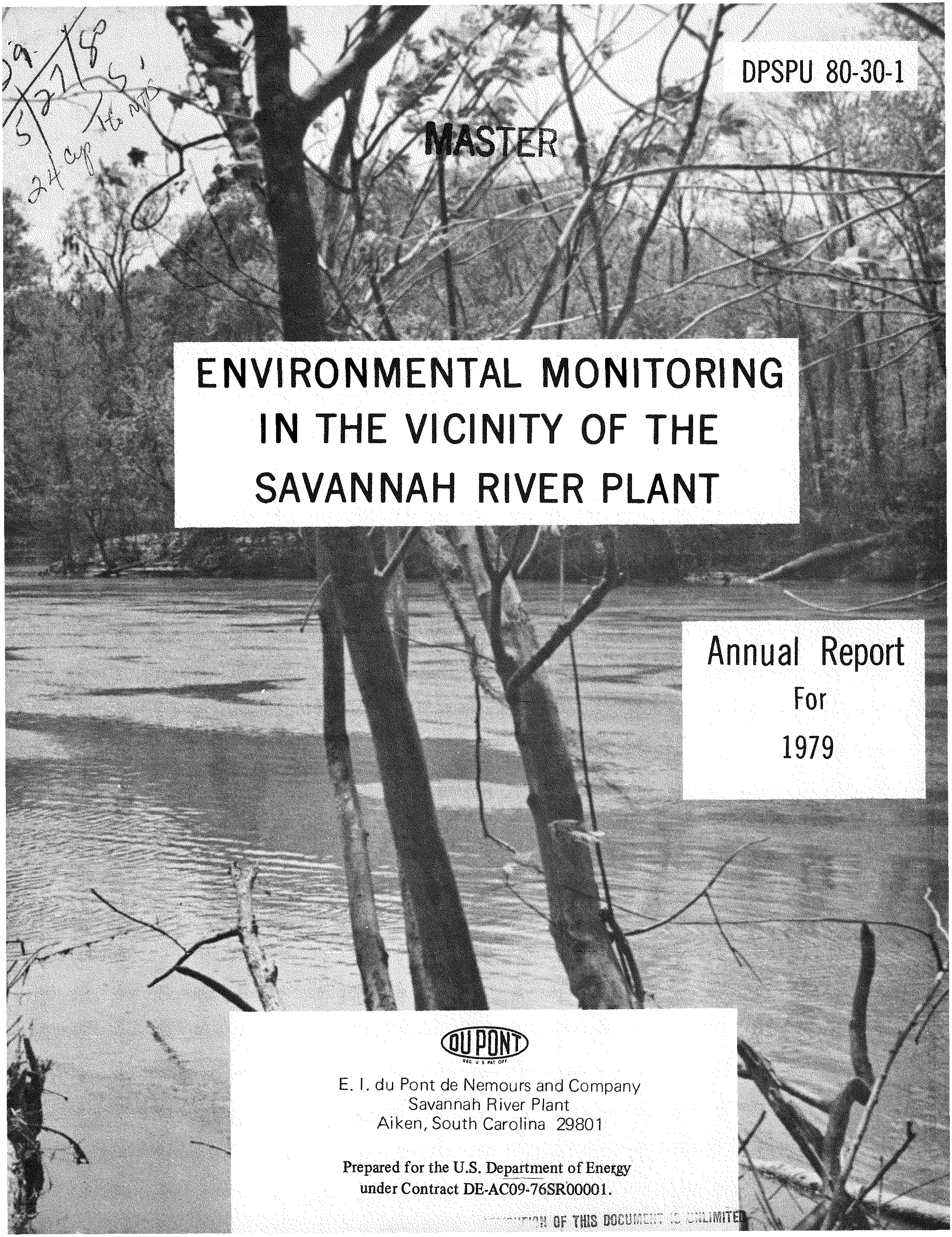

DPSPU 80-30-1

ENVIRONMENTAL MONITORING IN THE VICINITY OF THE SAVANNAH RIVER PLANT

Annual Report For 1979

DU PONT

E. I. du Pont de Nemours and Company
Savannah River Plant
Aiken, South Carolina 29801

Prepared for the U.S. Department of Energy
under Contract DE-AC09-76SR00001.

PREFIXES FOR UNITS OF MEASURE

	PREFIXES	SYMBOLS	NAMES
$0.1 = 10^{-1}$	deci	d	tenth
$0.01 = 10^{-2}$	centi	c	hundredth
$0.001 = 10^{-3}$	milli	m	thousandth
$0.000\ 001 = 10^{-6}$	micro	μ	millionth
$0.000\ 000\ 001 = 10^{-9}$	nano (năn′ oh)	n	billionth
$0.000\ 000\ 000\ 001 = 10^{-12}$	pico (pee′ ko)	p	trillionth
$0.000\ 000\ 000\ 000\ 001 = 10^{-15}$	femto	f	quadrillionth
$0.000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$	atto	a	quintillionth

CONVERSION TABLE

Multiply	By	To Obtain	Multiply	By	To Obtain
in.	2.54	cm	cm	0.394	in.
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
liq qt - U.S.	0.946	ℓ	ℓ	1.057	liq qt - U.S.
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
mCi/mi^2	0.386	mCi/km^2 (nCi/m^2)	mCi/km^2	2.59	mCi/mi^2
d/m	0.450	pCi	pCi	2.22	d/m
nCi	1×10^3	pCi	pCi	1×10^{-3}	nCi
d/m/ℓ	0.45×10^{-9}	μCi/cc	μCi/cc	2.22×10^9	d/m/ℓ
$d/m/ft^2$	0.01256	mCi/mi^2	mCi/mi^2	79.6	$d/m/ft^2$
pCi/ℓ (water)	10^{-9}	μCi/mℓ (water)	μCi/mℓ (water)	10^9	pCi/ℓ (water)
pCi/m^3 (air)	10^{-12}	μCi/cc (air)	μCi/cc (air)	10^{12}	pCi/m^3 (air)
mCi/km^2	1	nCi/m^2	nCi/m^2	1	mCi/km^2

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SUMMARY

Ensuring the radiation safety of the public in the vicinty of the Savannah River Plant (SRP) was a foremost consideration in the design of the plant and has continued to be a primary objective during 26 years of SRP operations.

An extensive surveillance program has been continuously maintained since 1951 (before SRP startup) to determine the concentrations of radionuclides in a 1,200-square-mile area in the environs of the plant and the radiation exposure of the population resulting from SRP operations. The results of this monitoring program (one of the largest of its type in the world) are reported annually to the public. This document summarizes the 1979 results.

The radiation dose at the plant perimeter or the population dose in the region from SRP operations is very small relative to the dose received from naturally occurring radiation. The annual average dose in 1979 from atmospheric releases of radioactive materials from SRP was 0.71 millirem (mrem) at the plant perimeter (approximately 1% of natural background). The maximum dose at the plant perimeter was 0.97 mrem, which is 0.2% of the Department of Energy limit for offsite exposures. The total radiation exposure at the plant perimeter from SRP releases and natural background radiation (92 mrems) was substantially less than the exposure of a person living in Columbia, SC (101 mrems); or Atlanta, GA (124 mrems). These differences are due to variation in natural radiation. The population dose to people living within 80 km (50 mi) of the center of SRP (population: 465,000) was 100 man-rems. During 1979, this same population received a radiation dose of 54,400 man-rems from natural radiation and an additional dose of 47,000 man-rems from medical x-rays. An individual consuming river water downstream from SRP would receive a maximum calculated dose of 0.21 mrem.

Air and water are the major dispersal media for radioactive emissions. Samples representing most segments of the environment that may conceivably be affected by these emissions were monitored to ensure a safe environment. Releases of radioactivity from SRP had very small effect on living plants and animals and were too minute to be detectable, and with a few exceptions, concentrations outside the plant boundary were too low to distinguish from the natural radioactive background and continuing worldwide fallout from nuclear weapons tests.

The average particulate beta concentration in air at the plant perimeter (approximately 0.02 pCi/m^3 -- essentially the same as 25 miles away) represented 0.02% of the concentration guide (CG, given in chapter 0524 of the DOE Manual). The average concentration of tritium at the plant perimeter (55 pCi/m^3 -- slightly higher than at more distant locations) was 0.03% of the CG.

Tritium, ^{137}Cs, and ^{90}Sr were the only radionuclides of plant origin detectable in Savannah River water by routine analyses. The tritium concentration in river water immediately downstream of the plant (3.1 pCi/ml, including 0.4 pCi/ml background river contribution) represented the highest CG percentage (0.10) of the three radionuclides measured in river water. Special research programs using ultra-low-level techniques may detect trace quantities of other radionuclides of plant origin. Radioactive materials in river fish downstream from the plant were less than the sensitivity of analyses (approx 0.3 pCi/g of ^{137}Cs).

Analyses of plant perimeter soil samples (0.5 cm deep) showed deposition of ^{137}Cs (54 mCi/km^2) and ^{239}Pu (1.2 mCi/km^2) within the range normally found in global fallout. ^{238}Pu in all soil samples was near the sensitivity of the analysis (approx 0.1 mCi/km^2).

Monitoring in a 5-square-mile swamp bordering the Savannah River immediately below the SRP boundary detected radioactivity (primarily ^{137}Cs) above the natural background levels. Only one-third of the swamp, which is largely uninhabited and inaccessible, is affected. Neither restrictions on use of the swamp nor remedial actions are considered warranted. Radiation measurements with thermoluminescent dosimeters showed levels similar to those observed for the past several years.

Atmospheric emissions of SO_2, fly ash, and smoke were within applicable standards.

Various water quality analyses of nonradioactive materials in river water indicated that Savannah River water was not adversely affected by SRP operations. This was substantiated by independent surveys of the health of Savannah River biota by the Academy of Natural Sciences of Philadelphia and pesticide analyses of river water and sediment by the U.S. Geological Survey Water Quality Laboratory, Atlanta, GA.

INTRODUCTION

The Savannah River Plant occupies an area of about 300 square miles along the Savannah River, principally in Aiken and Barnwell Counties of South Carolina. Most of the plant's environs are rural. Population density of nearby counties ranges from 10 to 400 people per square mile with the largest concentration in Augusta, GA, and its suburbs, which have a population approaching 200,000. The countryside is predominantly forested. Farming is diversified; the main crops being cotton, soybeans, corn, and small grains. Production of beef cattle continues to expand.

The climate is mild, with an average frost-free season of approximately 246 days. Annual rainfall averages about 45 in. and is fairly evenly distributed throughout the year. The Savannah River plantsite and surrounding area are described in more detail in DP-1323, Savannah River Plantsite [9].

Exclusion of the public from the plantsite creates a refuge for many animal species, both terrestial and aquatic. Growth of the deer population is limited (to prevent range deterioration and to minimize deer/vehicle accidents) by public hunting which was initiated in 1965. A thousand or more deer (1,079 in 1979) have been taken annually during controlled hunts.

In 1972, the SRP site was designated as the nation's first National Environmental Research Park (NERP). This designation opened the site to investigators from universities and other research organizations who wish to design and conduct research studies of man's impact on the environment. Over 25 research projects were conducted at the SRP site under the NERP program in 1979. These projects were in addition to the DOE-funded environmental research programs normally conducted at the site.

Since 1952, the U.S. Forest Service has planted over 100 million pine seedlings on over 80,000 acres of the plantsite. Significant quantities of pine and pulpwood, along with some hardwood sawtimber, have been harvested during this same period.

SRP's primary function is the production of plutonium, tritium, and other special nuclear materials for the national defense, for other governmental uses, and for some civilian purposes. Operating facilities include three nuclear reactors, a fuel and target fabrication plant, two chemical separations plants, a heavy water production plant, and the Savannah River Laboratory (a process development laboratory to support production operations). The reactors and separations plants are located near the center of the site; the other facilities are located near the periphery.

The reactors are fueled with uranium and moderated and cooled by heavy water which is circulated in a closed system through heat exchangers. Savannah River water and water from Par Pond, a manmade cooling water impoundment covering 2,640 acres, are used only as a secondary coolant in the heat exchangers. Water from the river or Par Pond does not pass directly through the reactors and so is not subject to neutron activation.

Nuclear fuels and targets, together with other reactor components, are manufactured in the fuel and target fabrication facility.

Reactor products are recovered in the fuel separations areas. ^{239}Pu and uranium are separated from each other and from fission products by complex chemical processes. ^{238}Pu is also an important SRP product that is processed in the separations areas. These areas also have facilities for the purification and packaging of tritium and for storage of fission product wastes.

The heavy water production plant separates and concentrates heavy water from the raw water of the Savannah River. The basic process for extraction of heavy water is chemical exchange with hydrogen sulfide gas at about 300 psig. Heavy water is not radioactive, but a portion of the heavy water production facility is used for the reconcentration of moderator from the reactors and this heavy water contains some tritium.

SRP production areas and effluent streams are shown in figures 1, 1A, 1B, 1C, and 1D.

APPLICABLE STANDARDS

The standards applicable to concentration of radionuclides in air and water at SRP are the Concentration Guides (CG's) given in chapter 0524 of the DOE Manual, and are derived for the most part from the whole body annual dose standard of 500 mrems to individuals at points of maximum probable exposure [1]. These CG's are based on recommendations of the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP), and the Federal Radiation Council (the latter is now a part of the Environmental Protection Agency). Concentration guides are summarized in table 1. For whole-body dose calculations from ingestion of tritium, ICRP values for translating intake to dose are used [2]. Specific guidance of the Federal Radiation Council (Report 7) is used in translation of a given intake of ^{137}Cs to radiation dose [3].

The National Pollutant Discharge Elimination System (NPDES) permit SC 00000175 for SRP, effective November 19, 1976, through November 19, 1981, requires plume temperature monitoring at three locations in the Savannah River. Limitations of maximum plume temperature and the rise above ambient temperature are the same as those in the South Carolina water quality standards.

Chemical and biological quality standards for the Savannah River are the requirements of the State of South Carolina for Class B streams [4] which are: "Waters suitable for domestic supply after complete treatment in accordance with requirements of the South Carolina Board of Health. Suitable also for propagation of fish, industrial and agricultural uses, and other uses requiring water of lesser quality." Specifications are summarized in table 2.

Principal nonradioactive releases to the atmosphere are sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and fly ash. South Carolina emission standards [5] and South Carolina [5] and Georgia [6] ambient air quality standards are summarized in table 3.

