Environmental Surveillance

CHAPTER 5

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Environmental surveillance at the Savannah River Site (SRS) is designed to survey and quantify any effects that routine and nonroutine operations could have on the site and on the surrounding area and population. Site surveillance activities are divided into radiological and nonradiological programs.

As part of SRS's radiological surveillance program, routine surveillance of all applicable radiation exposure pathways is performed on all environmental media (air, rain, surface water, soil, sediment, vegetation, drinking water, food products, and wildlife) that could lead to a measurable annual dose above background at and beyond the site boundary. Nonradioactive environmental surveillance at SRS involves the sampling and analysis of surface water, drinking water, sediment, groundwater, and fish. Results from the analyses of surface water, drinking water, sediment, and fish are discussed in this chapter. A description of the groundwater monitoring program analysis results can be found in chapter 7, "Groundwater."

The Regulatory Integration & Environmental Services Department's Environmental Monitoring (EM) section performs surveillance activities for SRS. The Savannah River also is monitored by other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC), the Georgia Department of Natural Resources, Georgia Power Company's Vogtle Electric Generating Plant (operating in Georgia), and the City of Savannah, Georgia. A complete description of the EM surveillance program, including sample collection and analytical procedures, can be found in section 1105 of the Savannah River Site Environmental Monitoring Program, WSRC–3Q1–2, Volume 1, Revision 4 [SRS EM Program, 2002a]. Brief summaries of analytical results are presented in this chapter; complete data sets can be found in tables on the CD housed inside the back cover of this report.

Radiological Surveillance

Air

Description of Surveillance Program (Table)

EM maintains a network of 15 sampling stations in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air.

Surveillance Results Summary

Except for tritium, no specific radionuclides were routinely detectable at the site perimeter in 2009. Both onsite and offsite radioactivity concentrations were similar to levels observed in previous years (see expanded discussion in paragraphs that follow).

Average gross alpha and gross beta results from 2009 were-similar to those of 2008, and are consistent with historical results in demonstrating long-term variability.

No 2009 samples contained detectable amounts of the manmade gamma-emitting radionuclide cesium-137. Historically, only a small number of air samples have contained detectable cesium-137 activity.

During 2009, detectable levels of uranium-234 were observed in 12 of 15 air samples, and detectable levels of uranium-238 were observed in 13 of 15 air samples; however, no detectable levels of uranium-235 were observed in any of the 2009 samples. These results are similar to those observed in 2008

and previous years. Uranium is naturally occurring in soil, and therefore expected to be present in low concentrations on some particulate filters. By weight, natural uranium is 99-percent uranium-238, 0.72-percent uranium-235, and 0.0055-percent uranium-234. However, by radioactivity, natural uranium is 48.9-percent uranium-234, 48.9-percent uranium-238, and 2.2-percent uranium-235. Because the analytical method quantifies the radioactivity, uranium-234 and -238 are sometimes detected when uranium-235 is not. Aside from uranium, alpha-emitting radionuclide activity was observed in nine air samples from four locations—three locations along the site perimeter and one at the 25-mile radius. The site perimeter locations revealed corresponding increases in plutonium-238, plutonium-239, and americium-241 during the same timeframe, which is consistent with the true presence of plutonium. Generally, these concentrations were consistent with historical results. For the remaining locations, all alpha-emitting isotopes were below detection levels. One 2009 strontium-89,90 result was above the minimum detectable concentration (MDC)—consistent with results since 2007, when the laboratory implemented a more sensitive analytical protocol. The dose consequences are explained in more detail in chapter 6 (“Potential Radiation Doses”).

Tritium-in-air results for 2009 were similar to—but generally lower than—those observed in 2008, and were consistent with the long-term variability of historical results. The Burial Ground North (BGN) tritium-in-air results were slightly higher than those observed in 2008. As in previous years, the BGN location showed average and maximum concentrations significantly higher than those observed at other locations. BGN concentrations are expected to be higher and more variable because of the location’s proximity to both the tritium facilities and the phytoremediation project near the center of the site, and are influenced by operations at these facilities. All tritium-in-air samples from the center of the site contained detectable levels of tritium. As expected, tritium concentrations generally decreased with increasing distance from the tritium facilities.

Rainwater

Description of Surveillance Program

SRS maintains a network of 15 rainwater sampling sites as part of the air surveillance program. These stations are used to measure deposition of radioactive materials.

Surveillance Results Summary (Tables A, B)

No detectable manmade gamma-emitting radionuclides were observed in rainwater samples during 2009.

Gross alpha and gross beta results from 2009 were consistent with those of 2008. In 2009, the average gross alpha and gross beta results generally were slightly higher than in 2008. Annual average gross alpha and gross beta concentrations, as well as individual sample results, are consistent with historical results, which demonstrate long-term variability.

Detectable levels of uranium-234 and uranium-238 were present in most samples. Uranium is naturally occurring in soil, and therefore expected to be present at low concentrations in some deposition samples. Both uranium-234 and uranium-238 results were higher at the D-Area perimeter location than at the other site perimeter locations; they also were higher at the BGN (onsite) location. This likely is attributable to the increased airborne particulate matter (dust) is present at these locations because of vehicle traffic on nearby dirt roads and fields. Plutonium-238 was observed in eight samples (four from the site perimeter and four from the 25-mile location). Americium-241 was observed in four samples from the site perimeter. The average concentrations of plutonium-238 and americium-241 were well below the drinking water standard. All other actinides, as well as strontium-89,90, either were below detection levels or were present in only a small number of samples (<3 percent) in 2009.

