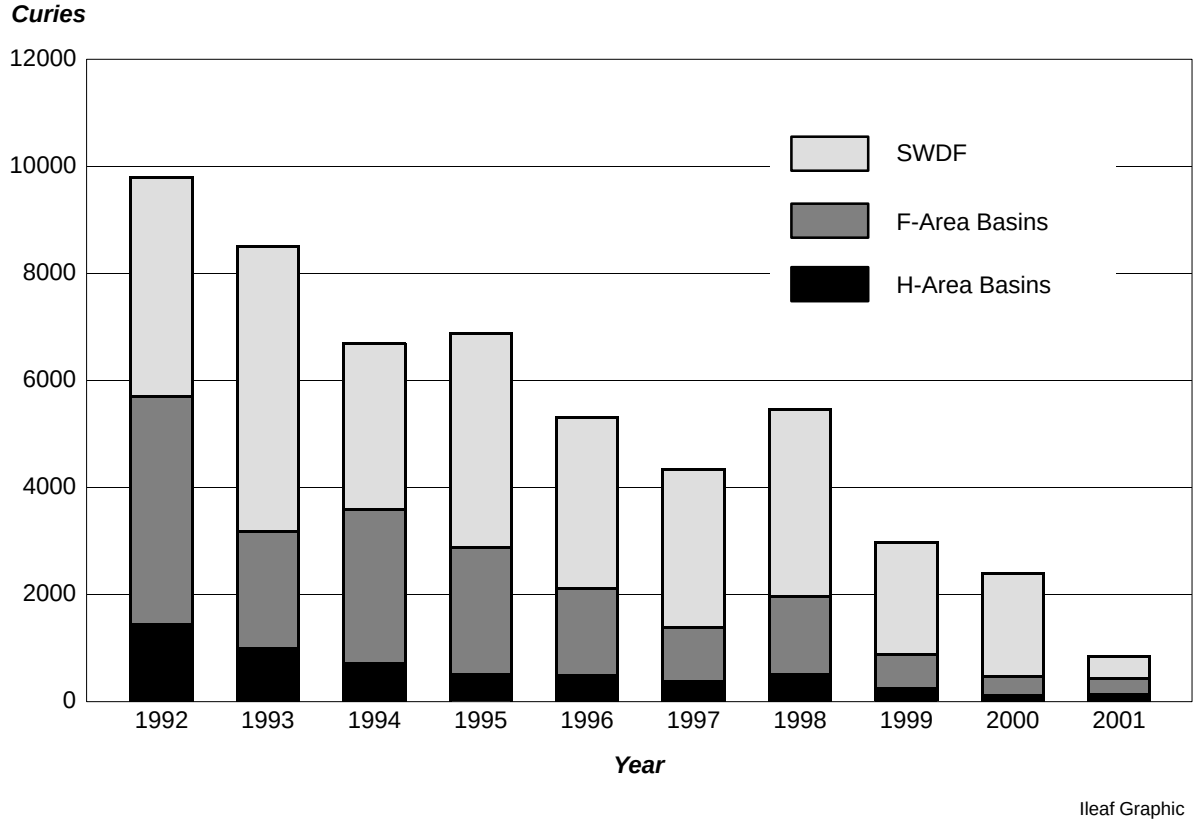


Figure 4–9 Tritium Migration Releases to Four Mile Creek from the F-Area and H-Area Seepage Basins and SWDF, 1992–2001

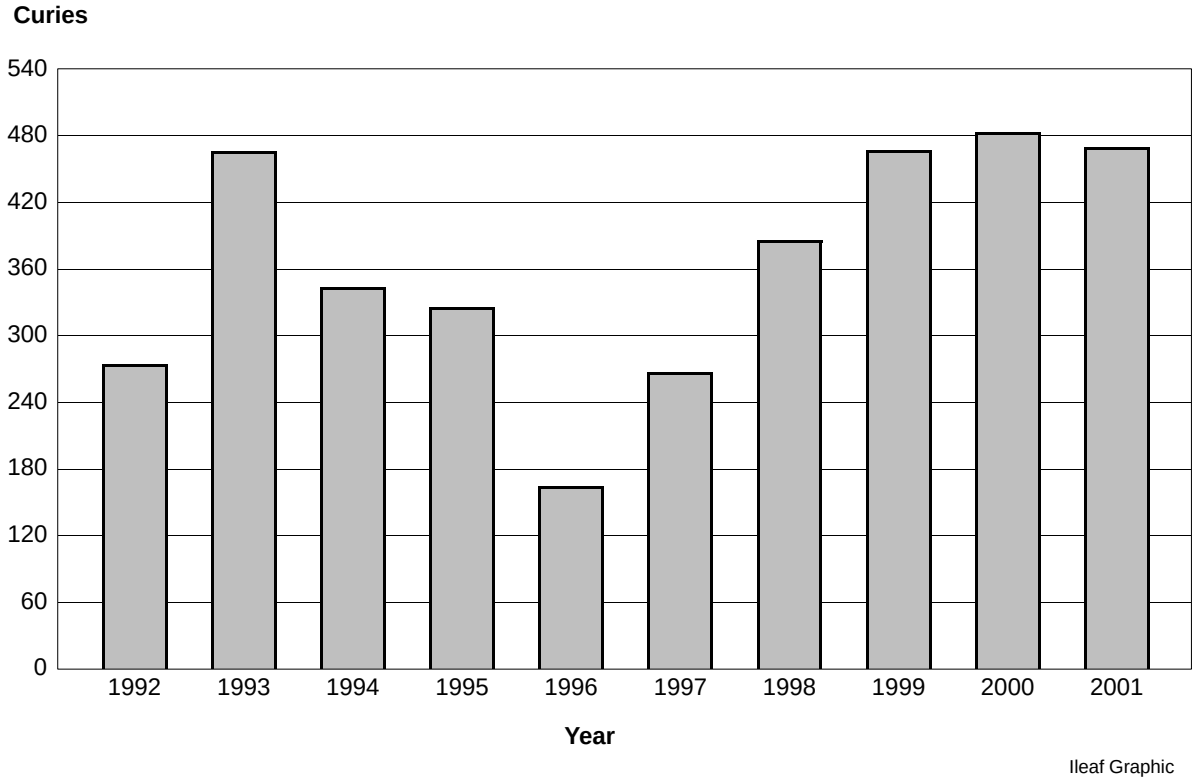


Figure 4–10 Tritium Migration Releases to Upper Three Runs from the General Separations Area and SWDF, 1992–2001

technetium-99—at each location except river mile (RM)–160.0.

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 4–4. The order of the locations begins at RM–160.0, above the site, and ends at RM–118.8, after all site streams enter the Savannah River. Samplers situated between RM–160.0 and RM–118.8 are located at regular intervals along the SRS boundary and where Plant Vogtle's discharges feed into the river (RM–150.4). RM–118.8 is the location of the site's hypothetical maximally exposed individual (chapter 5, "Potential Radiation Doses").

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The annual mean tritium concentration at RM–118.8 was (1.02 ± 0.06)E+03 pCi/L, which is about 5 percent of the drinking water standard.