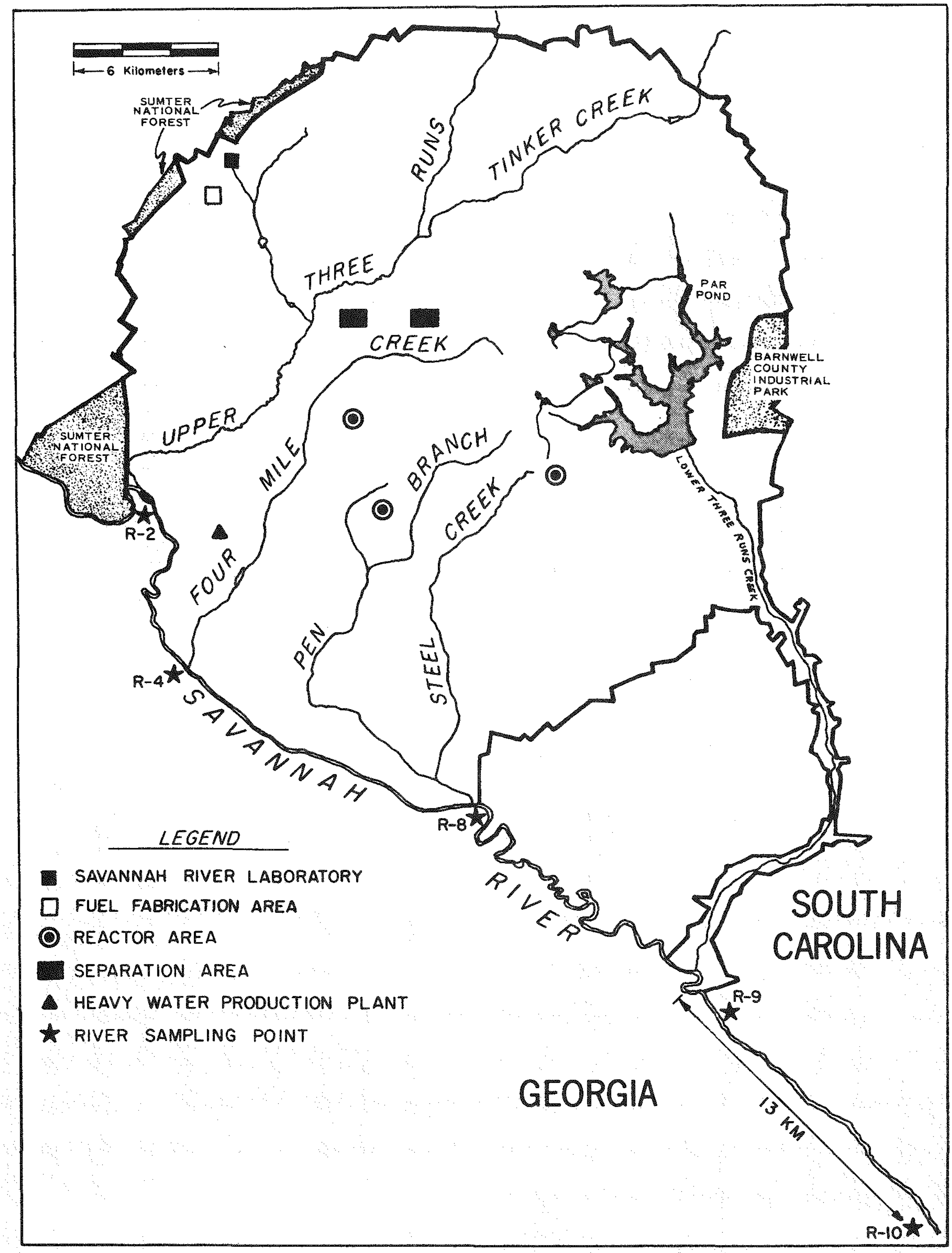

FIGURE 1. SRP PRODUCTION AREAS AND EFFLUENT STREAMS

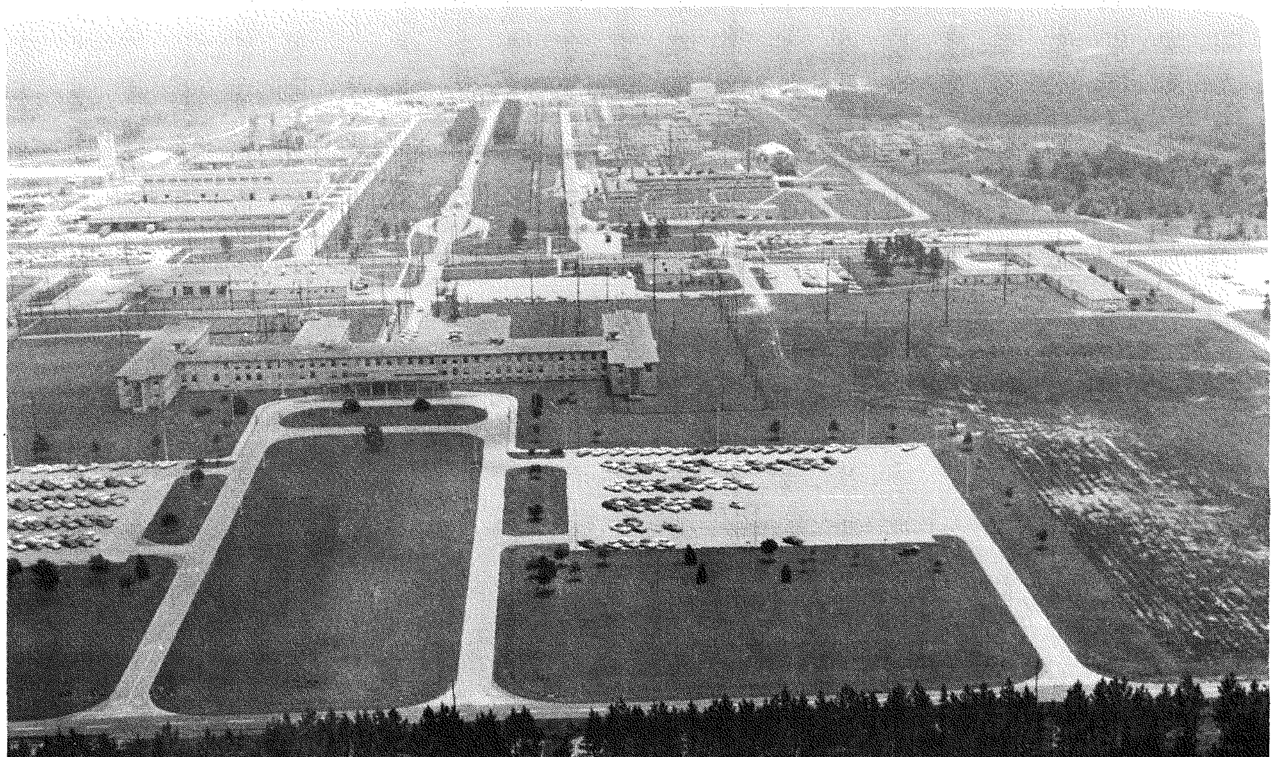

FIGURE 1A. ADMINISTRATION AREA AND FUEL AND TARGET FABRICATION PLANT

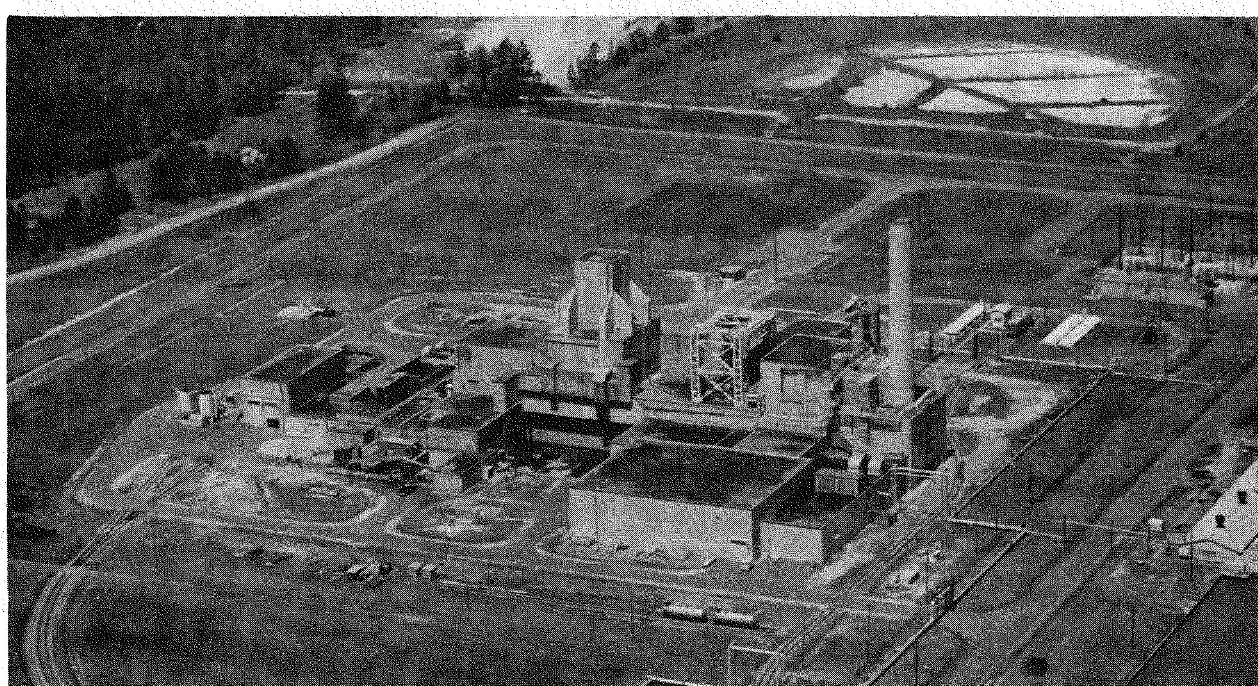

FIGURE 1B. REACTOR PLANT

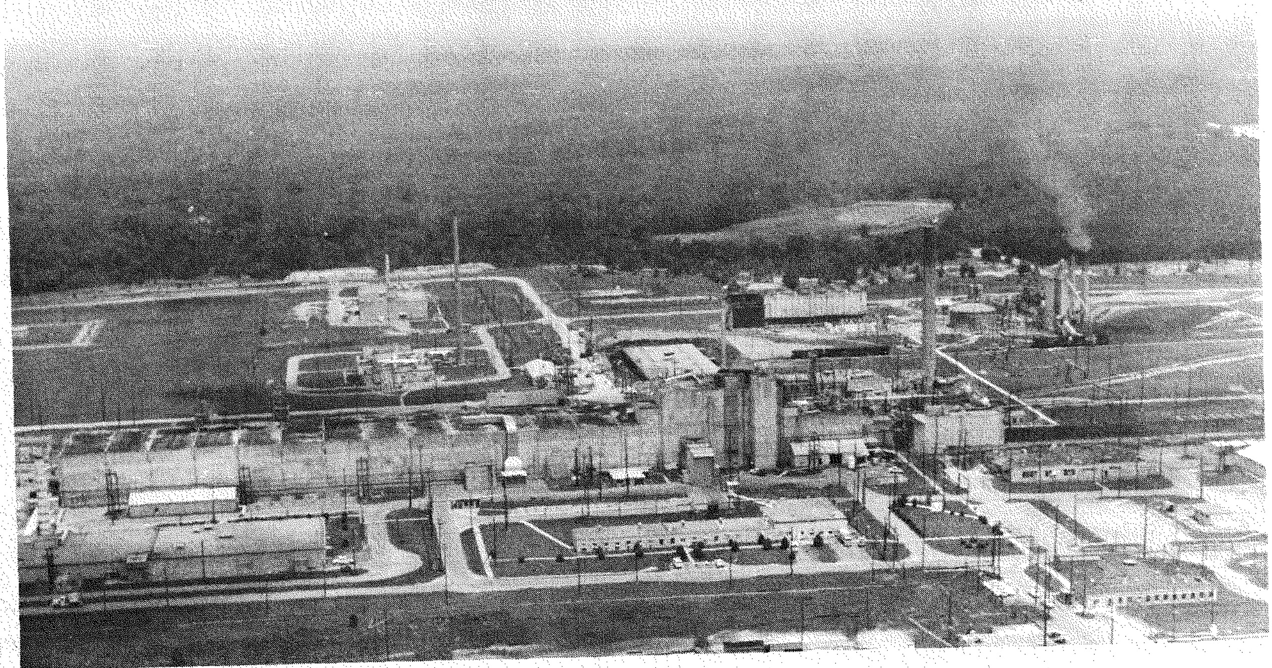

FIGURE 1C. CHEMICAL SEPARATIONS PLANT

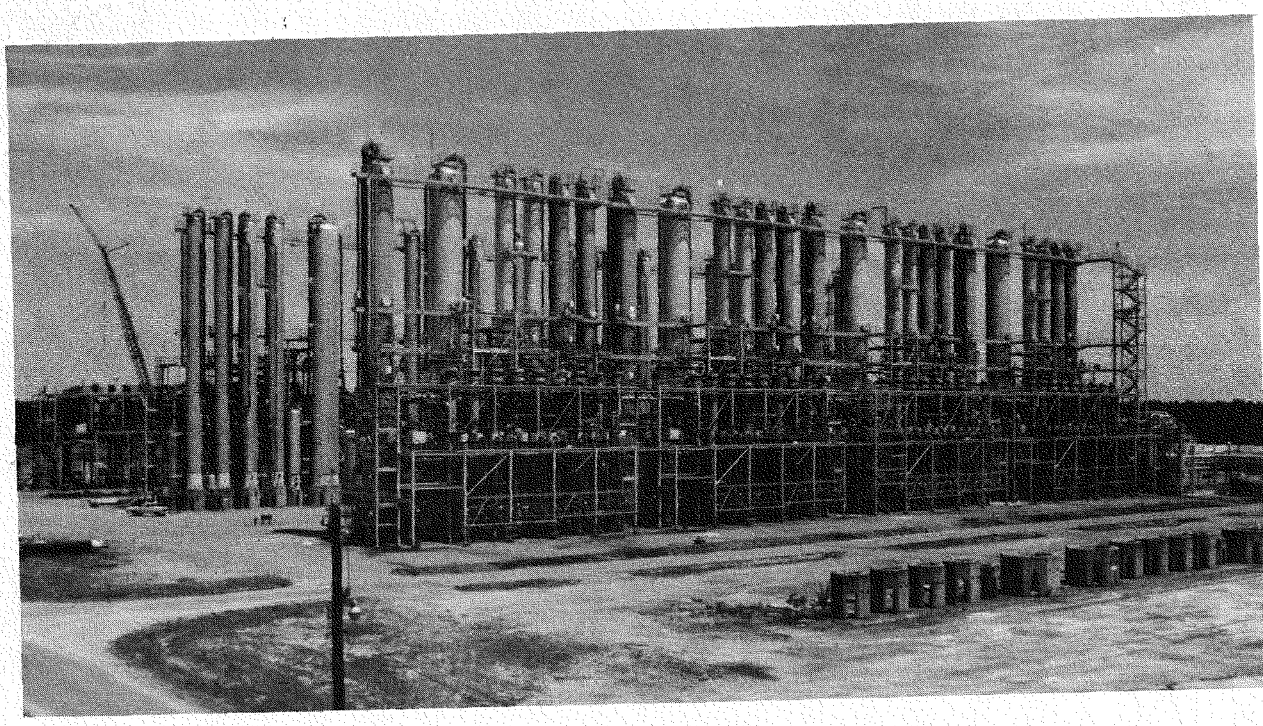

FIGURE 1D. HEAVY WATER PRODUCTION PLANT

TABLE 1
CONCENTRATION GUIDES (CG)