As in previous years, tritium-in-rain values were highest near the center of the site. All samples from the center of the site contained detectable tritium. This is consistent with the H-Area effluent release points that routinely release tritium. Beyond the center of the site, tritium was detected in 37 samples—31 from the site perimeter locations, five from the 25-mile locations, and one from the 100-mile location. As with tritium in air, concentrations generally decreased as distance from the effluent release points increased..

Gamma Radiation

Description of Surveillance Program

Ambient dose rates from gamma radiation exposures in and around SRS are monitored by a system of thermoluminescent dosimeters (TLDs).

Surveillance Results Summary (Table)

Ambient dose rates at all TLD monitoring locations show some variation based on normal site-to-site and year-to-year differences in the components of natural ambient gamma radiation exposure levels. In 2009, ambient dose rates varied between 55 and 152 mrem per year. The 2009 exposure rates were based on a calendar year timeframe (January through December); in the past, they were based on a fiscal year timeframe (October through September).

In general, the 2009 ambient gamma radiation monitoring results indicated dose rates lower than those observed at the same locations in 2008. The average annual dose rate was 80 mrem in 2009, compared to 87 mrem in 2008; 51 locations showed lower exposure, and three locations showed higher exposure. The BGN (onsite) location showed elevated dose rates for the second, third, and fourth quarters of 2009. However, these results generally are consistent with previously published historical results, and indicate that no significant difference in average annual dose rates is observed between monitoring networks—except in the case of population centers. Ambient dose rates in population centers are slightly elevated compared to the other monitoring networks—as expected—because of factors such as buildings and roadways, which emit small amounts of radiation.

Stormwater Basins

Description of Surveillance Program

Stormwater accumulating in site stormwater basins is monitored monthly because of potential contamination. In 2009, monitoring was conducted at six E-Area basins, as well as at the Z-Area Basin and F-Area Pond 400.

Surveillance Results Summary (Table)

There are no active discharges to site stormwater basins. The primary contributor is rainwater runoff. Rain events did not supply enough water to the E–06 basin for sampling purposes in 2009. The highest mean tritium concentration was measured in the E–05 basin, and was consistent with historical results—although 40 percent lower than the highest mean tritium concentration at the same location in 2008. No cobalt-60 or curium-244 was detected in any of the basins. Fission products, as well as some actinides, were observed in the basins. Technetium-99 was detected in all locations, with uranium-234, uranium-238, and plutonium-238 the primary actinides. Gross alpha and gross beta activity was detected in all the basins, and the concentrations were compared to those of previous years to identify any trends. The 2009 values were consistent with historical data.

Streams

Description of Surveillance Program

Continuous surveillance monitoring of SRS streams is utilized downstream of several process areas to detect and quantify levels of radioactivity in effluents transported to the Savannah River. The five primary streams are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. The frequency and types of analyses performed on each sample are based on potential quantity and types of radionuclides likely to be present at the sampling location.

Surveillance Results Summary (Table)

Detectable concentrations of tritium, the predominant radionuclide detected above background levels in SRS streams, were observed at least once at all stream locations in 2009, except at Upper Three Runs-1A (the stream control point). Overall, tritium releases to SRS streams were slightly higher in 2009 than in 2008, but the concentrations remain consistent with long-term tritium levels.

Cesium-137 was detected in three of the five major SRS streams—Fourmile Branch, Pen Branch, and Steel Creek. Gross alpha and gross beta activity was detected in all streams, but concentrations were consistent with levels of recent years. Other radionuclides were observed at locations throughout the site, but were consistent with the source of the material, and exhibited variations similar to those of previous years. No significant trends were observed in 2009 when compared to recent years.

Seepage Basin and Solid Waste Disposal Facility Radionuclide Migration (Table)

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, EM personnel continued to monitor and quantify the migration of radioactivity from site seepage basins and