The average alpha concentration at each river location was slightly above the representative MDC in 2001. The average alpha activity level at RM–118.8 was about the same as the level at

Table 4–4
Average 2001 Concentration of Radioactivity in the Savannah River (pCi/L)

Location	Gross Alpha	Gross Beta	Tritium
RM–160.0	(1.77 ± 0.40)E–01	(1.23 ± 0.11)E+00	(8.23 ± 2.88)E+01
RM–150.4	(7.12 ± 1.05)E–01	(1.76 ± 0.17)E+00	(2.28 ± 0.33)E+03
RM–150.0	(2.24 ± 0.46)E–01	(1.36 ± 0.12)E+00	(1.23 ± 0.04)E+03
RM–141.5	(2.10 ± 0.51)E–01	(1.24 ± 0.12)E+00	(1.22 ± 0.07)E+03
RM–118.8	(2.28 ± 0.54)E–01	(1.29 ± 0.13)E+00	(1.02 ± 0.06)E+03

RM–160.0, which is the sampling location upstream of all SRS discharge points.

Gross beta activities at all locations were slightly above the representative MDC for the analysis in 2001. Mean and maximum concentrations were similar at all locations, indicating that there was no significant release of beta-emitting nuclides attributable to SRS discharges.

Cesium-137, Cobalt-60, Strontium-89,90, and Actinides

The mean concentrations for cesium-137 and cobalt-60 were below their representative MDCs for analysis in 2001 at all Savannah River locations. The maximum concentration of cesium-137 at RM–118.8 was slightly above the representative MDC; no cobalt was detected. Activity levels for strontium-89,90 and for all actinides—including isotopes of uranium and plutonium—fluctuated around their respective representative MDCs.

Tritium Transport in Streams and River

Tritium is introduced into SRS streams and the Savannah River from 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 and SWDF 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)

During 2001, the total tritium transport in SRS streams decreased by approximately 28 percent (from 5,960 Ci in 2000 to 4,320 Ci in 2001). The 2001 measured tritium transport in the Savannah River (4,815 Ci) was more than the stream transport total. Some of this increase is attributed to Plant Vogtle's 2001 tritium releases, which totaled 1,492 Ci.

SRS tritium transport data for 1960–2001 are depicted in figure 4–11, which shows summaries of the past 42 years of direct releases, stream transport, and river transport determined by EMS.

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 the determination of water flow rates and of varying transport times.

In calculating doses from tritium, the stream transport value is used instead of the the river transport value or the direct-plus-migration value (chapter 3). This is because the stream transport value—measured in site streams just prior to their discharge to the Savannah River—most accurately reflects the actual amount of aqueous tritium leaving the site (chapter 5).

Drinking Water

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

Description of Surveillance Program

Onsite sampling consists of quarterly grab samples at large treatment plants in A-Area, D-Area, and K-Area and annual grab samples at wells and small systems. Collected monthly off site are composite 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

At all the offsite facilities, raw and finished water samples are collected daily and composited for analysis by EMS. All drinking water samples are screened for alpha, beta, and gamma emitters and analyzed specifically for tritium. The onsite samples also are analyzed once a year for actinides and strontium-89,90.

Surveillance Results

Gross Alpha and Gross Beta

All drinking water samples collected by EMS are screened for gross alpha and gross beta

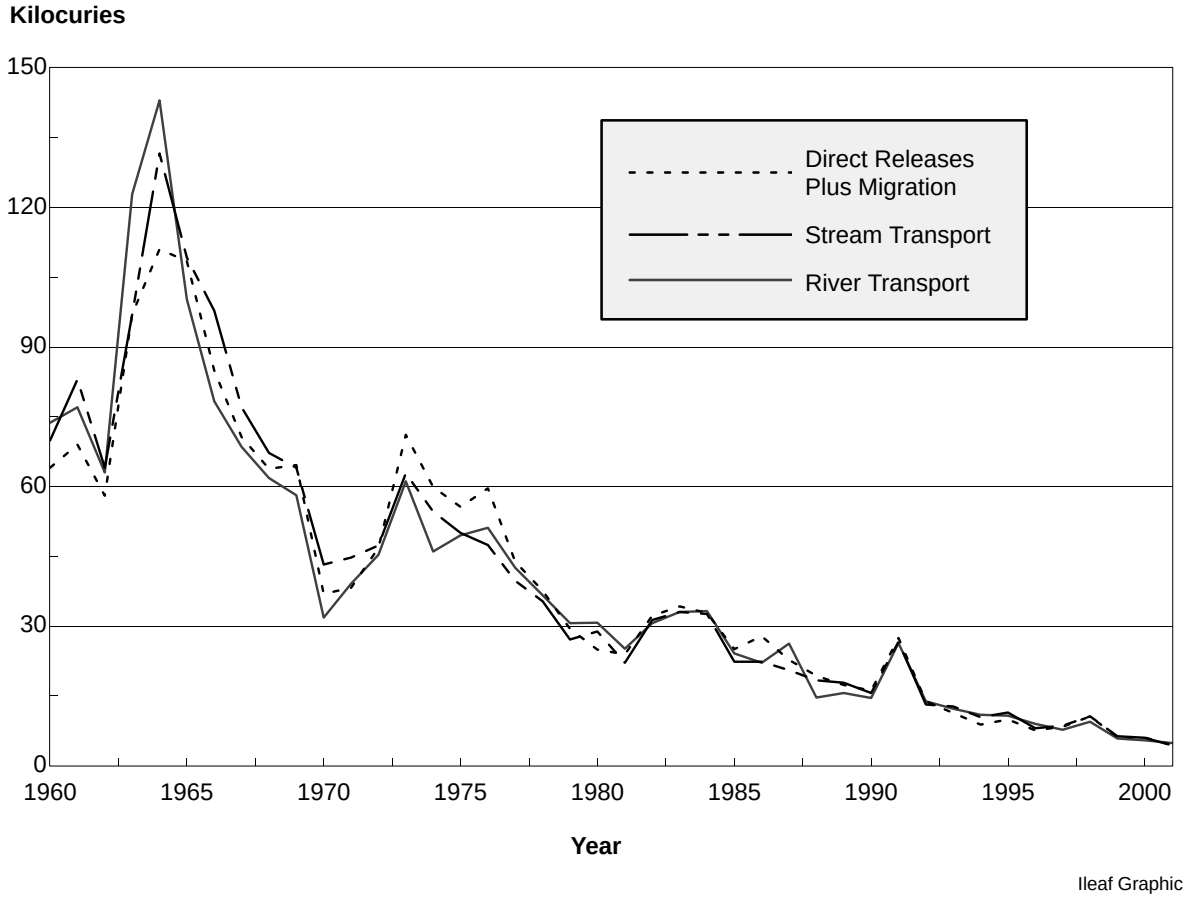


Figure 4–11 SRS Tritium Transport Summary, 1960–2001

SRS has maintained a tritium balance of direct releases plus migration, 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 because (1) the site's tritium production has stopped, (2) effluent controls have been developed, and (3) the tritium, which has a 12.3-year half-life, continues to decay at a rate of about 5 percent a year.

concentrations to determine if activity levels warrant further analysis. No samples collected in 2001 exceeded EPA's 1.50E+01-pCi/L alpha activity limit or 5.00E+01-pCi/L beta activity limit. In 2001, the highest alpha concentration in SRS drinking water was (3.06 ± 0.61)E+00-pCi/L—at the PAR Pond Laboratory (735–7G). No samples have exceeded 8.00E+00 pCi/L of beta activity—the EPA limit for strontium-90, which is the most restrictive beta-emitting radionuclide.