	In Water, pCi/l	In Air, pCi/m^3
Alpha	30	0.02
Nonvolatile beta	3,000	100
Tritium	3,000,000	200,000
^{239}Np	100,000	20,000
^{131}I	300	100
^{140}Ba-^{140}La	20,000	1,000
^{137}Cs	20,000	500
^{144}Ce	10,000	200
$^{103,106}Ru$	10,000	200
^{95}Zr-^{95}Nb	60,000	1,000
^{65}Zn	100,000	2,000
^{60}Co	30,000	300
^{89}Sr	3,000	300
^{90}Sr	300	30
^{54}Mn	100,000	1,000
^{51}Cr	2,000,000	80,000
^{35}S	60,000	9,000

TABLE 2
SOUTH CAROLINA WATER QUALITY STANDARDS

1. Fecal Coliform. Not to exceed a log mean of 1,000/100 ml based on five consecutive samples during any 30-day period; not to exceed 2,000/100 ml in more than 20% of the samples examined during such period (not applicable during or following periods of rainfall).
2. pH. Range between 6.0 and 8.5, except that swamp waters may range from pH 5.0 to 8.5.
3. Dissolved Oxygen. Daily average not less than 5.0 mg per liter with a low of 4.0 mg per liter, except that swamp waters may have an average of 4 mg per liter.
4. Temperature. Maximum temperature increase after mixing: 2.8°C (5°F). Maximum temperature after mixing: 32.2°C (90°F).
5. Phenolic Compounds. Not greater than 1 μg per liter unless caused by natural conditions.

TABLE 3
SOUTH CAROLINA EMISSION STANDARDS

Fly ash -- 0.6 lb/10^{6}m Btu heat input
SO^2 -- 3.5 lb/10^6 Btu heat input

SOUTH CAROLINA AND GEORGIA AMBIENT AIR STANDARDS
FOR PARTICULATES, SO_2, NO_x

	South Carolina	Georgia
Suspended particulates, μg/m^3		
24 hours	250	150
Annual geometric mean	60	60
SO_2, μg/m^3		
1 hour	a	715
3 hours	1,300	a
24 hours	365	229
Annual	80	43
NO_x, μg/m^3		
24 hours	a	300
Annual	100	100

[a] No standard.

SAMPLE COLLECTION AND ANALYTICAL PROCEDURES

Air Collection

Particulate airborne radioactivity is sampled continuously by drawing air through 2-in.-dia high-efficiency paper filters that are collected weekly. The air is sampled at about 7 x 10^4 ml/min (2.5 cu ft/min) with an auxiliary running-time meter and air flow meter at each station providing data on the volume sampled. A cartridge of activated coconut charcoal for collection of gaseous radioiodine is located downline from each paper filter. Moisture is concentrated from the atmosphere for determination of its tritium oxide content by pumping air through a silica gel column at a continuous rate of 100 ml/min (operated off the manifold of each vacuum pump). The column contains nonindicating silica gel; a backup column of indicating silica gel is used for evidence of any saturation of the desiccant. The concentration of tritium oxide in the air is calculated from the concentration in atmospheric moisture and the absolute humidity.

Deposition rates of radioactive materials are also determined by monthly analyses of rainwater ion exchange columns (fallout collectors). Fallout collection pans (2 x 2 ft) are located at offplant monitoring stations and at stations around the plant perimeter.

Rainwater flows by gravity from the collection pan through an ion exchange column (cation and anion resin). The columns are analyzed directly by gamma spectrometry for gamma emitters. Alpha and beta emitters are removed from the column with acid and analyzed by chemical methods. The rainwater passing through the ion exchange column is collected for weekly tritium analyses by liquid scintillation counting.

Alpha-, Beta-, and Gamma-Emitting Radionuclides are measured by a direct count of the paper filter; alpha on a ZnS scintillation counter, beta on a gas flow proportional counter, and gamma on a 9- x 9-in. NaI(Tl) well detector.

Stronium-89, -90 collected on filter papers is leached with 8N nitric acid, precipitated with fuming nitric acid, dissolved in 8N nitric acid, scavenged first with ferric hydroxide and then with barium chromate, precipitated as an oxalate and transferred to a stainless steel planchet (holder) for beta count on a gas flow proportional counter.

Uranium and Plutonium are leached from the filter paper in 8N nitric acid, dried, dissolved in 8N hydrochloric acid, and extracted into triisooctylamine (TIOA) by liquid ion exchange. The alpha emitters are stripped from the TIOA organic layer with 0.1N hydrochloric acid and evaporated to dryness. The residue is dissolved in 4N nitric acid and transferred to a stainless steel planchet for count on a ZnS alpha scintillation counter.

Iodine-131 is measured by a direct count of the charcoal canister using a 9- x 9-in. NaI(Tl) well detector.

Tritium in atmospheric moisture and rainwater samples are collected as described in the sample collection section. Tritium is determined by liquid scintillation counting of a distilled aliquot of each sample.

Plutonium is leached from the filter paper with 8N hydrochloric and 0.3N hydrofluoric acids, evaporated to dryness, dissolved in 7.2N nitric acid, and passed through an anion exchange resin ("Dowex" 1-X4). The resin column is eluted with 0.35N hydrochloric and 0.01N hydrofluoric acids and the plutonium in the eluate is electrodeposited on a platinum disk for alpha spectrometric analysis on silicon surface barrier detectors.

Water Collection

Continuous sampling of the Savannah River is accomplished with a sampler consisting of a "Plexiglas" water wheel suspended on two pontoons. As the water wheel is turned by flowing water, a small cup (or cups) on one paddle picks up a sample of water and deposits it into a trough. The sampled water flows by gravity from the trough through connecting tubing into a large polyethylene jug connected to the sampler. The sampled water (up to 6 gal) is collected weekly at river locations above and below SRP. Increased analytical sensitivity for water samples (containing insufficient radioactivity for direct processing) is achieved through concentration of radionuclides by ion exchange. The ion exchange column is counted directly for gamma-emitting radionuclides.

Alpha- and Beta-Emitting Radionuclides are measured by direct count of dried residue (in planchet) the same as for air.

Gamma-Emitting Radionuclides are measured by passing 25 liters of water through a cation-anion resin column and a direct count of the column using a 9- x 9-in. NaI(Tl) well detector. The resin column is then eluted with nitric acid; first with 2N nitric acid and then with 14N nitric acid for subsequent stronium analysis.

Strontium-90 is recovered from an aliquot of the above eluate. The acid is evaporated to dryness and dissolved in 0.08N hydrochloric acid. ^{90}Y is stripped from the strontium by liquid ion exchange using di-2-ethylhexyl phosphoric acid. Equilibrium of ^{90}Y is allowed over a 15-day period and then the short-lived ^{90}Y daughter is stripped once again and transferred to a stainless steel planchet and counted in a low-background gas flow beta proportional counter.

Uranium/Plutonium and Plutonium. After evaporation, both analyses are the same as for air filters.

Strontium-89, -90 analysis of an aliquot of the above eluate is the same as for air.

Tritium is measured in distilled water samples with a liquid scintillation spectrometer.

Milk

Strontium-90 is removed by a slurry of the whole milk with a cation resin ("Dowex" 50 W-X8). The resin is leached with 8N nitric acid and then analyzed the same as for water.

Cesium-137 is removed by passing approximately 2 liters of whole milk through a potassium-cobalt-ferro-cyanide resin column and a direct count of the column using a 9- x 9-in. NaI(Tl) well detector.

Iodine-131 is the same as for ^{137}Cs except an anion resin ("Dowex" 1-X8) column is used.

Strontium-90. Bone is ashed in a furnace at 700 to 900°C, leached with 8N nitric acid, and evaporated to dryness. Rhodizonic acid is used to separate calcium from strontium. The strontium is then precipitated with fuming nitric acid, scavenged with ferric hydroxide, precipitated as oxalate, plancheted, and counted.

Food

Uranium and Plutonium analysis is the same as for air after drying, ashing in furnace, and wet ashing with hydrochloric acid.

Strontium-90 analysis is the same as for water after the pretreatment described for uranium and plutonium.

Gamma-Emitting Radionuclides are determined by counting a bottled sample of the hydrochloric acid solution.

Tritium is measured in water obtained by freeze-drying samples and counting in a liquid scintillation counter.

Vegetation

Uranium/Plutonium and Strontium-90 analyses are the same as for food.

Gamma-Emitting Radionuclides are determined by counting dried vegetation in a standard geometry using a 9- x 9-in. NaI(Tl) well detector.

Soil

The technique used for collection and preparation of soil samples generally follows that used by the DOE Environmental Measurements Laboratory (EML) [7].

Plutonium. Dried soil is blended in a Z-blender, pulverized in a hammer mill to size approximately 20 mesh. Ten grams of the soil is then leached with 8N hydrochloric acid, evaporated to dryness, dissolved in 7.2N nitric acid, and passed through an anion exchange resin ("Dowex" 1-X4). The resin column is eluted with 0.35N hydrochloric acid - 0.01N hydrofluoric acid and the plutonium in the eluate is electrodeposited on a platinum disk for alpha spectrometric analysis.

Gamma-Emitting Radionuclides. Approximately 800 g of the pulverized soil is bottled in a 500-ml plastic bottle and counted as described for vegetation.

Strontium-90. 50 g of the pulverized soil is leached with 1N ammonium acetate, evaporated to dryness, dissolved in 0.08N hydrochloric acid, and analyzed the same as water.

Penetrating Radiation Measurements

External radiation is measured with thermoluminescent dosimeters (TLD's) mounted 1 m aboveground. The primary dosimeter is a CaF_2 (dysprosium) crystal (0.63 x 0.63 x 0.09 cm) positioned behind a silver filter to measure dose from photons with energies above 100 keV. LiF TLD's are positioned behind a paper filter to detect the presence of photons with energies below 100 keV. The TLD's are annealed, calibrated, and read by standard procedures (IEEE, Transactions on Nuclear Science, vol NS-21, No. 1, 1977).

ATMOSPHERIC MONITORING -- NONRADIOACTIVE

Atmospheric emissions of SO_2, NO_x, fly ash, and smoke are presently within applicable standards. There are seven coal-fired power plants at SRP which burn a total of about 500,000 tons of coal each year. Sulfur content of the coal averages 1.3%. The South Carolina standard for SO_2 emission is 3.5 lb/10^4 Btu input. Compliance with this standard is determined from analysis of coal received; all monthly average values were within the standard as shown in table 4. Installation of two-stage mechanical dust collectors on all stoker-fired boilers was completed by June 1, 1979.

Section 110 of the Clean Air Act Amendments of 1970 requires each state to establish, as part of its State Implementation Plan, a network to monitor the ambient air quality within that state. South Carolina and Georgia have each implemented air-sampling networks within the respective state. Air quality measurements of the South Carolina Network in the vicinity of SRP for 1978 are summarized in table 5.

TABLE 4

1979 MONTHLY SO_2 EMISSION RATE[a]

Month	lb/10^6 Btu	Month	lb/10^6 Btu
January	2.07	July	1.85
February	2.06	August	1.90
March	2.21	September	1.93
April	1.83	October	1.70
May	1.84	November	1.91
June	2.73	December	1.71

[a] Weighted annual average, 1.98 x 10^6 Btu for all power plants.

TABLE 5

1978 SOUTH CAROLINA AMBIENT

AIR QUALITY MEASUREMENTS, $\mu g/m^3$

	Suspended Particulates				Sulfur Dioxide				Nitrogen Dioxide			
Locations[a]	No. of Obs	24 hr Max	Geom Mean	Exceeds Std GA-SC 60 (yr)	No. of Obs	24 hr Max	Arith Mean	Exceeds Std SC 1,300 (3 hr)	No. of Obs	24 hr Max	Arith Mean	Exceeds Std GA-SC 100 (yr)
South Carolina												
1	48	127	46.8	No	–	–	–	0		–	–	No
2	45	126	46.1	No	51	115	11.9	0	51	58	20.3	No
3	54	204	51.7	No		–	–			–		–

[a] South Carolina locations: (1) Eustis Park School, Aiken; (2) Fire Station, Beach Island (Aiken Co.); and (3) Police Department, North Augusta, SC.

– No measurement.

ATMOSPHERIC MONITORING -- RADIOACTIVE

Concentrations of radioactive materials in the atmosphere are measured by weekly analyses of air filters collected at 13 monitoring stations near the plant perimeter and 12 stations around a circle of about 25 miles from the center of the plant (figure 2). Stations are spaced to permit continuous monitoring within every 30° sector on the plant perimeter and at the 25-mile radius, thereby increasing the probability of detecting a significant release of airborne activity by SRP regardless of wind direction. Deposition rates of radioactive materials at each station were also determined by monthly analyses of rainwater ion exchange columns (fallout collectors). Additional air-monitoring stations at Savannah and Macon, GA, and at Columbia and Greenville, SC (designated 100-mile-radius stations), are so distant from SRP that the effect of SRP operations is negligible; they serve, however, as reference points for determining background (figure 3). This system permits comprehensive surveillance of atmospheric radioactivity and also makes it possible to differentiate between global fallout and SRP releases.