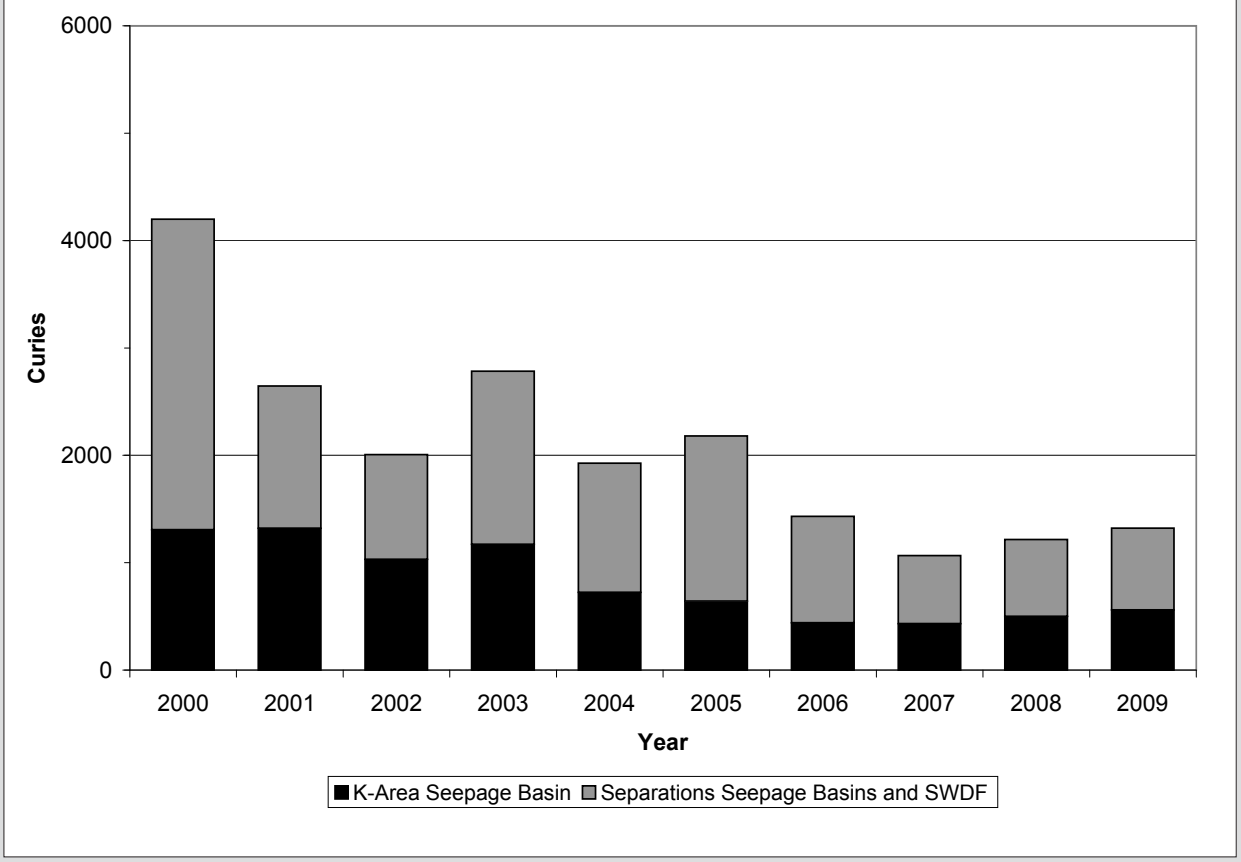

Figure 5–1 Tritium from SRS Seepage Basins and SWDF to Site Streams, 2000–2009

the Solid Waste Disposal Facility (SWDF) in 2009 as part of its stream surveillance program. Tritium, strontium-89,90, technetium-99, iodine-129, and cesium-137 were detected in migration releases.

Figure 5–1 is a graphical representation of releases of tritium via migration to site streams for the years 2000–2009. As can be seen in the figure, migration releases of tritium generally have declined the past 10 years, with year-to-year variability caused mainly by the amount of annual rainfall. During 2009, the total quantity of tritium migrating from site seepage basins and SWDF was 1,321 Ci.

Radioactivity previously deposited in the F-Area and H-Area seepage basins and SWDF continues to migrate through the groundwater and to outcrop into Fourmile Branch and Upper Three Runs. Because of their proximity, migration from the SWDF cannot be distinguished from migration from a part of H-Area Basin 4. Measured migration of tritium into Fourmile Branch in 2009 occurred as follows:

- from F-Area seepage basins, 27 Ci—a 62-percent decrease from the 2008 total of 71 Ci
- from SDWF and a part of H-Area seepage basin 4, 532 Ci—a 7.9-percent increase from the 2008 total of 493 Ci
- from H-Area seepage basins 1, 2, 3, and most of 4, 135 Ci—a 3-percent increase from the 2008 total of 131 Ci

The measured migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2009 was 68 Ci, compared with the 2008 total of 20 Ci—a fluctuation consistent with historical results. (The GSA is in the central part of SRS and contains all waste disposal facilities, chemical separations facilities, and associated high-level waste storage facilities, along with numerous

other sources of radioactive material.)

The total amount of strontium-89,90 entering Fourmile Branch from the GSA seepage basins and SWDF during 2009 was estimated to be 36.28 mCi. Migration releases of strontium-89,90 vary from year to year but have remained below 100 mCi the past 7 years.

In 2009, 19.29 mCi of technetium-99, 35.50 mCi of iodine-129, and 68.9 mCi of cesium-137 were estimated to have migrated into Fourmile Branch.

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 annually in Pen Branch. The 2009 migration total of 559 Ci represents a relatively slight (11.8-percent) increase from the 500 Ci recorded in 2008.

C-Area, L-Area, and P-Area Seepage Basins Liquid purges from the C-Area, L-Area, and P-Area disassembly basins were released periodically to their respective seepage basins from the 1950s until 1970. Migration releases from these basins are accounted for in the stream transport totals (see "Tritium Transport in Streams" section of this chapter).

Migration of Actinides in Streams

Migration into site streams of the actinides uranium, plutonium, americium, and curium no longer is quantified because of the actinides' historically low levels. However, the streams are sampled and analyzed annually for the presence of these actinides. The resulting concentrations are compared to those of previous years to identify any trends. Overall, values for 2009 were consistent with historical data, and generally remained at or below the analytical detection limit.