Tritium

No onsite or offsite drinking water samples collected and analyzed by EMS in 2001 exceeded the 2.00E+04-pCi/L EPA tritium limit. The highest level observed was (7.62 ± 1.30)E+02 pCi/L—at 661–G (Firing Range Pumphouse). 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 and Plant Vogtle operations into the Savannah River. The average tritium concentration in finished water at Beaufort-Jasper in 2001, (9.68 ± 2.64)E+02 pCi/L, was 4.84 percent of the EPA drinking water limit. The average tritium concentration at Port Wentworth, (8.67 ± 2.63)E+02 pCi/L, was 4.34 percent of the EPA drinking water limit. The levels of tritium at both treatment facilities were not significantly different than those measured in 2000.

Strontium

No drinking water samples collected and analyzed by EMS for strontium 89,90 in 2001 exceeded the 1.40E+00-pCi/L representative MDC.

Other Radionuclides

No cobalt-60, cesium-137, plutonium-238, or plutonium-239 were detected in any drinking water samples collected during 2001. Samples from some locations showed detectable levels of uranium isotopes and/or americium-241 and curium-244.

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

Meat, Fruit, and Greens

The food products surveillance program divides the area that surrounds the SRS, approximately 9 miles (15 km) beyond its perimeter, into four quadrants: northeast, southeast, southwest, and northwest. Samples of food—including meat (beef), fruit (melons or peaches), and a green vegetable (collards)—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.

Food samples are analyzed for the presence of gamma-emitting radionuclides, tritium, strontium-89,90, plutonium-238, and plutonium 239.

Milk

During 2001, EMS collected milk samples at five dairies within a 25-mile radius of SRS and from locally produced inventories of a major distributor.

Milk samples are collected monthly to be analyzed for the presence of tritium and gamma-emitting radionuclides, primarily cesium-137 and iodine-131. Additional samples are collected quarterly to be analyzed for the presence of strontium-89,90.

Surveillance Results

The 15 samples of milk collected during three quarters were analyzed for strontium-90, rather than strontium-89,90, in 2001 because of a laboratory error.

Gamma-Emitting Radionuclides

The only manmade gamma-emitting radionuclide detected in food products other than milk was cobalt-60, which was found in a beef sample from the 0–10-mile northwest quadrant; the concentration was (2.17 ± 0.64)E–02 pCi/g. Generally, concentrations of cesium-137 in indicator samples were similar to those measured at the control location, and these concentrations were similar to those observed in previous years.

Cesium-137 also was the only manmade gamma-emitting radionuclide detected in milk samples during 2001. Measured maximum concentrations ranged from a high of (5.08 ± 1.76)E+00 pCi/L at the Waynesboro, Georgia, location to lows below the representative MDC at several locations. The mean concentrations measured in 2001 were similar to those measured in 2000.

Iodine-131 was not detected in any 2001 milk samples. Because of its short physical half-life (8 days), iodine-131 generally is not detected, except

- shortly after tests of nuclear weapons
- in the wake of events such as the Chernobyl incident
- during reactor operations
- when processing fresh fuel
- when the isotope is used medically, industrially, or for research.

Tritium

Tritium in milk and other samples is attributed primarily to releases from SRS. Tritium concentrations in food products other than milk ranged from a high of (2.45 ± 0.34)E–01 pCi/g, measured in greens from the 0–10-mile northwest quadrant, to lows below the representative MDC in several samples. The concentrations were similar to those measured in 2001.

No tritium was detected above the representative MDC in any milk samples collected during 2001. The tritium concentrations measured in milk during 2001 were slightly lower than in 2000 and generally reflected atmospheric releases from the site.

Strontium

The highest strontium-89,90 concentration detected in food products other than milk during 2001 was

(7.03 ± 0.92)E–01 pCi/g—found in greens from the northeast quadrant; the lowest was below the representative MDC at one location. Strontium-89,90 levels generally were within the ranges observed during past years.

The 2001 results from the analysis of milk for strontium-89,90 and strontium-90 showed concentrations ranging from a maximum of (4.14 ± 0.95)E+00 pCi/L in a sample from locally produced inventories of a major distributor to minimums below their representative MDCs.

Plutonium

Only one terrestrial food product sample contained a detectable concentration of plutonium-238 in 2001—greens from the 0–10-mile southwest qudrant, at (2.87 ± 0.92)E–01 pCi/g. No plutonium-239 was detected in food products other than milk in 2001.

Aquatic Food Products

Description of Surveillance Program

The aquatic food product surveillance program includes fish (freshwater and saltwater) and shellfish. To determine the potential dose and risk to the public from consumption, both types are sampled.

Nine surveillance points for the collection of freshwater fish are located on the Savannah River (figure 4–12). These points are at

- the New Savannah Bluff Lock and Dam area (the control location), above the site
- five areas where site streams enter the Savannah River
- the U.S. Highway 301 Bridge Area, below the site
- Stokes Bluff Landing, below the site
- the U.S. Highway 17 Bridge Area, below the site

Nine surveillance points for freshwater fish collection also are located within the SRS boundary. These points are at PAR Pond, L-Lake, Pond B, Lower Three Runs, Upper Three Runs, Beaver Dam Creek, Pen Branch, Steel Creek, and Four Mile Creek. Freshwater fish are grouped into one of three categories: bass, panfish (bream), or catfish.

Saltwater fish are collected downstream from the U.S. Highway 17 Bridge Area and include composites of sea trout, red drum (spottail bass), and mullet. The fish are selected for sampling 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 GDNR's Wildlife Resources Division.

For analysis purposes, five fish from each category at each collection location are combined to create a composite. Composites are divided into edible (meat and skin only) and nonedible (scales, head, fins, viscera, bone) portions; however, catfish are skinned and the skin becomes part of the nonedible composite. Analyses are conducted for gross alpha and gross beta on edible portions for all locations and on nonedible portions for all offsite locations except those at Stokes Bluff Landing and at the U.S. Highway 17 Bridge Area. Freshwater fish collected from the New Savannah Bluff Lock and Dam location downstream through the U.S. Highway 301 Bridge Area also are analyzed for strontium-89,90; plutonium-238 and plutonium-239 and tritium (edible portions only); and gamma-emitting radionuclides. Freshwater fish (edible portions only) from river locations at Stokes Bluff Landing and the U.S. Highway 17 Bridge Area and from onsite streams and ponds are analyzed for gross alpha, gross beta, and gamma-emitting radionuclides.

Saltwater fish (edible portions only) also are analyzed for gross alpha, gross beta, and gamma-emitting radionuclides.

In the shellfish surveillance program, samples of oysters and crabs are collected on the coast near Savannah. The shellfish are analyzed for gross alpha, gross beta, strontium-89,90, and gamma-emitting radionuclides.

Calculations of risk from the consumption of fish from the Savannah River can be found in chapter 5.

Surveillance Results

In the following surveillance results discussion, uncertainty values are provided because most measurements were at or near the appropriate MDC.

Freshwater Fish

Savannah River All categories of freshwater fish from all nine Savannah River locations were collected during 2001.

Gross alpha activity in Savannah River edible and nonedible composites was below the MDCs at all nine sampling locations.