The small amount of particulate beta and alpha activity released to the atmosphere, primarily from the fuel separations areas, is generally obscured in the area surrounding the plant by worldwide fallout. The three location groups (plant perimeter, 25-mile radius, and 100-mile radius) had essentially the same monthly average concentrations. The average particulate beta concentration in air in 1979 was about one-fourth that observed in 1978. The average concentrations of beta activity (0.02 pCi/m^3) and alpha activity (0.0006 pCi/m^3) in air at the plant perimeter are 0.02 and 3.0% of the respective CG's. The alpha activity is essentially the same as in 1978.

Figure 4 shows the influence of weapons test fallout on particulate beta activity in air after testing was resumed in September 1961, and after testing by nonparticipants of the atmospheric test moratorium in late 1962. Some increase occurs each spring as a result of the mixing of the stratosphere with the troposphere. The beta activity for 1973, 1976, and 1979, however, was relatively low and the characteristic spring increase was not evident. During some recent years, the presence of fresh fallout from specific Chinese atmospheric nuclear detonations adds to this worldwide fallout increase which is usually observed during the spring months.

Radioactivity in air, determined from filter analysis and atmospheric moisture analysis of tritium, is shown in table B-1. Tritium, ^{7}Be, and trace concentrations of ^{137}Cs (only in several samples) were the only radionuclides detectable in air. The ^{137}Cs was of global fallout origin and ^{7}Be, the major gamma-emitting component, is a naturally occurring radionuclide formed by interaction of cosmic rays with oxygen and nitrogen in the upper atmosphere. Plant-released tritium was detectable at offplant monitoring stations. The maximum annual tritium oxide concentration at a plant perimeter station was 0.14% of the CG. The concentration in air at all plant perimeter stations averaged 55 pCi/m^3 (0.03% CG) compared with 20 pCi/m^3 at 25-mile-radius stations and 10 pCi/m^3 at 100-mile-radius stations.

Because plant releases of airborne beta or gamma activity were not detectable at the plant perimeter, concentrations were calculated by standard meteorological dispersion equations [8] and normalized to agree with measured dispersion of tritium. The calculated concentrations are listed in table 13, along with the annual releases and dose estimates.

After being measured for particulate alpha, beta, and gamma activities, weekly filters from each of the location groups (plant perimeter, 25- and 100-mile-radius stations) are combined and dissolved to produce three composite monthly samples for isotopic plutonium and gamma analyses. Plutonium is separated by ion exchange, electrodeposited, and counted for alpha emitters. ^{238}Pu and ^{239}Pu concentrations in air are listed in table B-1.

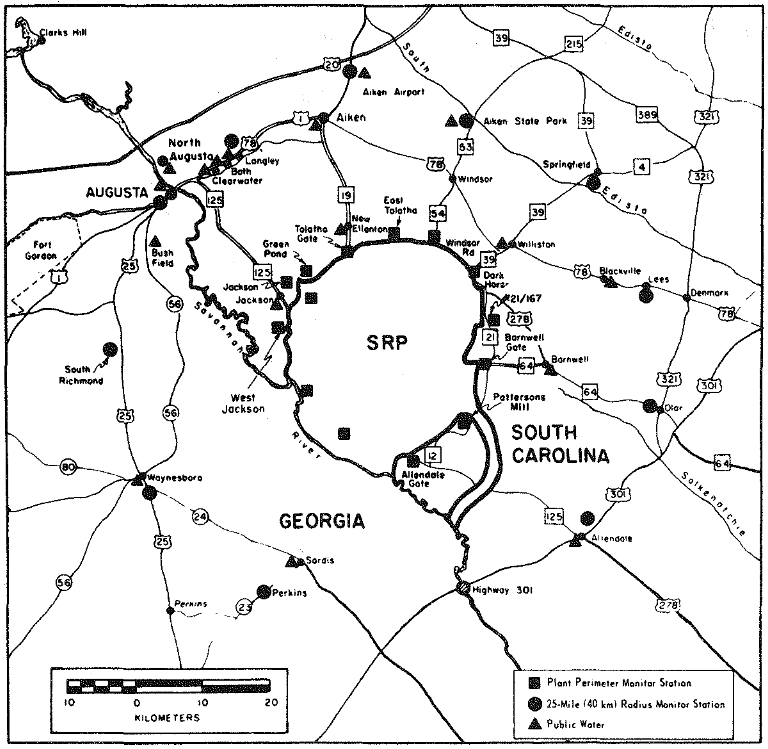

FIGURE 2. CONTINUOUS AIR MONITORING STATIONS AND PUBLIC WATER SAMPLE LOCATIONS

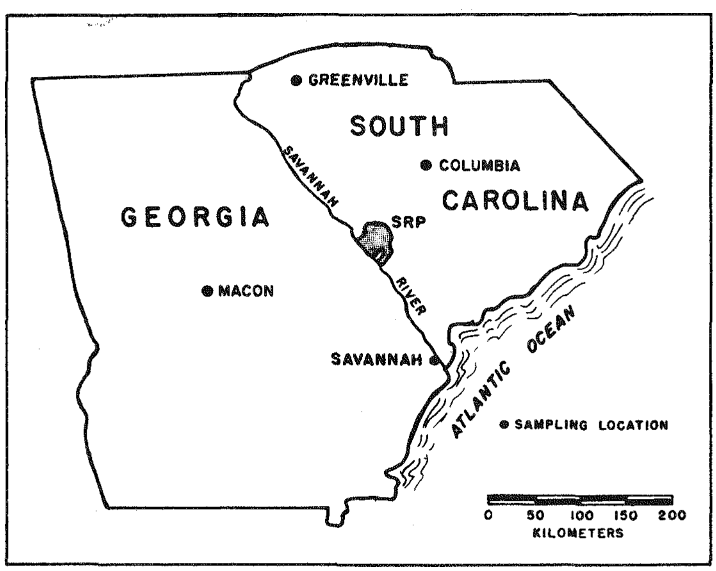

FIGURE 3. DISTANT AIR MONITORING STATIONS

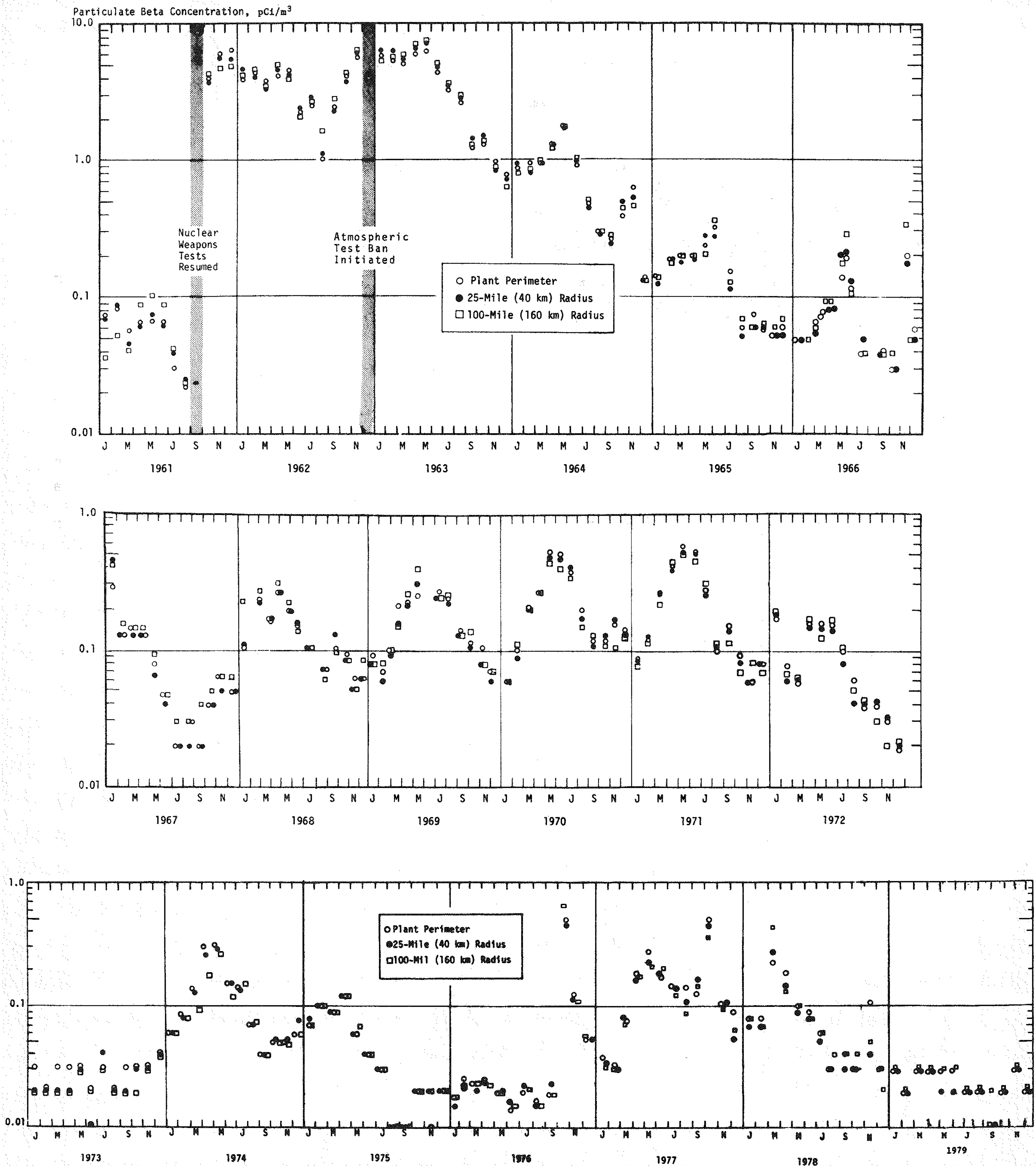

FIGURE 4. ATMOSPHERIC RADIOACTIVITY

In 1979, plutonium in air decreased several fold, as did the beta particulate activity. The average concentrations of ^{239}Pu were 8.1 aCi/m^3 at the plant perimeter, 8.0 aCi/m^3 at the 25-mile-radius stations, and 7.6 aCi/m^3 at the 100-mile-radius stations. Respective 1978 concentrations of ^{239}Pu in air were 42, 44, and 52 aCi/m^3. The 1979 ^{238}Pu concentrations were 1.7 aCi/m^3 at the plant perimeter, 1.3 aCi/m^3 at the 25-mile-radius stations, and 1.1 aCi/m^3 at the 100-mile-radius stations. Respective 1978 ^{238}Pu concentrations were 4.5, 3.6, and 4.0 aCi/m^3.

Deposition of plutonium was also determined from rainwater ion exchange columns (fallout collectors). Monthly samples were composited according to two groups: plant perimeter and 25-mile-radius stations (table B-2). ^{239}Pu deposition for 1979 was 1.1 pCi/m^2 at the plant perimeter and 1.3 at the 25-mile-radius stations. The ^{238}Pu depositions were near the minimum level of detection (0.12 to 0.24 pCi/m^2).

Deposition of gamma-emitting radionuclides from weapons tests fallout, with exception of an occasional trace of ^{137}Cs, was too low for detection. The deposition of gross beta was 2.6 nCi/m^2 at the plant perimeter, 2.1 nCi/m^2 at 25-mile-radius stations, and 3.0 nCi/m^2 at the 100-mile-radius stations. This activity included 0.65, 0.62, and 0.60 nCi/m^2 of ^{90}Sr for the three respective location groups. Comparable deposition values for weapons test fallout at the plant perimeter in 1978 was 6.5 nCi/m^2 and 65 nCi/m^2 in 1977. Rainwater was also analyzed bimonthly for tritium. The average concentration of tritium during 1979 at the plant perimeter stations was 2.6 pCi/ml (4.1 pCi/ml max) and at the 25-mile-radius stations, 0.9 pCi/ml (1.4 pCi/ml max).

Gamma radiation is measured continuously for quarterly periods with thermoluminescent dosimeters at the plant perimeter, 25-mile-radius, and 100-mile-radius air-monitoring locations (figure 2 and 3). Environmental gamma radiation data for 1979 (table B-3) were characteristic of measurements observed at individual stations for the past several years. Gamma radiation measured at plant perimeter and 25-mile-radius locations averaged 69 mR/yr. An environmental gamma radiation monitoring program, utilizing thermoluminescent dosimeters (TLD's), was initiated during 1973 to measure background radiation at 79 stations selected at 1-mile intervals along the plant perimeter. Exposure rates at the 79 perimeter stations averaged 73 $\pm$ 25 mR/yr for the two 1979 semiannual cycles monitored. All measurements are taken 1 m aboveground. The contribution of cosmic radiation to the annual background radiation exposure rate is 29 $\pm$ 1.5 mR/yr [DPSPU 76-30-1].

VEGETATION AND FOOD MONITORING

Vegetation

Radioactive contamination of growing plants may result from sorption of radioactive materials from the soil or from deposition. Bermuda grass is selected for analysis because of its importance as a pasture grass for dairy herds and its year-round availability.

Grass samples are routinely collected at seven locations on the plant perimeter, at seven other locations on a 25-mile radius (figure 5), and four 100-mile-radius stations. Samples are analyzed individually for alpha, nonvolatile beta, and tritium and composited monthly for analyses for specific gamma emitters. Trace ^{137}Cs in several samples was the only fallout gamma-emitting radionuclide detected in vegetation as shown in table B-4. Naturally occurring ^{7}Be was the major component in all samples. Alpha emitters in vegetation collected at the plant perimeter averaged 0.2 pCi/g and 0.1 pCi/g at 25- and 100-mile-radius locations. The respective beta emitter averages were 12, 13, and 17 pCi/g. Naturally occurring ^{40}K was a major contributor to this beta activity.

Tritium was the only radionuclide of plant origin detected in offplant vegetation. The average tritium concentration in the free water from vegetation collected at the plant perimeter was 5.5 pCi/ml as compared with 1.9 pCi/ml at a 25-mile radius and 0.5 pCi/ml at 100-mile-radius stations.