Savannah River

Description of Surveillance Program

Continuous surveillance is performed along the Savannah River at locations above and below SRS, including a location at which liquid discharges from Georgia Power Company's Vogtle Electric Generating Plant (VEGP) enter the river.

Surveillance Results Summary (Table)

Based on curies released, tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS and VEGP tritium releases (weekly composites) at River Mile (RM) 118.8 decreased in 2009, with levels again well below the drinking water standard. No gamma emitters were detected. Detectable gross alpha and gross beta activity was observed at all river sampling locations, and was consistent with long-term gross alpha and gross beta levels in the river, with one exception. A higher-than-expected gross beta result was observed in June at River Mile 150.4, located next to VEGP. Because of the analytical method used (ion exchange resin), excess sample water was not available for a rerun to verify the result, which is believed to have been caused by a laboratory error. The corresponding gross alpha result was within the normal range.

In addition to the weekly composite samples referenced above, SRS collects annual grab samples to provide a more comprehensive suite of radionuclides. Uranium-234 and uranium-238 were quantified in all these grab samples in 2009. Annual grab sampling also detected technetium-99 at River Mile 150.4.

Tritium Transport in Streams (Table)

Tritium is introduced into SRS streams and the Savannah River from former production areas on site. Because of the mobility of tritium in water and the quantities 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:

- total direct tritium releases, including releases from (1) facility effluent discharges and (2) measured migration of tritium from site seepage basins and SWDF migration (direct releases)
- tritium transport in SRS streams, measured at the last sampling point before entry into the Savannah River (stream transport)
- tritium transport in the Savannah River, measured downriver of SRS (near RM 118.8) after subtraction of any measured contribution above the site (river transport)

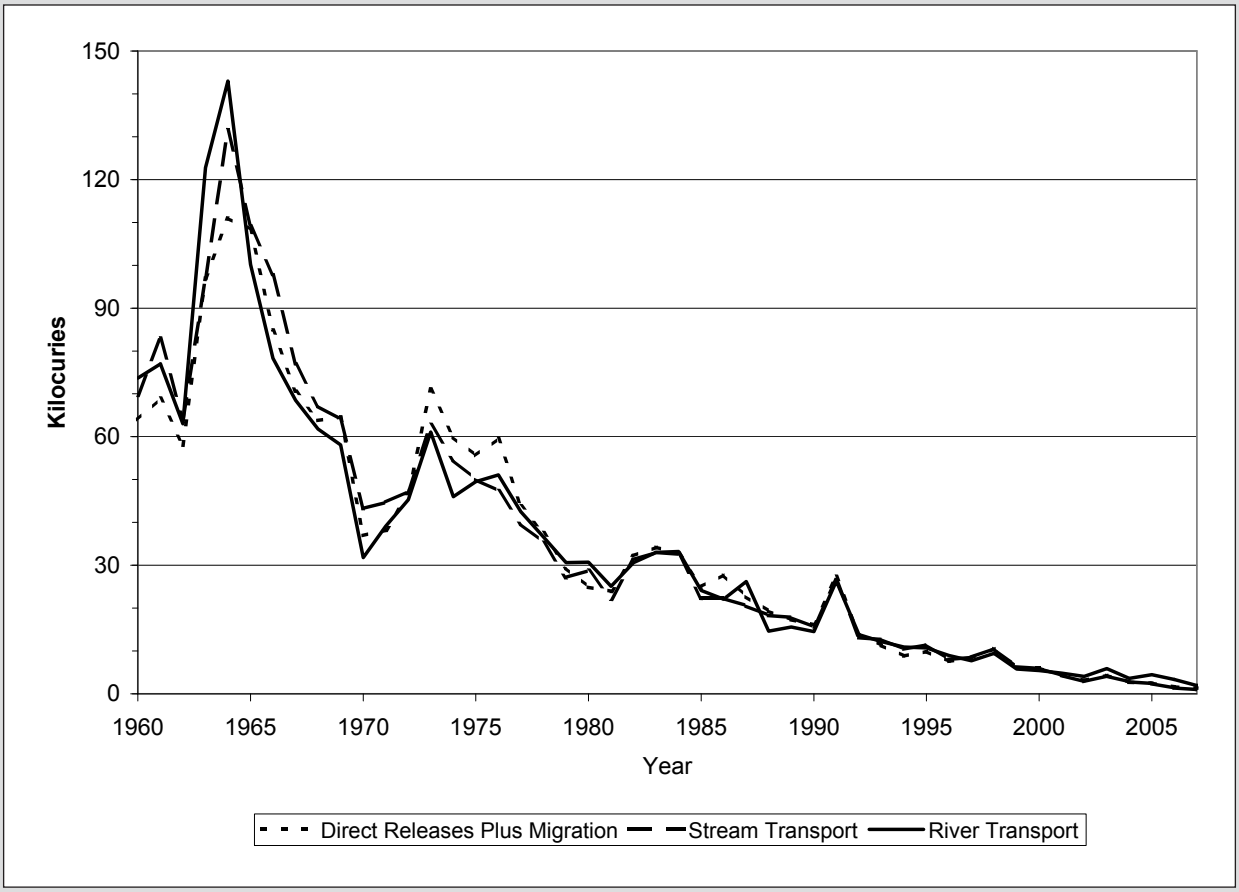

Figure 5–2 SRS Tritium Transport Summary, 1960–2009
SRS has maintained a tritium balance of direct releases plus migration, stream transport, and river transport since 1960 in an effort to account for and trend tritium releases in liquid effluents from the site. The general trend over time is attributable to (1) variations in tritium production at the site (production discontinued in the late 1980s); (2) the implementation of effluent controls, such as seepage basins, beginning in the early 1960s; and (3) the continuing depletion and decay of the site's tritium inventory.