Gross beta activity in Savannah River edible composites was detectable at all nine locations and was attributed primarily to the naturally occurring radionuclide potassium-40. The values ranged from a high of (3.24 ± 0.43)E+00 pCi/g in bass from the mouth of Beaver Dam Creek to lows below the

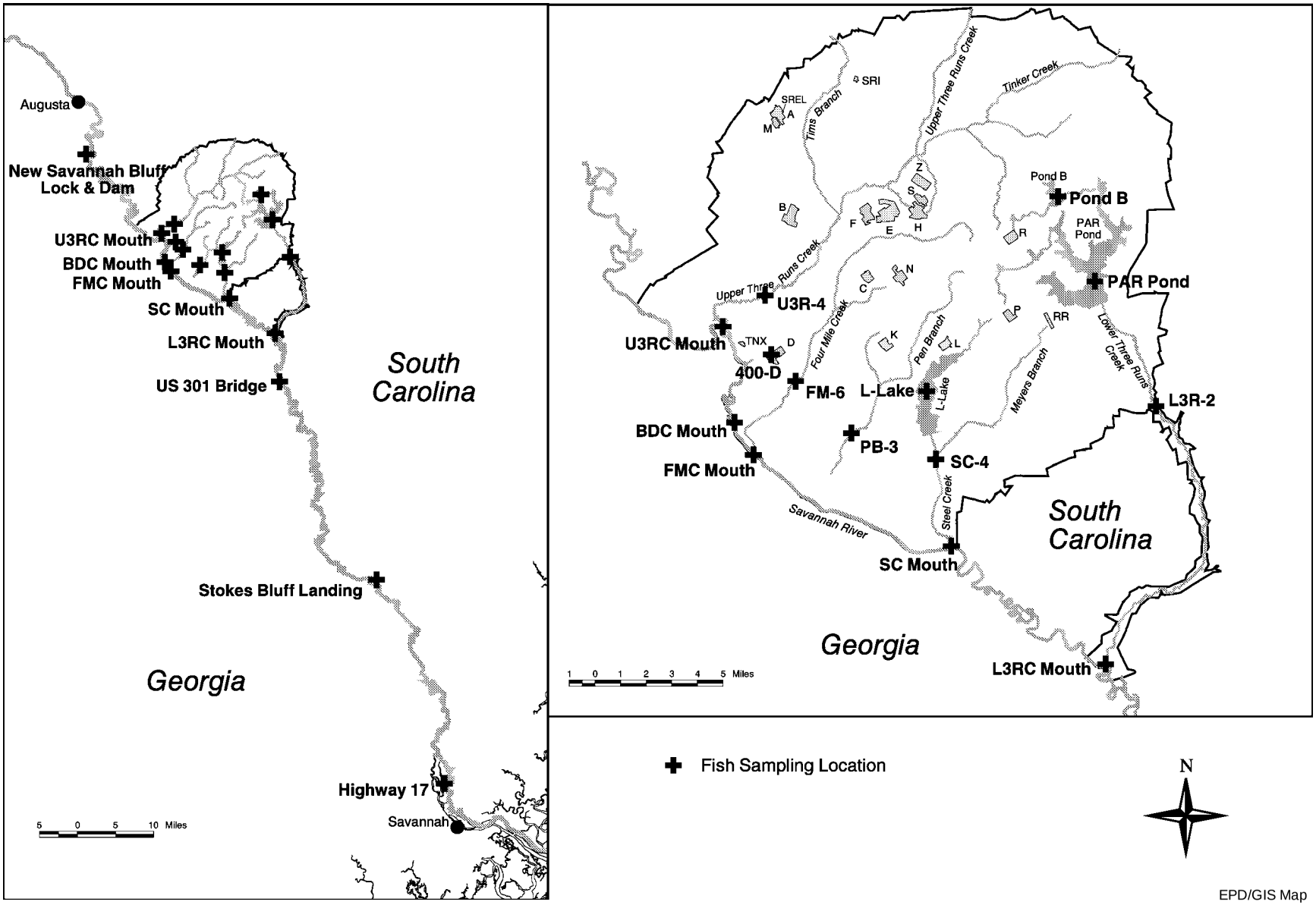


Figure 4–12 SRS Fish Sampling Locations

SRS collects fish (for both radiological and nonradiological analyses) from the Savannah River above, adjacent to, and below the site, as well as at Stokes Bluff Landing and near Savannah, Georgia.

MDCs in several composites. Gross beta activity in river nonedible composites was detected at four locations, ranging from a high of (4.00 ± 1.17)E+00 pCi/g in bass from the mouth of Beaver Dam Creek to lows below the MDCs in several composites.

Cesium-137 was the only manmade, gamma-emitting radionuclide detected in 2001 fish composites. Cesium-137 activity in Savannah River edible composites was detectable at all sampling locations, ranging from a high of (1.48 ± 0.03)E+00 pCi/g in bass from the mouth of Beaver Dam Creek to lows below the MDCs in several composites. Cesium-137 activity in river nonedible composites was detected at six of seven sampling locations, ranging from a high of (1.13 ± 0.28)E–01 pCi/g in bass from the mouth of Upper Three Runs to lows below the MDCs in several composites.

Strontium-89,90 activity in Savannah River edible fish in 2001 was detectable at four sampling locations, ranging from a high of (2.04 ± 0.50)E–02 pCi/g in bream from Upper Three Runs mouth to lows below the MDCs in several composites. Strontium-89,90 in river nonedible composites was detectable at six of seven sampling locations, ranging from a high of (2.18 ± 0.31)E–01 pCi/g in bass from Augusta Lock and Dam to a lows below the MDCs in several composites.

Tritium activity in Savannah River edible composites in 2001 was detectable at six of the seven sampling locations and ranged from a high of (7.92 ± 0.58)E–01 pCi/g in bream from Four Mile Creek mouth to lows below the MDCs in several composites.

Onsite Streams and Ponds Not enough fish of appropriate size could be collected from onsite streams and ponds in 2001 for any composite samples (five from the same category per location) from Four Mile Creek, Pen Branch, Steel Creek, Beaver Dam Creek, or Upper Three Runs.

Gross alpha activity in fish composites (edible portions only) from onsite streams and ponds was below detection at three of the four sampled locations. Gross alpha activity was observed in two Pond B samples, with a maximum concentration of (7.09 ± 0.33)E–01 pCi/g in bream. Gross beta activity, on the other hand, was detected at all of these locations and ranged from a high of (4.87 ± 0.12)E+01 pCi/g in bass from Pond B to below the MDC in bass from L-Lake.

Cesium-137—the only manmade, gamma-emitting radionuclide found in 2001 fish composites from onsite streams and ponds—was detectable at all four sampled locations. The activity ranged from a high of (8.85 ± 0.44)E+01 pCi/g in bass from Pond B to a low of (3.26 ± 0.42)E–01 pCi/g in bream from L-Lake.

Saltwater Fish

In the saltwater fish category, red drum (spottail bass) sea trout, and mullet were collected in 2001 from the U.S. Highway 17 Bridge Area. All gross alpha concentrations measured in saltwater fish composites during 2001 were below the MDC. Gross beta concentrations were detectable in all nine composites analyzed and ranged from a high of (2.55 ± 0.36)E+00 pCi/g in spottail bass to a low of (1.16 ± 0.30)E+00 pCi/g in sea trout. No manmade gamma-emitting radionuclides were detected in any saltwater fish sample.