Milk

Milk is sampled routinely at three dairies (Williston, SC, Langley, SC, and Waynesboro, GA) within a 25-mile radius of SRP. Samples are collected twice monthly and analyzed for tritium and radioiodine. Analyses are performed quarterly for ^{90}Sr and monthly for ^{137}Cs. Milk produced commercially in the area and sold by a major distributor is also analyzed for these radionuclides. Results are summarized in table B-5. Concentrations of radionuclides in milk were essentially the same as those reported by EPA for the southeastern United States. ^{90}Sr and ^{137}Cs in milk are attributed to weapons test fallout. Average concentrations of the radionuclides in milk were slightly lower than in 1978: 6 pCi/l for ^{137}Cs and 6 pCi/l for ^{90}Sr. ^{131}I in milk samples was less than the sensitivity of analysis (1 pCi/l) throughout the year.

Strontium and cesium values represent 2.0 and 0.03% of the respective CG's for water. When tritium is present in local milk, it is assumed to be associated with plant operations. The average tritium level (0.9 pCi/ml) is 0.03% of the CG for water.

Food

Over 60 samples of farm produce representing four food categories (grain, fruit, leafy vegetables, and poultry) were collected at 14 localities in the six counties surrounding SRP. Six locations were near the plant perimeter and eight at a distance of approximately 25 miles (figure 6). All samples were analyzed by gamma spectrometry for gamma-emitting radionuclides. Radiochemical analyses are used for ^{90}Sr and liquid scintillation counting for tritium. With exception of grains, all foods were prepared as though for human consumption. Peelings, seeds, and other nonedible parts were removed. Wheat, containing the whole grains only, and oats, containing both grains and husks, were processed unwashed. Results for 1979 are summarized in table B-6.

SRP contributions to the levels of radioactivity (excluding tritium) in farm produce were so low that they were indistinguishable from fallout. All radionuclides in food were near or below the levels of detection (max 0.29 pCi/g of ^{90}Sr in grain).

Fish

Fish were trapped in the Savannah River upstream, adjacent to, and downstream from the SRP effluents. Individual whole fish were analyzed by gamma spectrometry for ^{137}Cs and other gamma-emitting radionuclides; bone from each specimen was analyzed for $^{89,90}Sr$. Fish flesh samples were also freeze-dried for tritium analysis. Fish analysis data for 1979 are presented in table B-7.

During 1979, the radioactivity in fish showed only minor contributions by SRP, and concentrations were of minor significance from a radiation dose viewpoint. Concentrations of ^{137}Cs in most fish were near or less than the sensitivity of analysis (approximately 0.2 pCi/g). One bass collected in the river above the plant contained 6.5 pCi/g of ^{137}Cs, and one bream in river water adjacent to the plant contained 1.7 pCi/g. Oysters and crabs collected below the plant at Savannah, GA, showed no detectable ^{137}Cs activity.

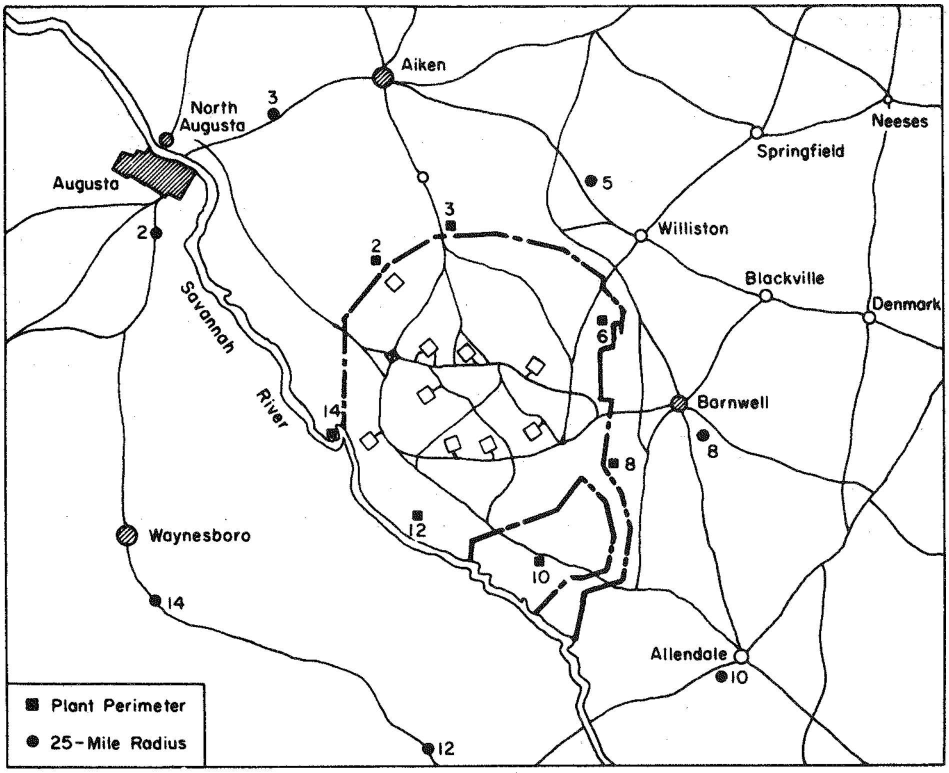

FIGURE 5. VEGETATION SAMPLE LOCATIONS AT PLANT PERIMETER AND 25-MILE RADIUS

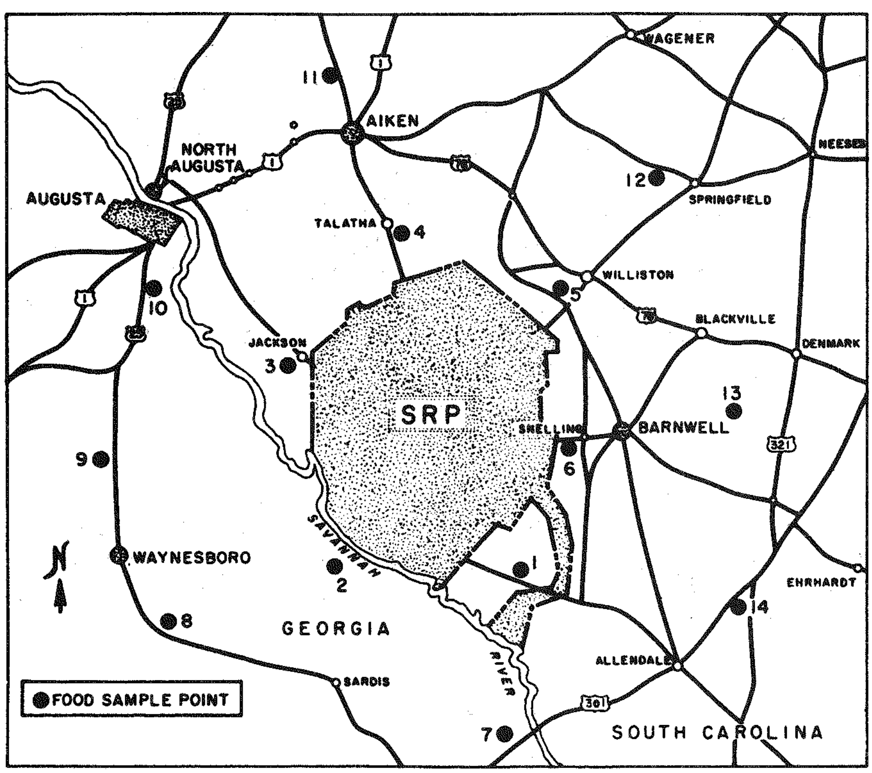

FIGURE 6. FOOD SAMPLE LOCATIONS

Tritium in fish from the river reflect tritium concentrations in the water. The 1979 results are similar to those observed during the past 9 years as shown in table 6. Tritium concentration in oysters and crabs from Savannah was 2 and 1 pCi/ml, respectively.

Average mercury levels in fish in 1979 were essentially the same as in recent years, however, there appears to be a slight decreasing trend when individual data are compared. More data are required to definitely establish this trend because fish collections in 1978 were unusually small and only 12 fish were analyzed for mercury. Average concentrations in fish collected in 1979 were less than 0.2 microgram/g. The Food and Drug Administration (FDA) action level for a daily intake of mercury in edible fish was changed in 1979 from 0.5 to 1.0 microgram/g. The guideline for establishing the FDA action level provides for analysis of fish composites, therefore, it is appropriate to compare average concentrations with the action level value of 1 microgram/g of flesh.

Mercury from industrial areas above the plantsite was detected in fish beginning in 1971. Initially, individual fish were analyzed; in 1972, fish samples were analyzed quarterly by species composites -- bream, bass, and catfish. From 1973 through 1975, species composites were analyzed semiannually; and from 1976 through 1979, river fish were again analyzed individually. Mercury data for 1979 are shown in table B-7, and the average concentrations in bass, bream, and catfish for the past 9 years are shown in table 7.

Deer and Hogs

Concentrations of ^{137}Cs in 1,079 deer and 61 hogs killed during the autumn 1979 hunts (figure 7) were estimated with a portable, single-channel scintillation instrument before releasing the animals to hunters. The estimated ^{137}Cs contents were verified by gamma-spectrometric analysis of muscle tissue from 52 deer.

^{137}Cs concentrations in deer originated almost entirely from fallout deposits from nuclear weapons tests. Average ^{137}Cs concentration in deer was 10 pCi/g with a maximum in one deer of 98 pCi/g. Edible meat from that deer weighed about 31 lb and would, therefore, contain about 1.4 microcurie of ^{137}Cs. An adult eating all of this deer meat would receive a radiation dose of 85 mrems to the whole body, less than the annual dose South Carolina residents receive from natural radiation [9]. Deer and hog data are shown in table B-8. A summary of ^{137}Cs concentrations detected in deer during all of the public hunts, beginning in 1965, is summarized in table 8. Also included are data for comparison with that of South Carolina Coastal Plain (SCCP) deer provided by the School of Forest Resources, University of Georgia, Athens, GA. Concentrations of ^{137}Cs in four deer killed in December 1979 on the Fort Jackson, SC, military reservation, were generally the same as in deer killed at SRP during the 1979 hunts. Concentrations of ^{137}Cs in the Fort Jackson deer averaged 15 pCi/g with a maximum of 22 pCi/g.

Thyroids from 52 deer showed no detectable concentrations of ^{131}I. Plutonium in bone from two Fort Jackson deer and 15 SRP deer were near or below the levels of detection (max 0.004 ± 0.001 pCi/g).

Game Birds

Twenty-seven ducks trapped on the plant near Par Pond contained an average ^{137}Cs concentration of 1.0 pCi/g with a maximum of 5 pCi/g. Four coots from Par Pond contained 1.1 pCi/g of ^{137}Cs (max 2.2 pCi/g) and five quail trapped near Steel Creek contained 0.4 pCi/g of ^{137}Cs (max 0.5 pCi/g). No other gamma-emitting radionuclide was detected in the game birds.

TABLE 6
TRITIUM IN FISH

Year	River Fish, pCi/ml (Free Water)					
	Above Plant		Adjacent to Plant		Below Plant	
	Max	Avg	Max	Avg	Max	Avg
1970	6	4	8	5	11	5
1971	7	3	15	8	11	7
1972	9	4	16	7	17	8
1973	5	2	16	6	12	6
1974	8	4	54	12	12	8
1975	33	5	6	3	12	6
1976	9	5	10	5	16	8
1977	26	8	24	11	20	13
1978	a	1	a	4	7	7
1979	3	<1	16	5	19	6

[a] Fish collections in 1978 and 1979 were small, in some instances only one sample for a location. More efficient traps will be used in the future.

TABLE 7
AVERAGE CONCENTRATIONS OF MERCURY IN FISH, μg/g

Year	River Above SRP			River Below SRP		
	Bass	Bream	Catfish	Bass	Bream	Catfish
1971	0.3	0.3	0.3	a	0.4	0.4
1972	1.4	0.4	0.6	a	0.4	0.7
1973	1.1	0.6	0.3	2.8	0.4	0.4
1974	0.8	0.3	0.2	1.1	0.4	0.5
1975	0.2	0.1	0.2	0.4	0.2	0.3
1976	0.2	0.2	0.2	0.4	0.4	0.4
1977	a	0.6	1.5	0.5	0.4	0.6
1978	0.4	0.3	a	a	a	0.2
1979	<0.2	<0.2	<0.2	a	a	<0.2

[a] No analysis.

TABLE 8
^{137}Cs IN DEER, pCi/g

Year	No. of Deer Killed		Average		Maximum	
	SRP	SCCP[a]	SRP	SCCP[a]	SRP	SCCP[a]
1965	198		<10		10	
1966	541		6		24	
1967	1,032		9		104[b]	
1968	669	34	11	23	74[c]	80
1969	889[d]	31	15	15	204[c]	72
1970	864	33	18	20	77[c]	57
1971	865	42	11	21	48	42
1972	808	72	8	11	38	32
1973	1,158	78	6	16	31	49
1974	1,551	89	5	9	52	23
1975	1,391	42	9	17	36	38
1976	1,357	35	11	16	41	36
1977	1,271	41	10	16	42	25
1978	1,287	36	5	11	65	21
1979	1,079	e	10	e	98	e

[a] South Carolina Coastal Plains.
[b] Killed along Four Mile Creek.
[c] Killed near Steel Creek.
[d] Approximately 20% of deer monitored before 1969; each deer monitored since 1969.
[e] Data not available.

FIGURE 7. U.S. FOREST SERVICE PERSONNEL – PUBLIC DEER HUNT

WATER MONITORING

Savannah River -- Radioactivity

The plantsite is drained by five streams that flow to the Savannah River (figure 1). The primary sources of the small amount of radioactivity that reaches the river are the reactor facilities. Tritium accounts for the largest quantity of radioactivity released by the reactors to the effluent streams. However, the SRP contribution of tritium to the Savannah River amounts to only 0.10% of the Concentration Guide (CG).

River water is sampled above and below the plant (sampling method described earlier) and analyzed weekly. Concentrations of alpha, nonvolatile beta emitters, and tritium in river water for 1979 are summarized in table B-9. The alpha and beta values represent the radioactivity associated with dissolved and suspended solids and are near or less than the sensitivity of analysis. Upstream measurements are attributed to natural radioactivity and worldwide fallout from nuclear weapons tests. Downstream measurements reflect these sources plus releases from SRP.