The *direct releases* of tritium in 2009 totaled 1,559 Ci, compared to 1,535 Ci in 2008.

The *stream transport* of tritium increased to 1,271 Ci in 2009 (from 1,185 Ci in 2008).

The *river transport* of tritium measured in the Savannah River in 2009 was 2,350 Ci, compared with the previous year's 2,659 Ci. Both VEGP and SRS contributed to these values.

SRS tritium transport data for 1960–2009 are depicted in figure 5–2, which shows the history of direct releases, stream transport, and river transport, as determined by EM personnel.

EM continued to assess the tritium flux in the Lower Three Runs system in 2008. A more extensive tritium flux assessment initially was conducted in 2004—and described in the *SRS Environmental Report for 2004*. As it has during the past several years, a small but measurable amount of tritium from earlier Energy*Solutions* LLC (formerly Chem-Nuclear Systems) low-level radioactive waste disposal facility operations entered the stream system in 2009. The facility is privately owned and located adjacent to SRS. The amount of tritium entering the system is expected to continue a gradual decline over time. Energy*Solutions* LLC began a program of capping the tritium sources in 1991, thereby reducing the amount of tritium entering the groundwater. The

tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. EM and Energy*Solutions* will maintain a monitoring program for Lower Three Runs to evaluate this tritium migration.

Domestic Water

Description of Surveillance Program

EM collected domestic water samples in 2009 from locations at SRS and at water treatment facilities that use Savannah River water. Potable water was analyzed at offsite treatment facilities to ensure that SRS operations did not adversely affect the water supply and to provide voluntary assurance that drinking water did not exceed EPA drinking water standards for radionuclides.

Onsite domestic water sampling consisted 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. Composite samples were collected monthly off site from

- the Beaufort-Jasper Water and Sewer Authority's Chelsea and Purrysburg Water Treatment Plants
- the City of Savannah Industrial and Domestic Water Supply Plant
- the North Augusta (South Carolina) Water Treatment Plant

Surveillance Results Summary (Table)

All domestic water samples collected by EM in 2009 were screened for gross alpha and gross beta concentrations to determine if activity levels warrant further analysis. No domestic water exceeded EPA's 15-pCi/L alpha activity limit or 50-pCi/L beta activity limit. Also, no onsite or offsite domestic water samples exceeded the 20,000-pCi/L EPA tritium limit or the 8-pCi/L strontium-89,90 MDC.

No cesium-137, uranium-235, plutonium-239, or curium-244 was detected in any domestic water samples in 2009. On site, strontium-89,90, cobalt-60, curium-244, and plutonium-238 each was detected at one location. Uranium-234 was detected at six locations, uranium-235 at one location, and uranium-238 at seven locations.

Terrestrial Food Products

Description of Surveillance Program

The terrestrial food products surveillance program consists of radiological analyses of food product samples typically found in the Central Savannah River Area (CSRA). These foods include milk, meat (beef), fruit (melons or peaches), and green vegetables (collards). 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 validate dose models and determine environmental trends.

Samples of food—including meat, fruit, and a green vegetable—are collected from one location within each of four SRS 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 quarterly from seven dairies within a 25-mile radius of the site. Two of the eight dairies were open during only two quarters in 2009; a third was open for three quarters. The food product surveillance program was expanded in 2005 to include secondary crops on a rotating schedule. Soybeans and wheat were sampled in 2009 as part of this program.

Food samples typically are analyzed for the presence of gamma-emitting radionuclides, tritium, strontium-89,90, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, americium-241, curium-244, gross alpha, and gross beta. Technetium-99 was added to analytical suite in 2009. A laboratory detection method for neptunium-237 in food products is being developed.

Surveillance Results Summary (Tables A, B)

The gamma-emitting radionuclides detected in food products in 2009 were cobalt-60 in milk at one location, and cesium-137 in collards at four locations and soybeans at one. Strontium-89,90 was detected in collards at all five locations and in soybeans at one location. Uranium-234 was detected in collards at all locations, and in fruit, beef, and soybeans at one location. Uranium-235 was detected in collards at one location, while uranium-238 was detected in collards at four locations and beef at one. Plutonium-238 was detected in collards at three locations and beef at two. Americium-241 was detected in collards at one

location and in wheat at one. Technetium-99 was detected in collards at one location. Gross beta was detected in all food products. The 2009 results appeared to be randomly distributed among the monitoring locations, and no underlying spatial distribution was observed.