Shellfish

A sample of oysters and a sample of crabs—both from near the mouth of the Savannah River—were collected in 2001. No manmade radionuclides above the MDCs were detected in these samples.

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 dose resulting from consumption is calculated for each animal, and each hunter's cumulative total is tracked to ensure compliance with the U.S. Department of Energy (DOE) dose limit for the general public. 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

A total of 79 deer and 102 feral hogs were taken from the site as part of a special animal control program in 2001. This compares with 294 deer and 38 feral hogs taken during 2000. After 14 hunts in 2000, the 2001 program included only four days of animal control activities—targeting specific high-density areas—because of security concerns in the wake of the terrorist attacks of September 11. The increase in the number of hogs taken is attributable to special hunts held in early 2001 for additional control of the growing hog population on site.

Gamma-Emitting Radionuclides

In 2001, the maximum field measurement of cesium-137 in deer muscle was approximately 2 pCi/g (compared with 57 pCi/g in 2000), while the mean cesium-137 concentration was approximately 1 pCi/g. The large decrease in the maximum is believed to be attributable to the limited scope of the hunts in 2001. In feral hogs, the maximum field measurement of cesium-137 in muscle was approximately 6 pCi/g, while the mean concentration was approximately 1 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 it is estimated will result in a hunter's annual dose exceeding 25 mrem (approximately 25 percent of the DOE limit)—either alone or in combination with previous animals killed by the hunter. In 2001, eight samples from eight animals were collected and analyzed for gamma-emitting radionuclides.

As observed during previous hunts, cesium-137 was the only manmade gamma-emitting radionuclide detected during laboratory analysis. Generally, the cesium-137 concentrations measured by the field and lab methods were comparable. Field measurements from all animals ranged from approximately 1 pCi/g to 6 pCi/g, while lab measurements ranged from approximately 1 pCi/g to 8 pCi/g.

Strontium

Strontium levels are determined in some of the animals analyzed 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.

Because of the reduced size of the daily harvest in 2001, no bone or muscle samples were collected for strontium 89,90 analysis.

Turkeys

Description of Surveillance Program

Wild turkeys are trapped on site by the South Carolina Wildlife and Marine Resources Department and used to repopulate game areas in South Carolina and other states. All turkeys are monitored for cesium-137 with portable sodium iodide detectors before leaving SRS. No turkey with a reading above 25 pCi/g is released off site.

Surveillance Results

EMS monitored only 12 turkeys in 2001 because of reduced program needs. Concentrations of cesium-137 generally were similar to those measured in the past, with all results 4.0 pCi/g or less. This compares to maximum concentrations of 5.0 pCi/g in 2000, of 4.0 pCi/g in 1999, of 5.0 pCi/g in 1998, and of 6.0 pCi/g in 1997. All concentrations below the LLD are assigned a value of 1.0 pCi/g.

Beavers

Description of Surveillance Program

The U.S. Forest Service harvests beavers in selected areas within the SRS perimeter to reduce the beaver population and thereby minimize dam-building activities that can result in flood damage to timber stands, to primary and secondary roads, and to railroad beds. All beavers are monitored for cesium-137 with portable sodium iodide detectors and disposed of in the SRS sanitary landfill.

Surveillance Results

No beavers were monitored at SRS in 2001 because of programmatic difficulties. The highest concentrations of cesium-137 found in beavers during previous years were 47 pCi/g in 2000, less than 1.0 pCi/g in all 11 beavers monitored in 1998 (none were monitored in 1999), and 12.5 pCi/g in 1997.

Soil

The SRS soil monitoring program provides

- data for long-term trending of radioactivity deposited from the atmosphere (both wet and dry deposition)
- 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 2001 (as shown in figure 4–13) from

- four uncultivated and undisturbed onsite locations—in E-Area (burial ground), F-Area, H-Area, and Z-Area

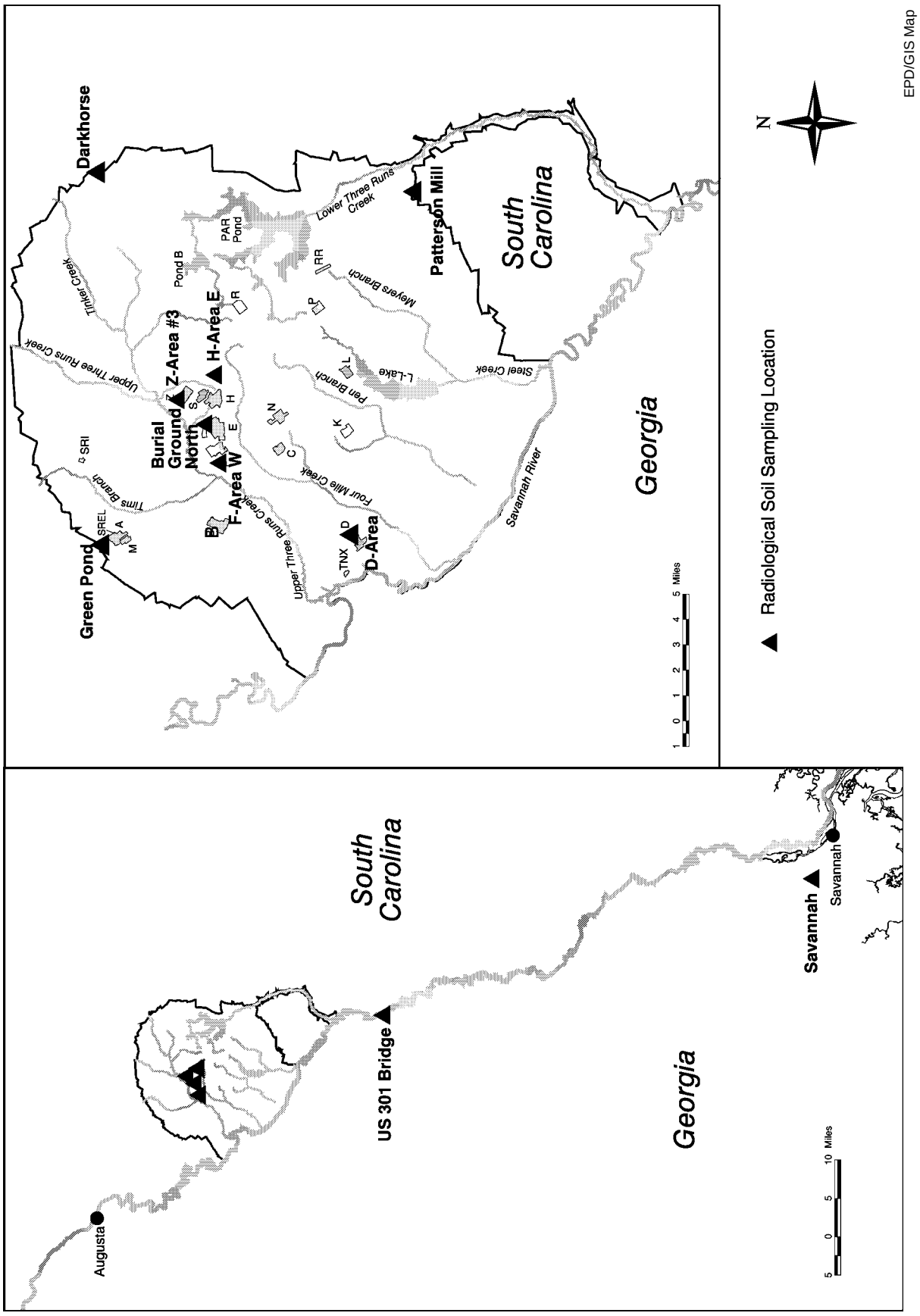


Figure 4–13 Radiological Soil Sampling Locations
SRS collected soil samples in 2001 from four onsite locations, four site perimeter locations, and two offsite locations—one near the U.S. Highway 301 Bridge over the Savannah River and one near Savannah, Georgia.