Tritium, trace amounts of ^{137}Cs, and ^{90}Sr were the only radionuclides of SRP origin detected in river water at the downstream location. ^{90}Sr and tritium from worldwide fallout were also detected in river water upstream from SRP effluents. Average concentrations of all radionuclides found in river water during 1979 (table B-10) were small fractions of the CG's. The tritium concentration in river water below the plant was 3.1 pCi/ml (includes 0.4 pCi/ml background river contribution) and represented the highest CG percentage (0.1%). The concentration guide for tritium in water (DOE Manual chapter 0524) is 3,000 pCi/ml. The EPA tritium guide for drinking water is 20 pCi/ml.

Savannah River -- Chemical Water Quality and General River Health

The water quality of the Savannah River (table B-11) is not adversely affected by the operation of the Savannah River Plant. More fecal coliform bacteria are found in the river water entering the plant than in the effluent water re-entering the river. With respect to thermal effect, several miles of onsite streams and a large swamp permit dissipation of almost all heat generated at SRP. Results of temperature profile surveys of the Savannah River relative to the NPDES permit limitations are given for 1976 and 1977 in annual reports DPSPU 77-30-1 and 78-30-1, respectively. A temperature profile study of the Savannah River below the mouth of Steel Creek met the NPDES permit requirements.

The Limnology Department of the Academy of Natural Sciences of Philadelphia (ANSP), under contract to Du Pont, has performed a continuing survey of aquatic environment and water quality of the Savannah River upstream (station 1) and downstream (station 6) from SRP since 1951. The purpose of this survey is to determine the effect, if any, of SRP effluent discharges on general river health.

Diatometers are positioned in the river at three locations (one above and two below the SRP site) to provide a continuous monitor of the effects of plant effluents on one major group of river organisms. The diatometers contain glass slides on which diatoms accumulate. The slides are replaced biweekly, and the slides containing dried diatoms are sent to ANSP for analysis.

In rivers adversely affected by pollution, the number of species will be reduced in varying amounts corresponding to the degree of pollution. The less tolerant species are eliminated while the more tolerant species become dominant. Thus, while total populations may increase in size, the number of different species will be reduced. Detailed readings and summaries of the diatometer surveys are issued quarterly by ANSP. There is no evidence that the operation of the Savannah River Plant affected the diatom flora of the Savannah River.

Quarterly surveys of other algae, insects, invertebrates, and fish are also conducted by ANSP. Specialists in entomology, algology, invertebrate zoology, and ichthyology sample river biota during times of the year most suitable to their specialty. An algologist or entomologist accompanies every survey to provide continuity of collecting and methodology and to observe environmental conditions. Results of the quarterly surveys are summarized and published annually by ANSP.

In 1979, the Academy of Natural Sciences conducted four cursory surveys immediately above the plant at station 1 and about 5 miles below the plant at station 6. Results of the 1979 algal studies were quite consistent between stations and seasons. Although the high water conditions during April and November made it impossible to accurately assess total algal growth, there was no evidence of any imbalance in 1979. High water was the major factor influencing the loss of many invertebrate species at both stations. The overall results of hand and trap insect collections indicated no degradation in the study area resulting from the operations of the Savannah River Plant. Comparison of diversity and abundance of fish for 1978 and 1979 also indicated no significant plant affect in the fish study area.

Periodically or as a result of major changes in the physiography of the river, ANSP also makes comprehensive surveys of the biota and chemical water quality above, adjacent to, and below SRP to ascertain effects of SRP operations on river conditions. Determinations obtained during the last comprehensive survey (1976) showed no marked changes in the number of species in the various classes of organisms studied. All indications were that the condition of the river was better at all stations than it was during the last comprehensive survey in 1972. For example, three species of fish, previously unrecorded at river stations, were collected during the 1976 survey. Although these species were represented by few individuals, their occurrence suggests water quality improvement. Also, the beds of rooted aquatic plants, which indicated degraded water quality, were no longer dominating the shallows in 1976 as in 1972.

Savannah River -- Pesticides

Arrangements were made in 1971 for the U.S. Geological Survey (USGS) Water Quality Laboratory, Washington, DC (now located in Atlanta, GA), to analyze water and sediment from SRP streams and the Savannah River for pesticides. Water samples were previously analyzed for pesticides by the Federal Water Pollution Control Administration (now Environmental Protection Agency) at Athens, GA, and all results were less than sensitivity of analyses. The analyses performed on water and sediment samples are listed in table 9.

Gas chromatographic water analyses in 1979 showed concentrations of pesticides in river water both upstream and downstream from the plant less than sensitivity of analyses (less than 0.05 microgram/l). A trace quantity of polychlorinated biphenyls (PCBs) (approximately 0.1 microgram/l) was detected in river water upstream from SRP. River sediment from SRP in 1979 showed trace quantities of DDE and DDT. These pesticides are not used at SRP. River sediment collected above the plant also showed PCB (15 microgram/kg). Some pesticides and herbicides are used moderately in areas where insect and vegetation control is necessary for security and safety. Some herbicide and chemical treatment is also carried on by the U.S. Forest Service in timber management. Results of river sediment analyses for the past 4 years are shown in table 10. The pattern of concentrations detected in sediment continues to indicate that offplant sources are the primary contributors. Possible offsite sources for pesticides found in the river include domestic and industrial discharges and drainage from urban and agricultural areas.

Temperature Survey -- National Pollutant Discharge Elimination System Permit (NPDES)

A temperature profile survey of the Savannah River made on November 19, 1979, showed that the thermal plume below Steel Creek was within NPDES permit requirements. The permit specifies a maximum temperature above ambient of 2.8°C, measured 100 yards downstream of Steel Creek; the measurements showed a maximum temperature above ambient of 0.3°C. Effluent streams are effectively cooled before entering the river at Steel Creek Landing. Heat from K-Area reactor cooling water is dissipated in the swamp before entering Steel Creek, and P-Area reactor cooling water is returned to Par Pond.

The standard applicable to the Savannah River as stated in the USDOE NPDES Permit SC 00000175 is as follows:

> During the period beginning on effective date and lasting through expiration, the permittee is authorized to discharge from outfalls-once-through cooling water.
>
> Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations Instantaneous Maximums	Monitoring Requirements Measurement Frequency	Sample Type
Plume Temp, °C	32.2[a]	1/quarter	Grab
Plume Temp Rise Above ambient, °C	2.8[a]	1/quarter	Grab

[a] Measured at the edge of the approved mixing zone. The zone for mixing shall be limited to not more than 25% of the cross-sectional area and/or flow of the Savannah River and shall not include more than one-third of the surface area measured from shore to shore. Mixing zone lengths shall not exceed 100 yards below the mouth of Beaver Dam Creek, 300 yards below the mouth of Four Mile Creek, and 100 yards below the mouth of Steel Creek. Ambient temperature shall be determined upstream from Beaver Dam Creek. Monitoring shall be conducted for a period of 1 year, during the months of May, August, November, and February and shall include three-dimensional data collection and plots. Data collection should be at low river flow to the extent practicable.

Figure 8 shows the cross-sectional temperature profile in the Savannah River at the edge of the approved mixing zone length: 100 yards below the mouth of Steel Creek. The river flow on the day of the survey was 11,800 ft^3/sec. The profile extended from the South Carolina shore at 10-ft intervals for a distance of one-third the river width.

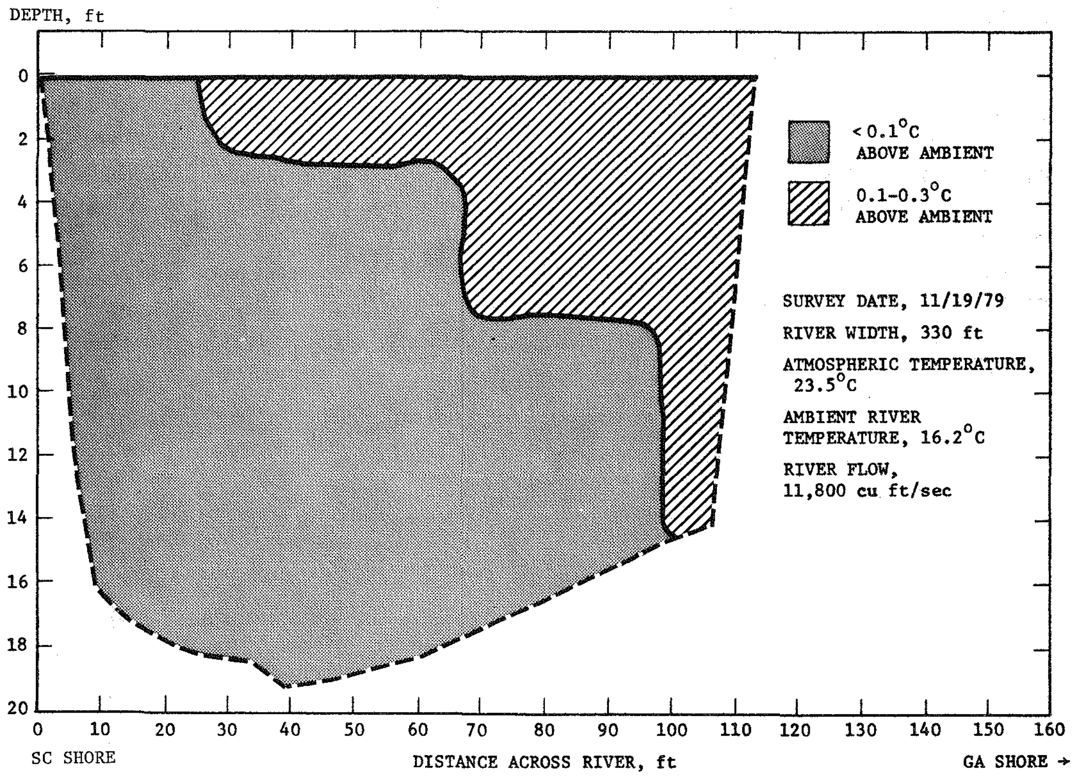

FIGURE 8. TEMPERATURE IN RIVER 100 YARDS BELOW STEEL CREEK

Drinking Water

Communities near SRP get drinking water from deepwells or surface streams. Public water supplies from 14 surrounding towns are sampled and analyzed semiannually. Radiological data from analyses of all public water samples from the immediate vicinity of the plant are shown in table B-12. Drinking water wells onplant show concentrations of radioactivity similar to those offplant.

Average alpha activity (0.8 pCi/l) and beta activity (less than 7 pCi/l) are essentially the same as those observed before plant startup. The sensitivity of the alpha analysis is 0.2 pCi/l and sensitivity of the beta analysis is 7 pCi/l. Very low levels of tritium are found in drinking water of several of the towns that use surface water (annual maximum 0.5 pCi/ml). Concentrations of tritium in water from deepwells are near or less than the sensitivity of the analyses (0.3 pCi/ml).

The Beaufort-Jasper Water Authority operates a treatment facility to furnish drinking water, partially obtained from the Savannah River, to most of Beaufort County, SC. Water is supplied through a canal from the river at a point about 90 miles below SRP. A water treatment plant at Port Wentworth, GA, supplies water to a business-industrial complex near Savannah. Locations of the water treatment plants are shown in figure 9. These two water supplies are analyzed monthly for tritium content.

Tritium concentrations in water collected from the Beaufort-Jasper plant averaged 1.3 pCi/ml and 2.7 pCi/ml in water from the Port Wentworth plant. The EPA guide for tritium in drinking water is 20 pCi/ml.

SAVANNAH RIVER SWAMP MONITORING

During the 1960's, radioactive materials from SRP releases were deposited in about 1.7 square miles of offsite swamp downstream from SRP. Waterborne sediments settle in the swamp during periods of high flow in the river when the river overflows its natural banks into the swamp. When the swamp is flooded, the flow from SRP surface streams generally follows a path through the swamp paralleling the main river channel and bordering the north swamp margin. This swamp flow does not enter the main river channel until high ground is encountered at Little Hell Landing, approximately 4 miles from the SRP boundary (figure 10).

Associated with the deposit in the offsite swamp were approximately 25 Ci of ^{137}Cs and less than 1 Ci of ^{60}Co. Most of the ^{137}Cs and ^{60}Co in the swamp were from releases from L- and P-Area reactor fuel basins to Steel Creek. The discharges to Steel Creek were substantially reduced in 1970 following modifications to one reactor and shutdown of the other reactor. Aerial radiological surveys and ground surveys conducted in 1974 [10,11] showed that approximately 4.8 Ci of ^{137}Cs and most of the ^{60}Co were deposited in a 1/4-mile-long section of swamp (43 acres) immediately adjacent to the band bordering the north swamp margin, terminating at the Little Hell Landing area. The 1979 radiation survey of the swamp showed no significant change in levels of radioactivity from those measured and reported for the past several years.

Fifty-two locations on private property were selected along 10 trails transecting the swamp for sampling vegetation and soil and radiation (TLD) measurements (figure 10). The trails were established in 1974, and samples have been collected annually as near as possible to locations sampled in 1974.

During the period 1974 to 1977, annual surveys of the 10 trails included soil, vegetation, animals, fish, and TLD radiation measurements. Because results of these surveys have shown no significant change in radiological conditions, the 1978 and 1979 surveys included only the TLD measurements.