Tritium in food products is attributed primarily to releases from SRS. Tritium was detected only in collards at two locations in 2009. These results are similar to those of previous years.

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—from above SRS at Augusta, Georgia, to the coast at Savannah, Georgia. Composite samples—comprised of three to five fish of a given species—are prepared for each species from each location. Analyses for technetium-99, iodine-129, and the actinide series (uranium-234, uranium-235, and uranium-238, plutonium-238 and plutonium-239, americium-241, and curium-244) were added to all samples in 2006. Neptunium-237 was added in 2008.

Surveillance Results Summary

Cesium-137 was the only manmade gamma-emitting radionuclide found in Savannah River edible fish composites during 2009. Strontium-89,90, uranium-234, uranium-238, plutonium-238, and tritium were detected in freshwater fish at most of the river locations. Concentrations were similar to those of previous years. Technetium-99 was detected at four river locations. Curium-244 was detected at one location and neptunium-237 was detected at none of the locations. Uranium-234, uranium-235, uranium-238, plutonium-238 and strontium-89,90 were detected in saltwater fish; uranium-234 uranium-238, and plutonium-238 were detected in shellfish. Concentrations were similar to those of previous years.

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, EM personnel use portable sodium iodide detectors to perform field analyses for cesium-137. 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. SRS established an administrative dose limit of 30 mrem per year for the consumption of game animals in 2006. This limit, which ensures that no single pathway contributes more than 30 percent to the all-pathway dose limit of 100 mrem, is consistent with DOE guidance. The doses from deer and hog consumption are quantified and reported in chapter 6.

Surveillance Results Summary

A total of 396 deer and 78 feral hogs were taken during the 2009 site hunts. 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 1 pCi/g to 9.17 pCi/g, while lab measurements ranged from 1 pCi/g to 8.24 pCi/g. The average field cesium-137 concentration was 1.38 pCi/g in deer (with a maximum of 9.17 pCi/g) and 1.06 pCi/g in hogs (with a maximum of 2.78 pCi/g). This range of concentrations is slightly below normal for the site's deer and hog populations.

The muscle and bone samples from a subset of the animals returned to the lab for cesium-137 analysis also are analyzed for strontium-89,90. Because of its chemistry, strontium is more readily measured in bone than in muscle tissue. In 2009, strontium was detected in seven of 68 deer muscle tissue samples and one of the five hog muscle tissue samples. These positive results were slightly above the minimum detection limit for strontium. Lab measurements of strontium-89,90 in bone ranged from 1.47 pCi/g to

8.38 pCi/g in deer, and from 1.67 pCi/g to 5.32 pCi/g in hogs. These results are similar to those of previous years.

Turkeys/Beavers

Description of Surveillance Programs

Prior to 2003, wild turkeys were trapped on site by the South Carolina Department of Natural Resources and used to repopulate game areas in South Carolina and other states. Since that time, the program has remained inactive because of reduced needs.

During April 2009, a special hunt for the mobility impaired was held that resulted in the harvest of 27 turkeys. The average cesium-137 concentration measured in the field was 1.30 pCi/g, which is comparable with the results from previous hunts.

The U.S. Department of Agriculture Forest Service–Savannah River harvests beavers in selected areas within the SRS perimeter to reduce the 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. This activity resumed during 2006. Although population control activities continued in 2009, no beavers were removed from their habitat for disposal.

Soil

Description of Surveillance Program

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

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. However, the data is available in previous environmental reports and can be evaluated over a period of years to determine and analyze long-term trends.

Surveillance Results Summary (Table)

In 2009, radionuclides were detected in soil samples from all 21 locations, as follows:

- cesium-137 at 11 locations (two onsite, eight perimeter, and two offsite)
- uranium-234 at all locations
- uranium-235 at all locations
- uranium-238 at all locations
- neptunium-237 at six locations (four perimeter and two offsite)
- plutonium-238 at 15 locations (four onsite, seven perimeter, and four offsite)
- plutonium-239 at 11 locations (four onsite, four perimeter, and three offsite)
- strontium-89,90 at four locations (one onsite and three perimeter)
- americium-241 at 15 locations (three onsite, eight perimeter, and four offsite)
- curium-244 at two locations (one onsite and one perimeter)

The concentrations at these locations are consistent with historical results. Uranium is naturally occurring in soil and therefore expected to be present in soil samples.

Settleable Solids

Description of Surveillance Program

Settleable-solids monitoring in effluent water is required to determine—in conjunction with routine sediment monitoring—whether a long-term buildup of radioactive materials occurs 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 SRS 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, EM uses TSS results—gathered as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program—from outfalls co-located at or near radiological effluent points. If an outfall shows that TSS levels regularly are greater than 30 ppm, a radioactivity-levels-in-settleable-solids program and an increase in sediment monitoring will be implemented.

Surveillance Results Summary

In 2009, only two NPDES TSS samples exceeded 30 ppm. Both samples were collected from NPDES Outfall D–1D—one in April, the other in May—with results of 32 and 38 ppm, respectively. Second TSS samples were collected each of the two months, with results of 8 ppm and 10 ppm, respectively, to establish and verify compliance with permit average limits. The higher results (32 and 38 ppm) were attributed to infiltration of solids from nearby construction activities and did not lead to permit exceptions. The 2009 NPDES TSS results indicate that overall, SRS remains in compliance with the DOE radioactivity-levels-in-settleable-solids requirement.