- four site perimeter locations (on Darkhorse Road, Green Pond Road, and Patterson Mill Road—and in D-Area)
- one offsite control location near the U.S. Highway 301 Bridge over the Savannah River
- another offsite location approximately 100 miles from SRS, near Savannah

One sample was collected from each of the 10 locations.

Hand augers or other similar devices are used in sample collection to a depth of 3 inches. The samples are analyzed for gamma-emitting radionuclides, 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 representative MDC in 2001 at three onsite, all four perimeter, and one offsite location. The highest onsite concentration detected, (5.94 ± 0.49)E–01 pCi/g, was in a sample taken from H-Area, and the lowest was below the representative MDC. The highest perimeter concentration, (4.19 ± 0.36)E–01 pCi/g, was detected at the Darkhorse at Williston Gate location. The highest offsite concentration was (2.71 ± 0.36)E–01 pCi/g, at the 100-mile-radius location near Savannah.

Plutonium

Two of the four onsite soil sampling locations showed concentrations of plutonium-238 above the representative MDC in 2001. The highest concentration, (4.63 ± 0.72)E–02 pCi/g, was in F-Area. Two of the onsite locations also had concentrations of plutonium-239 above the representative MDC—F-Area, at (4.60 ± 0.73)E–02 pCi/g, and H-Area, at (9.51 ± 0.87)E–02 pCi/g.

None of the four perimeter locations had a concentration of plutonium-238 above the representative MDC, while three of four perimeter locations had concentrations of plutonium-239 above the representative MDC—with the highest at D-Area, (8.34 ± 1.52)E–03.

One offsite location, the 100-mile-radius location near Savannah, had concentrations above the representative MDCs, as follows: plutonium-238, (1.38 ± 0.28)E–02 pCi/g, and plutonium-239, (3.53 ± 0.46)E–02 pCi/g.

Strontium

Soil samples from all 10 locations were analyzed for strontium-89,90 in 2001, and the results of none of the 10 showed concentrations above the representative MDC.

Settleable Solids

Description of Surveillance Program

Settleable-solids monitoring in effluent water is required to ensure—in conjunction with routine sediment monitoring—that a long-term buildup of radioactive materials does not occur in stream systems.

DOE limits on radioactivity levels in settleable solids are 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides.

Low total suspended solids (TSS) levels result in a small amount of settleable solids, so an accurate measurement of radioactivity levels in settleable solids is impossible. Based on this, an interpretation of the radioactivity-levels-in-settleable-solids requirement was provided to Westinghouse Savannah River Company (WSRC) by DOE in 1995. The interpretation indicated that TSS levels below 40 parts per million (ppm) were considered to be in *de-facto* compliance with the DOE limits.

To determine compliance with these limits, EMS uses TSS results—gathered as part of the routine National Pollutant Discharge Elimination System monitoring program—from outfalls co-located at or near radiological effluent points. If an outfall shows that TSS levels regularly are greater than 40 ppm, a radioactivity-levels-in-settleable-solids program and an increase in sediment monitoring would be implemented.

Surveillance Results

During 2001, only two TSS samples exceeded 40 ppm—one from outfall A–11 (101 ppm) and the other from outfall X–08 (43 ppm). Outfall A–11 is not associated with radiological discharges.

An investigation into the cause of the X–08 concentration determined that maintenance activities in a weir box upstream of the outfall resulted in the visible disturbance and transport of detritus. An examination of the 2001 X–08 TSS results indicated that

- the annual mean—including the 43-ppm value—was 5 ppm, considerably lower than the 40-ppm compliance limit

- if the 43-ppm value is discounted, the highest TSS level at X–08 is 4 ppm.

Based on these facts, it was determined that the monitoring of radioactivity levels in settleable solids was not required at X–08.

Overall, the TSS results indicate that SRS is in compliance with the DOE radioactivity-levels-in-settleable-solids requirement.

Sediment

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in stream beds and in the Savannah River bed. Significant year-to-year differences may be evident because of the continuous deposition and remobilization occurring in the stream and river beds—or because of slight variation in sampling locations—but the data obtained can be used to observe long-term environmental trends.

Description of Surveillance Program

Sediment samples (annual) were collected at 21 locations in 2001—eight in the Savannah River and 13 in site streams (figure 4–14). Samples are obtained with a Ponar dredge or an Emery pipe dredge and 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 2001 were similar to those of past years.

Gamma-Emitting Radionuclides

Cesium-137 and Cobalt-60 were the only manmade gamma-emitting radionuclides observed in river and stream sediments during 2001.

The highest cesium-137 concentration in streams, (1.76 ± 0.09)E+02 pCi/g, was detected in sediment from R-Area Downstream of R–1; the lowest concentrations were below the representative MDC at Tims Branch 5 near Road C and at U3R–1A. The highest level found on the river, (2.49 ± 0.33)E–01 pCi/g, was at the mouth of Lower Three Runs; the lowest levels were below the representative MDC at several locations. Generally, cesium-137 concentrations were higher in stream sediments than in river sediments. This is to be expected because the streams receive radionuclide-containing liquid effluents from the site. Most radionuclides settle out and deposit on the stream beds or at the streams' entrances to the swamp areas along the river.

Cobalt-60 was detected above the representative MDC in sediment from the following locations:

- Four Mile Creek Swamp Discharge
- Four Mile A–7A
- R-Area Downstream of R–1

The highest Cobalt-60 concentration, (4.79 ± 0.48)E–01 pCi/g, was measured at R-Area Downstream of R–1; concentrations at the other sediment sampling locations were below the representative MDC.

Plutonium/Uranium

Concentrations of plutonium-238 in sediment during 2001 ranged from a high of (1.21 ± 0.07)E+00 pCi/g at the Four Mile 2 at Road 4 location to lows below the representative MDC at several locations. Concentrations of plutonium-239 ranged from a high of (3.53 ± 0.23)E–01 pCi/g—at the Four Mile A–7A location—to lows below the representative MDC at several locations. Uranium-235—at (1.02 ± 0.32)E–01 pCi/g—was detected in sediment from River Mile 150.2 below Four Mile Creek.

As expected, concentrations of these isotopes in streams generally were higher than concentrations in the river. Differences observed when these data are compared to those of previous years probably are attributable to the effects of resuspension and deposition, which occur constantly in sediment media.