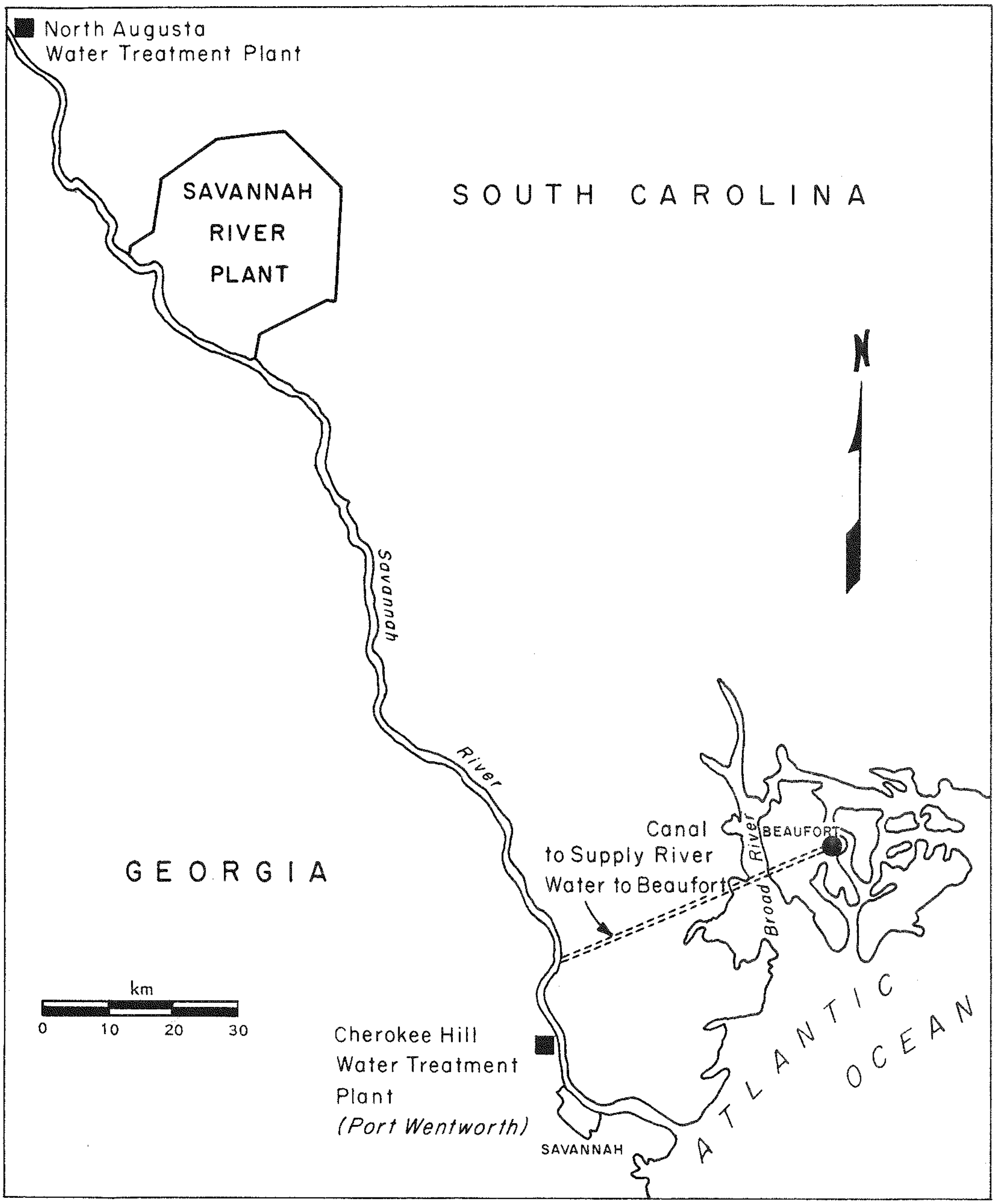

FIGURE 9. WATER TREATMENT PLANTS USING SAVANNAH RIVER WATER

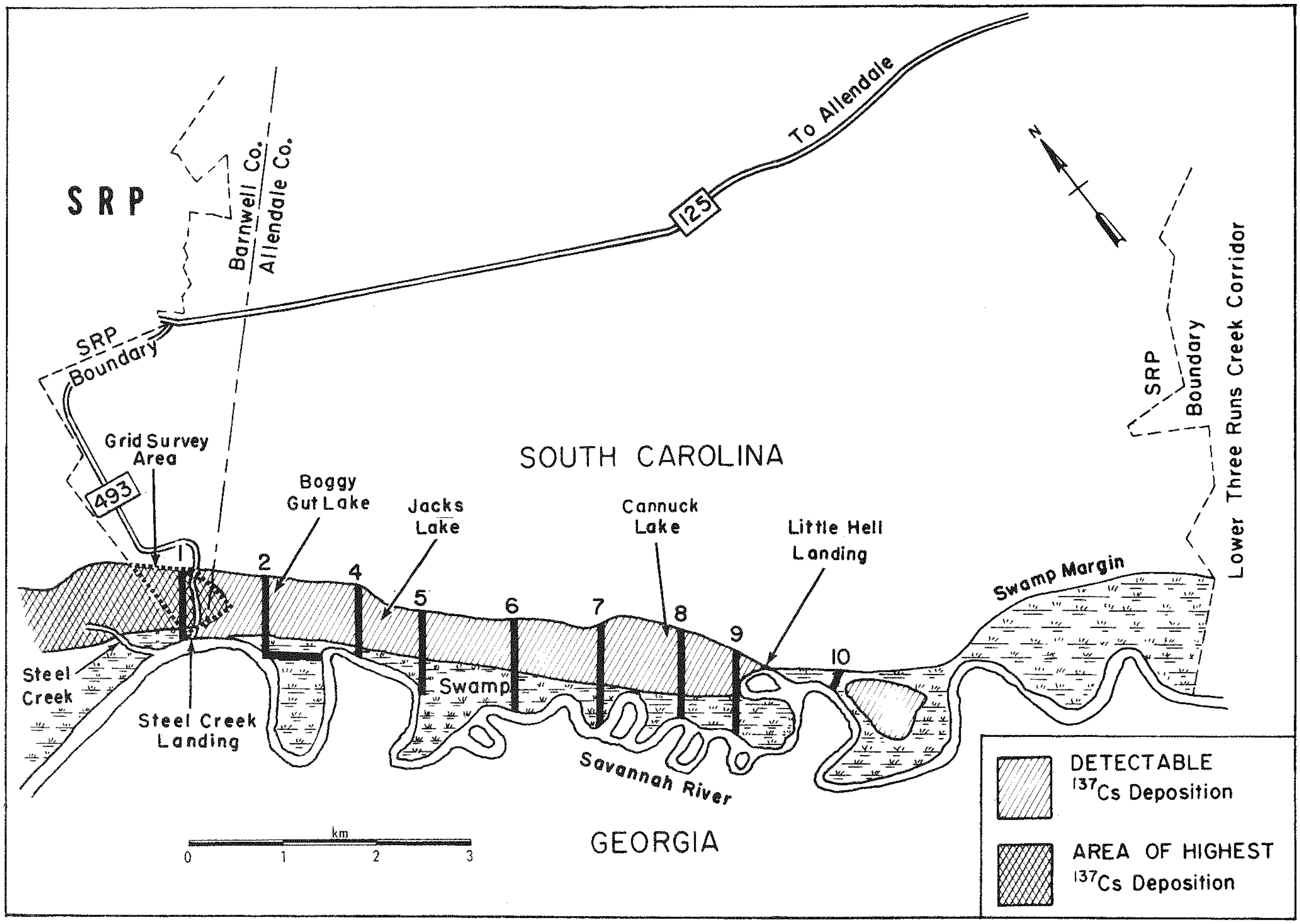

FIGURE 10. RADIOACTIVITY DEPOSITION IN THE SAVANNAH RIVER SWAMP

Annual TLD surveys are considered adequate to indicate any significant changes in radioactivity distribution in the swamp. Unless additional surveys are warranted by changes in the TLD radiation annual measurements, comprehensive surveys will be conducted every 5 years. Results of the 1974 through 1977 surveys are summarized in DPSPU 78-30-1.

The TLD radiation measurements were made 1 m aboveground at specified intervals along each trail. Gamma radiation measurements in 1979 ranged from 0.18 to 1.38 mR/day compared to a 1978 range of 0.19 to 1.56 mR/day. The slight fluctuations between the 1978 and 1979 measurements, as shown in table B-13, are attributed primarily to statistical errors associated with each measurement. However, radiation measurements are influenced by water level fluctuations in the swamp. This was evidenced by the lower radiation measurements observed in 1975 when high water levels were observed in the swamp. In 1976, 1977, and 1978, when water levels were lower, radiation measurements returned to levels previously recorded in 1974.

Aerial radiological surveys of the offsite swamp area were conducted by EG&G in June 1974 and June 1979. Isopleths of gamma exposure rates for the two principal contaminants showed a maximum ^{137}Cs exposure rate (1 m aboveground) of 0.46 mR/day for both years; the maximum ^{60}Co exposure rate was 0.17 mR/day in 1974 and 0.09 mR/day in 1979, reflecting the 5-year half-life of ^{60}Co. Areas showing these maximum rates were less than 0.5 acre in size. Typically, the exposure rate for natural background radiation in the SRP area is 0.14 ± 0.05 mR/day, depending on the surface soil composition of the particular area.

SOIL MONITORING

Concentrations of radiocesium and plutonium in soils collected at four locations near the plant perimeter and two locations approximately 100 miles distant during 1979 are similar to the deposition values reported for previous years. The average concentration of ^{137}Cs in the top 5 cm at both the plant perimeter and 100-mile-distance locations averaged 0.7 pCi/g. The ^{239}Pu in the top 5 cm averaged 0.016 pCi/g at the plant perimeter and 0.003 pCi/g at 100-mile-distance location. The respective concentrations of ^{90}Sr averaged 0.09 and 0.11 pCi/g. Deposits of cesium, plutonium, and strontium measured in soils for the past 5 years are summarized in table 11. Deposition of the three radionuclides in all samples are within the range normally found in global fallout. ^{238}Pu in plant perimeter and 100-mile-radius soil samples were near sensitivity of the analysis (0.001 pCi/g). Soil data are shown in table B-14.

Soil samples from noncultivated areas were first collected for radioanalysis in 1973 at four locations along the plant perimeter (representing each quadrant) and at three locations up to 100 miles from the plant. In each successive year, samples have been collected at the plant perimeter locations and at two of the 100-mile-radius locations. At each site, 10 soil cores, 5-cm-deep, are taken in a straight line 30 cm apart for plutonium analysis. Ten 15-cm soil cores were taken at each site for ^{137}Cs analysis prior to 1976. The soil cores were composited by location for radioanalysis.

RADIATION DOSE COMMITMENT -- INDIVIDUAL AND POPULATION

As used in this report, "radiation dose" means "radiation dose equivalent" as defined by the International Commission on Radiological Protection [12]. Radiation dose commitment is the amount of radiation dose received from major pathways of exposure, internal and external, throughout the lifetime of an individual from direct first-pass exposure. (A brief

TABLE 9

PESTICIDE ANALYSES

Aldrin total	Dieldrin total	Heptachlor total	PCN total
Chlordane total	Endosulfan total	Lindane total	Perthane total
DDD total	Endrin total	Malathion total	Silvex total
DDE total	ETH Parth total	MFT Parth total	Toxaphene total
DDT total	ETH Trith total	MET Trith total	2.4-D total
Diazinon total	Ethion total	Mirox total	2.4-DP total
	Hept Epox total	PCB total	2.4.5-T total

TABLE 10

RIVER SEDIMENT, μg/kg[a]

	River Above Plant				River Below Plant			
	1976	1977	1978	1979	1976	1977	1978	1979
DDD	4.6	1.9	b	b	2.1	b	b	b
DDE	2.2	0.5	0.5	0.2	2.3	b	b	0.5
DDT	b	3.5	b	1.3	0.6	b	0.2	0.8
Dieldrin	b	2.0	0.1	b	b	b	0.2	b
PCB	b	8.0	b	15.0	b	b	b	b
Chlordane	b	b	b	b	b	b	1.0	b

[a] River water results were less than the sensitivity of the analyses with exception of 0.1 μg/l PCB in river water above the plant.

[b] Not detected.

TABLE 11

RADIOACTIVITY IN SURFACE SOIL, mCi/km^2

	Plant Perimeter				100-Mile Radius			
Year	^{239}Pu	^{238}Pu	^{137}Cs	^{90}Sr	^{239}Pu	^{238}Pu	^{137}Cs	^{90}Sr
1973[a]	1.78	<0.08	78	79	1.69	<0.12	105	120
1974	1.19	<0.11	73	-	1.26	<0.13	59	-
1975	1.13	<0.07	88	-	0.68	<0.02	72	-
1976	1.30	<0.07	63	6	1.09	<0.06	74	25
1977	1.18	<0.07	52	8	1.22	<0.04	54	14
1978	1.90	0.12	57	8	1.10	0.06	57	11
1979	1.2	0.10	54	7	0.23	0.08	52	9

[a] 15-cm deep cores in 1973.

description of dose calculational techniques is given in appendix C.) Population dose commitment is the sum of radiation dose commitment of individuals and is expressed in units of man-rem. (For example, if 1,000 people each received a dose of 1 rem, their population dose would be 1,000 man-rems.) The segments of the population that receive the highest radiation dose commitments from SRP releases of radioactive materials to the environment are described in the following sections.

Persons Living in the Area Surrounding the Savannah River Plant and Exposed to Radioactive Materials via Atmospheric Pathways

The radiation dose received by people from atmospheric releases of radioactive materials from SRP is too low to permit direct measurement of all pathways of exposure; therefore, radiation dose commitments are calculated with mathematical models using known dispersive characteristics of the atmosphere and the known major pathways of exposure to man.

During 1979, the average dose commitment to an individual from atmospheric releases of radioactive materials from SRP was calculated to be 0.7 mrem at the plant perimeter (table 13). The major contributors to this dose were tritium (^3H), 77.8%; ^{41}Ar, 13.9%; and ^{14}C, 5.5%. The remaining 2.8% was from krypton and xenon isotopes (chemically inert noble gases), $^{129,131}I$, and miscellaneous radioactive particles. The calculated population dose commitment from release of radioactive materials from SRP to the atmosphere in 1979 to people living within 80 km (50 mi) of the center of SRP (population: 465,000) is 100 man-rems. Table 13 shows the amount of each radionuclide released to the atmosphere from normal SRP operations and calculated whole body radiation dose commitment.

Tritium (T), the major contributor to population dose from normal SRP releases in 1979 is a radioactive isotope of hydrogen with a radiological half-life of 12.33 years. The maximum energy of the beta particle emitted during decay is 0.0186 MeV; the average energy is about 0.006 MeV. At SRP, some tritium is unavoidably released during normal operations both as an elemental gas (T_2, HT, DT) and in combination with oxygen (T_2O, HTO, DTO). Both forms are readily dispersed in air and will enter into the same chemical and biological reactions as hydrogen or water vapor.

The low energy beta particle emitted by tritium during decay will penetrate human tissue only 0.013 cm. As an elemental gas, tritium constitutes little hazard because the weak beta is completely attenuated (absorbed) in the inert external skin layer (epidermis). Only 0.004% of the gas inspired is converted to the oxide and retained in the body. Almost all tritium oxide (water vapor) inhaled is absorbed in the lungs and enters the body water pool. In addition, almost as much tritium oxide is absorbed through the skin as is absorbed during inhalation. Because of the great difference between the biological assimilation of tritium gas and tritium oxide, the concentration guide [1] for tritium oxide is several hundred times more restrictive than for elemental gas. The environmental radiation dosimetry program used at SRP makes the conservative assumption that all normal SRP releases are in the oxide form and thus, there is an overestimation of individual and population dose commitment from tritium.