Sediment

Description of Surveillance Program

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.

Sediment samples were collected at eight Savannah River and 19 onsite stream locations in 2009.

Surveillance Results Summary (Table)

Cesium-137 was the only manmade gamma-emitting radionuclide observed in river and stream sediments in 2009. The highest cesium-137 concentration in streams, 85.40 pCi/g, was detected in sediment from R-Canal; the lowest levels were below detection at six locations. The highest level from the river, 1.50 pCi/g, was at River Mile 150.2; the lowest levels were below detection at two 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 swamp areas along the river.

Strontium-89,90 was above the MDC in sediment at seven stream locations in 2009. The maximum detected value was 27.60 pCi/g at the FM3–A Below F-Area Effluent location.

Plutonium-238 was detected in sediment during 2009 at 14 stream locations and five river locations. The results ranged from a maximum of 0.30 pCi/g at FM–2A at Road 4 to below detection at several locations. Plutonium-239 was detected in sediment at 11 stream and no river locations. The maximum value was 0.08—at FM–A7A. Uranium-234, uranium-235, and uranium-238 were detected at most locations.

The distribution and concentration of radionuclides in river sediment during 2009 were similar to those of previous years.

Concentrations of all isotopes generally were higher in streams than in the river. As indicated in the earlier discussion of cesium-137, this is to be expected. 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.

Grassy Vegetation

Description of Surveillance Program

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 to help validate the dose models used by SRS. Bermuda grass is preferred because of its importance as a pasture grass for dairy herds.

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
- all air sampling locations

Surveillance Results Summary (Table)

Radionuclides in the grassy vegetation samples collected in 2009 were detected as follows:

- tritium at three locations (one onsite, two perimeter)
- cesium-137 at six locations (perimeter)
- strontium-89,90 at all but two locations (one onsite and the 100-mile-radius)
- uranium-234 at all 17 locations
- uranium-235 at three locations (one onsite, one perimeter, and one offsite)
- uranium-238 at all 17 locations
- plutonium-238 at three locations (one onsite and two perimeter)
- plutonium-239 at two locations (one onsite and one perimeter
- americium-241 at three locations (one onsite and two perimeter)
- curium-244 one location (offsite)
- gross beta at all 17 locations
- gross alpha at one location (perimeter)

Overall results show a slight increase in radionuclide concentrations from the past several years, but remain consistent with historical results.

Savannah River Swamp Surveys

Description of Surveillance Program

The Creek Plantation, a privately owned land area located along the Savannah River, borders part of the southern boundary of SRS. In the 1960s, an area of the Savannah River Swamp on Creek Plantation—specifically, the area between Steel Creek Landing and Little Hell Landing—was contaminated by SRS operations. During high river levels, water from Steel Creek flowed along the lowlands comprising the swamp, resulting in the deposition of radioactive material. SRS studies estimated that a total of approximately 25 Ci of cesium-137 and 1 Ci of cobalt-60 were deposited in the swamp.

Comprehensive and cursory surveys of the swamp have been conducted periodically since 1974. These surveys measure radioactivity levels to determine changes in the amount and/or distribution of radioactivity in the swamp. A series of 10 sampling trails—ranging from 240 to 3,200 feet in length—was established through the swamp. Fifty-four monitoring locations were designated on the trails to allow for continued monitoring at a consistent set of locations. [Fledderman, 2007]

The 2009 survey was designated as a cursory survey, requiring limited media sampling and analysis. Cursory surveys provide assurance that conditions observed during the more detailed comprehensive surveys have not changed significantly. A comprehensive survey requiring extensive media sampling and analyses was conducted in 2007 and is planned again for 2012.

Surveillance Results Summary (Table)

As anticipated, based on source term information and historical survey results, cesium-137 was the primary manmade radionuclide detected in the 2009 survey. Cesium-137 was detected in all 40 soil samples while no cobalt-60 was detected in any of these samples. Cesium-137 concentrations varied from a minimum of 0.22 pCi/g to a maximum of 49.90 pCi/g. These levels are comparable with those from previous surveys. Examination of the 10

shallow core samples showed that in general, higher concentrations of cesium-137 were observed in the shallow depths. Increased activity at shallower depths was observed as far away as trail 10, while higher concentrations were present on trails 1, 4, 5, 6, and 9 (see Environmental Data/Maps section on accompanying CD/website). Stronium-89,90 was detected in 10 of the 40 soil samples.

Cesium-137 was detected in eight of the 10 vegetation samples while no cobalt-60 was detected in any of these samples. Detectable concentrations varied from a minimum of 0.38 pCi/g to a maximum of 7.60 pCi/g. These levels are comparable with results of previous surveys. Higher concentrations generally were observed on trails 1, 4, 5, and 7, which correlates well with the Cs-137 concentrations in soil on these trails. Strontium-89,90 was detected in eight of the 10 vegetation samples.