Strontium

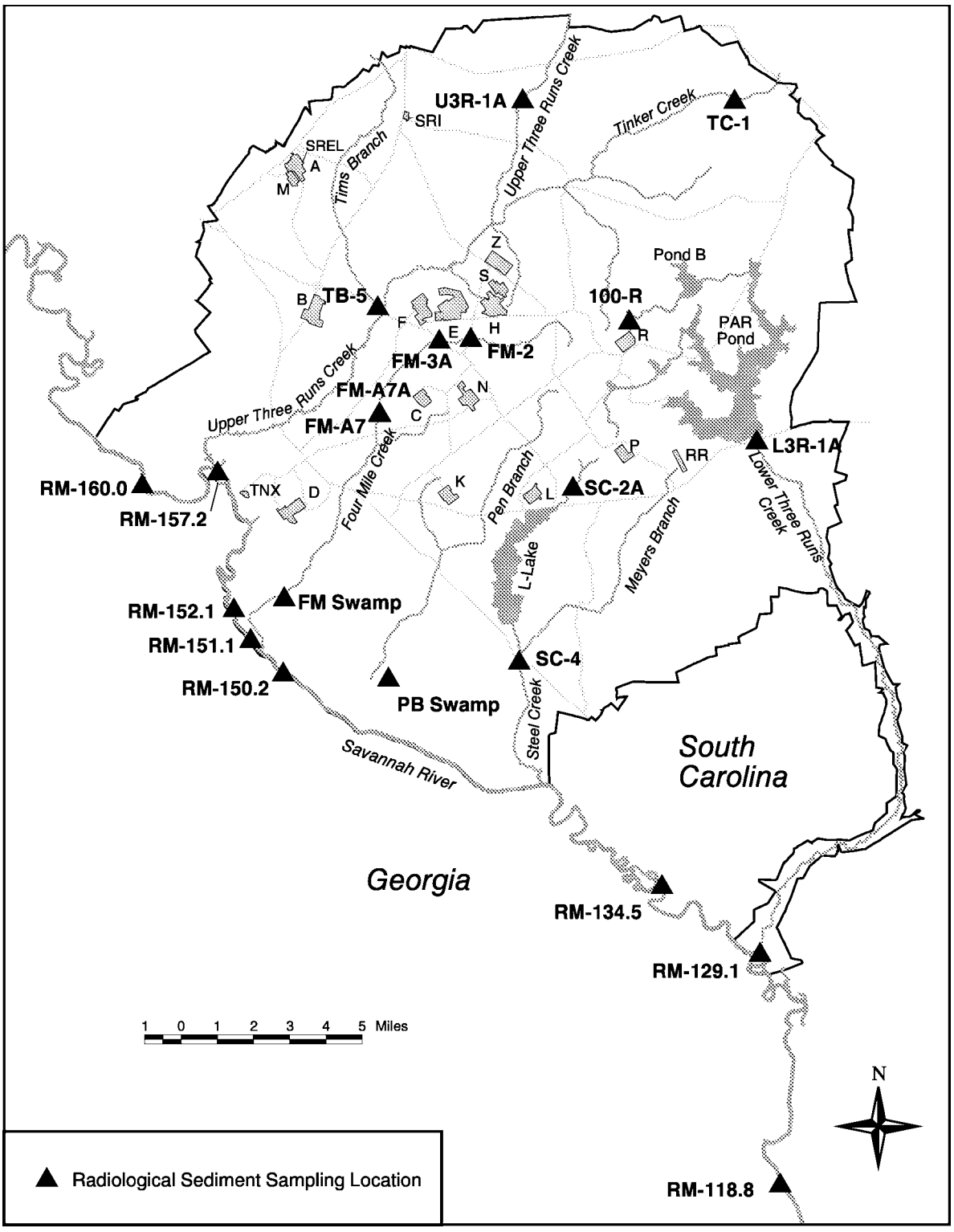
Concentrations of strontium-89,90 in sediment ranged from a high of (3.78 ± 0.56)E–01 pCi/g at the FM–A7 location to lows below the representative MDC at all eight river locations and 11 of the 13 site stream locations.

Grassy Vegetation

The radiological program for grassy 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.

The program also provides information that can be used to determine the effects, if any, of various radioactive material operations on the surrounding vegetation.

Typically, grasses are collected for vegetation because of their year-round availability. Bermuda



EPD/GIS Map

Figure 4–14 Radiological Sediment Sampling Locations

Sediment samples were collected in 2001 at eight Savannah River locations—upriver of, adjacent to, and downriver of the site—and 13 site stream locations.

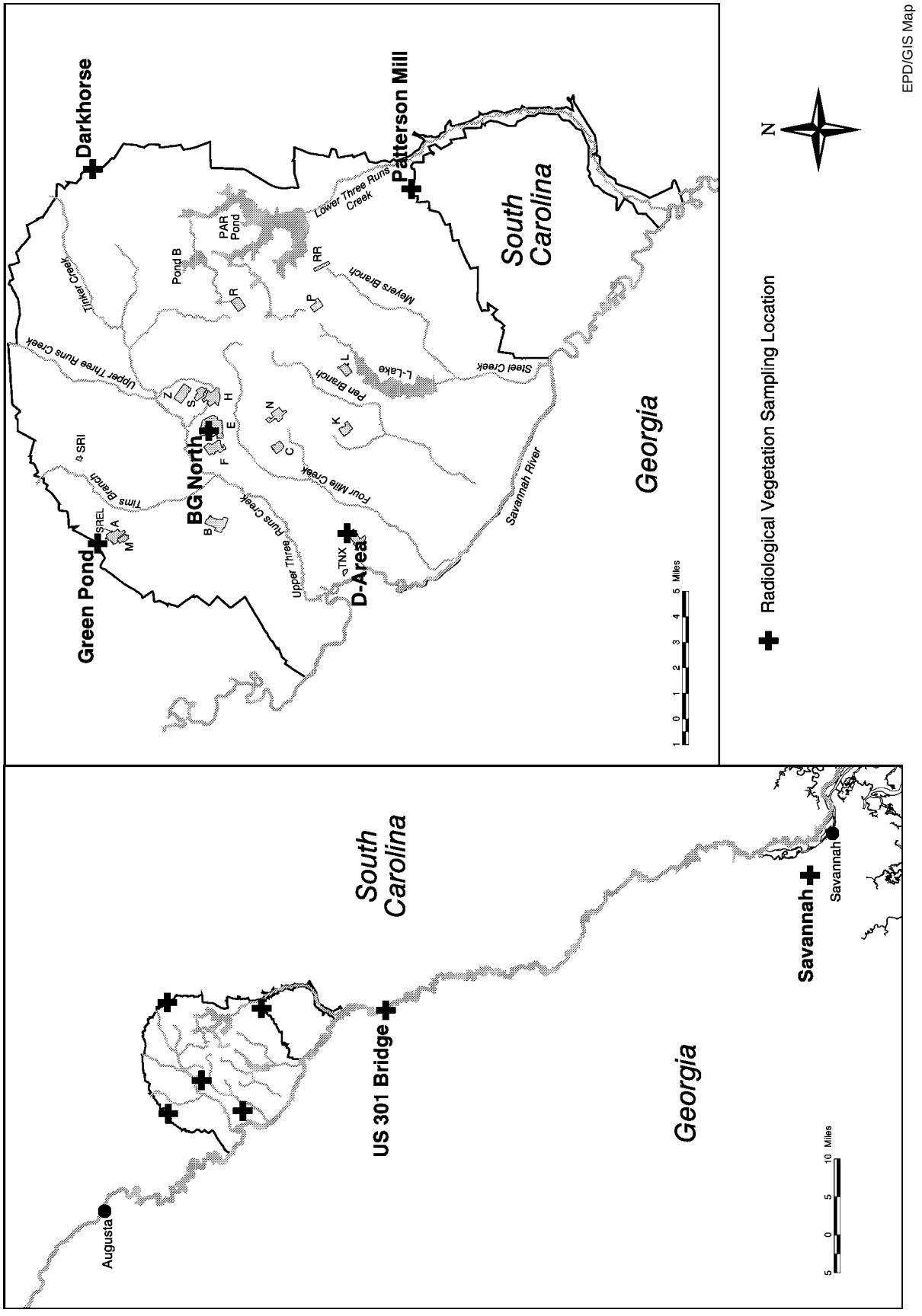


Figure 4–15 SRS Vegetation Sampling Locations
Vegetation samples were collected for radiological analysis in 2001 from five locations on site and two off site (near Savannah, Georgia, and at the U.S. Highway 301 Bridge over the Savannah River).

grass is preferred because of its importance as a pasture grass for dairy herds.

Description of Surveillance Program

Vegetation samples 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

An onsite location is near the geographical center of the site, and four perimeter locations are situated near air monitoring stations that provide sampling within each 30-degree sector around the site boundary. Two offsite locations—selected as control sites—are in the vicinity of the environmental air monitoring stations at the U.S. Highway 301 Bridge over the Savannah River and near the city of Savannah. All the vegetation locations, which continue to be sampled annually, are shown in figure 4–15.

In addition to actinides, vegetation samples are analyzed for gross alpha and gross beta, gamma-emitting radionuclides, tritium, plutonium, and strontium. 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 vegetation surveillance program makes no attempt to differentiate between contributions of the external and internal contaminations, contributions can be approximated when radionuclide concentrations in local soils are known.

The sampling and analysis programs for grassy vegetation are documented in WSRC–3Q1–2, Volume 1, Section 1105.3.10.2. Operational details of sample collection are in procedure manual WSRC–3Q1–3, while analytical procedures are in WSRC–3Q1–4 and WSRC–3Q1–6.

Surveillance Results

All surveillance results are based on dry weight. The 2001 grassy vegetation analysis results showed tritium, cesium, strontium, plutonium, and actinide activity near minimum detectable concentrations at several locations. Gross beta activity was detected at all seven locations but was attributed primarily to the naturally occurring radionuclide potassium-40. Plutonium and actinide results for the U.S. Highway 301 Bridge Area had to be discarded because of laboratory error.

Georgia Well Sampling

Contamination of groundwater has been detected at several locations within SRS. Concern has been raised by State of Georgia officials that groundwater contaminated with tritium might migrate through aquifers underlying the Savannah River into Georgia by what is sometimes referred to as trans-river flow.

DOE and the State of Georgia jointly selected a panel of experts to review available information and previous studies regarding tritium migration to determine if additional studies are needed. The Tritium Migration Independent Scientific Peer Review Panel convened January 30, 2001; the results of its review are expected in January 2002.

Previous Studies

The U.S. Geological Survey (USGS), in cooperation with DOE and GDNR, began a study (the Trans-River Flow Project) in 1988 to describe groundwater flow and quality near the Savannah River and to determine the potential for movement beneath the river. The study area was bounded by the fall line, which is about 20 miles northwest of SRS, and extended to about 20 miles south of the site.

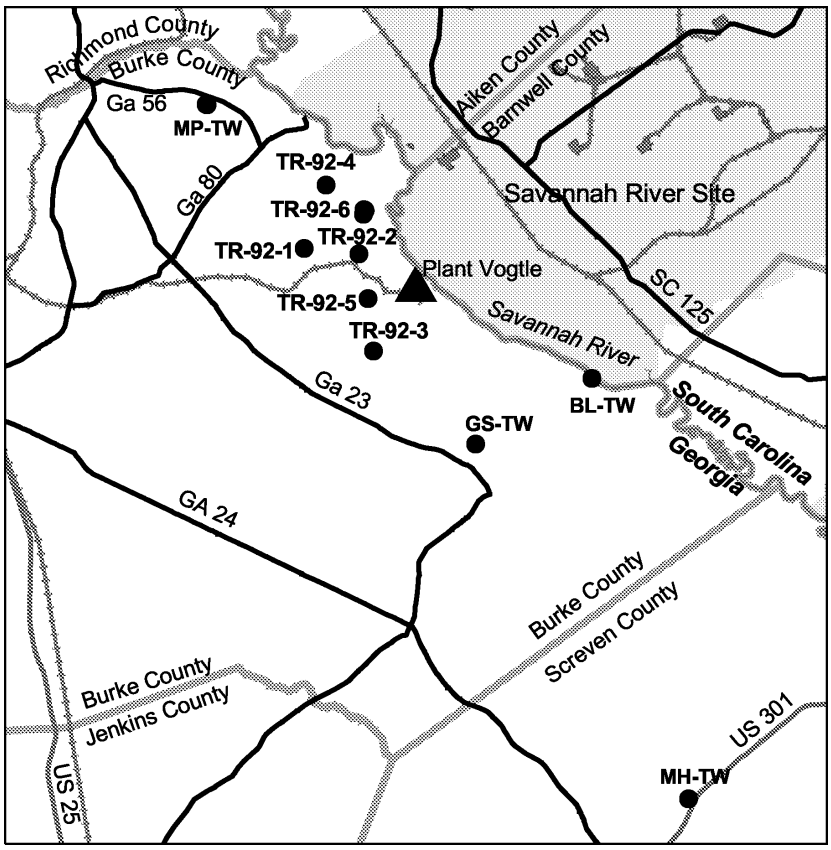
Summaries of the Trans-River Flow Project results may be found in 1992–1996 SRS environmental reports, which concluded that there was no potential for groundwater with tritium contamination to flow under the river, and that the low levels of tritium found in Burke County came from rainfall.

SRS acquired and performed pump maintenance on 14 USGS wells in Burke and Screven counties in 2000. The addition of these wells to the 30 monitoring wells SRS acquired from GDNR in 1999 brought the total number of Georgia wells available for sampling to 44. Figure 4–16 shows the location of the 10 well clusters in the study.

Current Study and Results

EMS personnel sampled 41 of the 44 wells during 2001, when joint sampling was conducted by GDNR for the first time. The overall trend of the data showed a continued gradual decline in tritium levels.

The highest value reported in 2000 came from well TR92–2A, a well screened in the water table. The value was 1,260 pCi/L, which is about 6 percent of the EPA drinking water standard of 20,000 pCi/L. The highest values in 2001—from wells TR92–1H and TR–92–2A—were 1,070 pCi/L and 1,060 pCi/L, respectively; these values are about 5 percent of the drinking water standard and are consistent with conclusions from the earlier studies that the tritium



EPD/GIS Map

Figure 4–16
Burke/Screven County Well Locations

Groundwater samples were collected for tritium analysis in 2001 from nine well clusters in Burke County, Georgia, and one in Screven County. Forty-one samples were collected from the 44 total wells.

comes from rainfall. Well TR92–2A was not sampled in 1997–1999, but its tritium values from 1994, 1995, and 1996 were 1,500 pCi/L, 1,300 pCi/L, and 1,700 pCi/L, respectively.

Well TR92–5B, located at DeLaigle Trailer Park, showed tritium levels slightly above the minimum detection limit. This location will be resampled and reanalyzed to verify the result.

SRS and GDNR will jointly sample the Burke and Screven County wells for tritium again in February 2002.