TLD sets were placed at all 54 monitoring sites in 2009 to determine ambient gamma exposure rates, and all were retrieved from the swamp. The exposure time varied from 55 to 62 days. The gamma exposure rate ranged from 0.20 to 0.55 mrem/day, which is consistent with the range observed historically. The highest exposure rates were measured on trails 1, 4, 5, and 9. This follows the trends observed in previous surveys, and correlates well with the soil cesium-137 concentration results in this survey.

Nonradiological Surveillance

Air

SRS does not conduct onsite surveillance for nonradiological ambient air quality. However, to ensure compliance with SCDHEC air quality regulations and standards, SRNL most recently conducted air dispersion modeling for all site sources of criteria pollutants and toxic air pollutants in 2001. This modeling indicated that all SRS sources were in compliance with air quality regulations and standards. Since that time, additional modeling conducted for new sources of criteria pollutants and toxic air pollutants has demonstrated continued compliance by the site with current applicable 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.

SRNL sponsors a monitoring and collection station in support of the National Mercury Deposition Network of the National Atmospheric Deposition Program (NADP). This network provides data on the geographic distributions and trends of mercury in precipitation. It is the only network providing a long-term record of mercury concentrations in North American precipitation. All monitoring sites follow standard procedures and have uniform precipitation collectors and gauges. In 2008 (the last year for which data is available), the SRNL monitoring station (SC03) was one of 100 sites that satisfied NADP completeness criteria for national mapping of total mercury concentration and wet deposition. Data from this station indicated that the average (volume weighted) concentration of total mercury in precipitation in 2008 was 9.3 ng/L and the wet deposition rate was 9.5 µg/m^2. Data from 2009 will not be available until the fall of 2010. Additional information on this network is accessible via the following link: http://nadp.sws.uiuc.edu/mdn/.

Surface Water

SRS streams and the Savannah River are classified by SCDHEC as “Freshwaters,” which 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”) of this report provides some of the specific guidelines used in water quality surveillance, but because some of these guidelines are not quantifiable, they are not tracked at SRS.

Surveillance Results Summary (Table)

Water quality parameters were measured at all 16 locations, and metals were detected in at least one sample at each location. No samples had detectable pesticides/herbicides in 2009. These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the river.

Drinking Water

Most of the drinking water at SRS is supplied by three systems that have treatment plants in A-Area, D-Area, and K-Area. The site also has 14 small drinking water facilities, each of which serves populations of fewer than 25 persons.

Surveillance Results Summary

All samples collected from SRS drinking water systems during 2009 were in compliance with SCDHEC and EPA water quality standards. Additional information is provided in the Safe Drinking Water Act section of chapter 3, "Environmental Compliance."

Sediment

The nonradiological sediment surveillance program provides a method to determine the deposition and accumulation of nonradiological contaminants in stream systems. Sample preparation prior to analysis was changed in 2007 from an extraction (toxicity characteristic leaching procedure, or TCLP) to a total sample digestion.

Surveillance Results Summary (Table)

In 2009, as in the previous 5 years, no pesticides or herbicides were found to be above the quantitation limits in sediment samples. Metals analyses results for 2009 also were comparable to those of the previous 5 years.

Fish

EM personnel analyze the flesh of fish caught from the Savannah and Edisto Rivers to determine concentrations of mercury in the fish. In 2008, the addition of metals (arsenic, cadmium, manganese, and antimony) to the analytical suite was completed. The fish analyzed represent the most common edible species of fish in the CSRA (freshwater) and at the mouth of the Savannah River (saltwater).

Surveillance Results Summary (Table)

In 2009, mercury analyses were performed on 513 fish from the Savannah River and 21 from the Edisto River at West Bank Landing. Concentrations of mercury generally were slightly lower than those observed in 2008. The highest concentrations were found in the Savannah River—in bass at the Highway 301 bridge area (1.254 µg/g), in catfish at Upper Three Runs Creek Mouth (0.944 µg/g), and in bream at the Augusta Lock and Dam (0.722 µg/g). The highest concentrations found at West Bank Landing were 0.889 µg/g in bass, 0.929 µg/g in bream, and 0.897 µg/g in catfish.

Arsenic was detected in 16 samples, with the highest concentration in mullet (1.05 µg/g) at RM–08 of the Savannah River. Cadmium was below detection in all samples. Manganese was detected at all 10 locations, with the highest concentration in catfish (5.57 µg/g) at Upper Three Runs Creek Mouth. Antimony was detected in 100 samples, with the highest concentration in bass (0.760µg/g) at the mouth of Steel Creek.

River Water Quality Surveys

Description of Surveys

Academy of Natural Sciences (ANS) personnel conducted biological and water quality surveys of the Savannah River from 1951 through 2003, when EM assumed this responsibility. The surveys were 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 geographically associated with the site
- patterns of change over seasons or years that indicate improving or deteriorating conditions

EM conducted macroinvertebrate sampling during the spring and fall of 2009, and diatom sampling was conducted monthly. The diatom slides were sent to ANS for archiving. No adverse biological impacts have been identified in the Savannah River diatom communities.

Macroinvertebrates collected from river traps during 2008 were similar in species diversity to those documented in surveys during the 1990s. An overall decrease in total populations was observed that likely is associated with low flow in the river and incipient drought conditions. No evidence of adverse biological impacts was found in the observed macroinvertebrate communities. Collections from 2009 will be sorted and archived during 2010.