Persons Living Downstream from SRP and Consuming Savannah River Water Containing Low Concentrations of Radioactive Materials

Radioactive materials released to plant streams on the SRP site flow to the Savannah River. The description of SRP hydrology is given in "The Savannah River Plant Site" [DP-1323] [9]. There is no known use of river water for irrigation downstream from SRP. Fish from the river are not an important source of food for any large segment of the population. The most important pathway of exposure of a population segment to radioactive materials in the river is from consumption of river water. Two water

TABLE 12

RIVER TRANSPORT AND DOSE -- 1979

Nuclide	Curies Released at Emission Source[a]	Average Conc in River, μCi/ml	Calculated Individual Dose Commitment, mrem: Whole Body	Bone	Lower Large Intestine	Thyroid[b]	Testis	Calculated Population Dose Commitment, man-rem
^{3}H	2.9×10^{4}	1.3×10^{-6} c	0.12					5.8
		2.4×10^{-6} d	0.21					4.3
^{32}P	4.0×10^{-3}	3.4×10^{-13}	<0.00001	0.00003				<0.0001
^{35}S	1.1×10^{-1}	9.4×10^{-12}	0.00001				0.00004	<0.0007
^{51}Cr	5.4×10^{-1}	4.6×10^{-11}	<0.00001		0.00003			0.0001
$^{68,60}Co$	4.1×10^{-1}	3.5×10^{-11}	0.00007		0.00084			0.0049
$^{89,90}Sr$	4.8×10^{-1}	4.1×10^{-11}	0.00007	0.027				0.0046
$^{134,137}Cs$	2.4×10^{-1}	2.1×10^{-11}	0.00092					0.064
^{137}Cs	6.9×10^{-5}	5.9×10^{-15}	<0.00001					<0.0001
Uranium	6.4×10^{-2}	5.5×10^{-12}	<0.00001		0.00014			<0.0001
^{239}Pu	8.7×10^{-3}	7.4×10^{-13}	0.00001	0.00035				0.0006
Total			0.12[e] 0.21[f]	0.027	0.00010		0.00004	10.2

[a] Includes direct releases to streams and ground water migration from earthen basins used for retention of low level radioactivity.
[b] No radionuclides which cause thyroid dose were detectable in 1979 liquid releases.
[c] Beaufort-Jasper concentrations are measured values.
[d] Port Wentworth concentrations are measured values.
[e] Summation for Beaufort-Jasper.
[f] Summation for Port Wentworth.

TABLE 13

ATMOSPHERIC TRANSPORT AND DOSE -- 1979

Nuclide	Curies Released at Emission Source	Calculated Average Conc at Plant Perimeter, μCi/cm^{3}	Calculated Whole Body Dose to Individual at Plant Perimeter, mrem: Average	Maximum	Calculated Population Dose Commitment, man-rem: 80 km	100 km
Gases and Vapors						
^{3}H	3.4×10^{5}	8.9×10^{-11}	0.55	0.74	85.2	106.7
^{14}C	5.6×10^{1}	1.5×10^{-14}	0.039	0.053	6.1	7.6
^{41}Ar	5.3×10^{4}	7.0×10^{-12}	0.098	0.15	7.0	7.5
^{85m}Kr	1.8×10^{3}	3.4×10^{-13}	0.0007	0.0010	0.068	0.076
^{85}Kr	4.8×10^{5}	1.3×10^{-10}	0.0017	0.0024	0.30	0.38
^{87}Kr	1.5×10^{3}	1.6×10^{-13}	0.0027	0.0043	0.16	0.17
^{88}Kr	2.3×10^{3}	3.8×10^{-13}	0.0097	0.015	0.82	0.91
^{131m}Xe	9.1×10^{0}	2.4×10^{-15}	<0.00001	<0.00001	0.0006	0.0008
^{133}Xe	5.3×10^{3}	1.4×10^{-12}	0.0013	0.0019	0.18	0.22
^{135}Xe	4.5×10^{3}	1.0×10^{-12}	0.0030	0.0044	0.34	0.39
^{129}I	1.3×10^{-1}	3.5×10^{-17}	0.0008	0.0012	0.093	0.11
^{131}I	8.4×10^{-2}	1.6×10^{-17}	0.00001	0.00002	0.0016	0.0019
Particulates						
^{60}Co	4.0×10^{-4}	2.3×10^{-20}	<0.00001	<0.00001	<0.0001	<0.0001
$^{89,90}Sr$	2.5×10^{-3}	1.4×10^{-19}	<0.00001	<0.00001	<0.0001	<0.0001
^{95}Zr	1.3×10^{-2}	7.5×10^{-19}	<0.00001	<0.00001	<0.0001	<0.0001
^{95}Nb	2.6×10^{-2}	1.6×10^{-18}	<0.00001	<0.00001	<0.0001	<0.0001
^{103}Ru	4.8×10^{-3}	2.8×10^{-19}	<0.00001	<0.00001	<0.0001	<0.0001
^{106}Ru	5.5×10^{-2}	3.2×10^{-18}	<0.00001	<0.00001	<0.0001	<0.0001
^{134}Cs	2.7×10^{-4}	1.6×10^{-20}	<0.00001	<0.00001	<0.0001	<0.0001
^{137}Cs	3.2×10^{-3}	1.9×10^{-19}	<0.00001	<0.00001	<0.0001	<0.0001
^{141}Ce	1.7×10^{-4}	9.8×10^{-21}	<0.00001	<0.00001	<0.0001	<0.0001
^{144}Ce	1.8×10^{-2}	1.0×10^{-18}	<0.00001	<0.00001	<0.0001	<0.0001
Uranium	2.4×10^{-3}	1.4×10^{-19}	<0.00001	<0.00001	0.0001	0.0001
^{238}Pu	1.4×10^{-3}	8.1×10^{-20}	0.00010	0.00014	0.0094	0.011
^{239}Pu	4.0×10^{-4}	2.3×10^{-20}	0.00004	0.00005	0.0033	0.0033
^{241}Am	3.6×10^{-4}	2.1×10^{-20}	0.00002	0.00003	0.0022	0.0025
^{244}Cm	3.9×10^{-4}	2.3×10^{-20}	0.00001	0.00002	0.0012	0.0013
Totals			0.707	0.974	100.3	124.1

treatment plants downstream from SRP supply treated river water to customers in Beaufort and Jasper Counties in SC and Port Wentworth, GA. Of the radioactive materials released to effluent streams on SRP during 1979 (table 12), only tritium is measurable by routine water monitoring techniques of the water from the treatment plants. Data shown for other nuclides are calculated, based on dilution by known river flow rates. Of the radioactive materials in water, tritium is the source of 99% of the whole-body dose commitment to consumers. People who consume this water at a rate of 1.2 liters per day would receive a dose commitment from tritium as shown below; these dose rates are within the National Interim Primary Drinking Water Regulation of 4 mrems/yr.

Beaufort-Jasper	0.12 mrem
Port Wentworth	0.21 mrem

The population dose commitment from tritium to these two groups from 1979 SRP tritium releases are 5.8 man-rems to consumers of Beaufort-Jasper water (population: 50,000) and 4.3 man-rems to consumers of Port Wentworth water (estimated consumer population: 20,000 -- most of Port Wentworth water is used for industrial purposes), a total of 10.1 man-rems to river water consumers. Radionuclides other than tritium contribute an additional 0.1 man-rem population dose commitment as shown in table 12.

Comparison of Calculated Dose Commitment from Plant Releases with that from Other Sources

Population dose commitment (man-rem) can be used for comparison with radiation exposure from other sources, such as natural radioactivity and medical radiation exposure. The 1979 population dose commitment from SRP releases (100 man-rems from atmospheric releases to people within 80 km of the center of the plant and 10 man-rems from liquid releases to people consuming Beaufort-Jasper and Port Wentworth water) is compared with radiation dose from natural and medical sources in the following table.

Source of Exposure	Population Dose, man-rem
Natural	63,000
Artificial	
Medical diagnosis [13]	54,000
Weapons fallout [14]	2,700
SRP releases	110

Even though SRP contribution to population is very small (0.17% of that from natural sources), SRP has a continuing program to improve operating techniques and to develop new technology directed toward reducing releases of radioactive materials to the environment.

Tritium Quality Factor

Tritium doses were calculated using a quality factor of 1.7 for the low energy beta particle emission. The concentration guide (CG) for tritium published in the Code of Federal Regulations, Title 10, Part 20 (10CFR20) was derived with this same quality factor. In 1969 [15], the International Commission on Radiological Protection (ICRP), and in 1971, the National Council on Radiation Protection and Measurement (NCRP) recommended a quality factor of 1.0 as being appropriate within the degree of precision required for purposes of radiological protection. However, this recommendation has not yet been reflected in the federal regulations. A quality factor of 1.0 would have the effect of lowering the calculated population dose from tritium.

APPENDIX A

DATA ANALYSIS AND QUALITY CONTROL

Data Analysis

The sensitivity of laboratory analyses (table A-1) refers to the minimum amount of radioactivity that can be detected by the radiochemical analytical technique in use. It is based on statistical counting error (95% confidence level) and is influenced by sample size, counter and procedure efficiencies, length of count, counter background, and decay. Where samples are analyzed by gamma spectrometry, the lower level of detection of a given radionuclide varies with the background of each individual channel grouping, with the geometry and volume of sample analyzed, and with number of radionuclides present in the sample. For this reason, average sensitivities are given for only milk and vegetation.

Many of the concentrations of radioactive materials in ambient environmental samples are at or near zero and should statistically show a distribution at or near zero. Because of this, when a chemical or instrument background is subtracted from an environmental measurement, it is possible, not only to obtain net values that are less than the minimum detection level (MDL), but to obtain zero and negative values (values less than zero). In this report, negative values are used in reporting individual measurements and in determining averages. It is believed that the best estimate of the mean is obtained if the negative values are averaged with the extremely low and positive values. Additionally, this new approach, without any arbitrary cutoff of small or negative values, will allow all data to be reported and possibly permit better statistical evaluation to determine trends.

Average values are usually accompanied by a plus or minus (±) limit value. This value, designated 2 Std Dev, is the standard deviation (95% confidence level) of the average and is a measure of the range in the concentration encountered at that location. When the average is given for groups of locations, the std dev is the measure of the range in concentration found at all locations. In some tables, the standard deviation is not calculated because of the small number of sample results (designated - insufficient data). When a ± number accompanies an individual result, such as the maximum (max) or minimum (min), it represents the statistical counting error at the 95% confidence level, which in many cases exceeds the net value of the sample. Max and min refer to the greatest and smallest concentrations found in a single sample collected during the year.

No self-absorption corrections have been applied to total alpha and nonvolatile beta results. If activity appears unusual, and specific analyses are not routinely scheduled, further analyses are performed for verification.

Also in this report, recognition is given to geometric means and geometric standard deviations. Although the conventional arithmetic average and standard deviation, as in the past, are used in reporting all measurements of radioactivity, geometric means and geometric standard deviations are routinely calculated for evaluation. The arithmetic average and standard deviation are appropriate analyses if the data have a normal (Gaussian) distribution; the standard deviation being an increment of the average. If the distribution of the data is skewed toward higher values and the logarithms of the data conform to a normal distribution, the data is said to be log-normal. Such data may then be more appropriately described using the geometric mean and standard geometric deviation. The standard geometric deviation is a multiplier of the geometric mean. The characteristics of log-normal techniques are such that annual averages are not dominated by the few largest data values, and mean values can be determined when a major portion of the data are less than the minimum detection values. Recent analyses of several sets of environmental monitoring data have shown log-normal distributions; however, in most cases, there is little advantage in treating the data as log-normal. Each set of data is fitted to both normal and log-normal plots in which the abscissa is in units of sigma (0 sigma = 50 percentile, +1.0 sigma = 84.17 percentile, and -1.0 sigma = 15.83 percentile, etc.). This is equivalent to probability paper and allows a least squares routine to be used to draw the fit line. Linearity of the data suggest the distribution. Although the log-normal plots possibly show better linearity, the averages of the data are given by the 0 intercepts and are similar for both plots. Log-normal statistical treatment may prove helpful in future evaluation of environmental data.

Quality Control -- Radioactive Analyses

An internal quality control program is maintained by (1) monthly calibration of counting instruments; (2) daily source and background counts; (3) routine yield determinations of radiochemical procedures; (4) duplicate analyses to check precision; (5) reagent blank analyses to check purity of all chemicals. Accuracy of radioactivity measurements is established by use of standards obtained from the National Bureau of Standards or their equivalent.

In 1976, participation in a Department of Energy program of quality assurance was initiated. Environmental samples are sent from the Environmental Measurements Laboratory (EML) to various laboratories on a quarterly basis for analysis of a number of nuclides in various media. EML was previously known as the Health and Safety Laboratory (HASL).

Samples received quarterly during 1979 included soil, vegetation, animal bone (tissue), water and air filters. The sample aliquots are already prepared for radioassay; the soil pulverized and blended, the vegetation ashed and sieved, the bone ashed, ground, sieved, and blended, and the water acidified. The air filter samples consist of two glass fiber filters; each has been moistened with solution, evenly distributed, and dried. Suggested radionuclide determinations for each sample are listed. The results are submitted to EML prior to a reporting deadline and an intercomparison of data obtained by other participating laboratories (on split samples of the same media) are returned to each laboratory.

The results of the sample analyses are summarized in table A-2. The EML values with which all laboratory results are compared are not necessarily the true value, but are used as the reference value throughout the quality assurance program. The EML value is the mean of replicate determinations by EML for each nuclide. The SRP Environmental Monitoring goal is to obtain ratios of SRP/EML values in the range of 0.8 to 1.20 (100 ± 20%). This range is considered acceptable because of variations in radiochemical and radiometric techniques.

Quality Control -- Water Quality

The quality control program in the water quality laboratory is designed to constantly evaluate results of the analyses. A quality control program is maintained by (1) routine calibration of instruments, (2) routine yield determinations of procedures and analysis of standards furnished by the Environmental Protection Agency (EPA), (3) routine standardization of titrating solutions used in procedures, and (4) duplicate analyses.

Because spikes are not run for biochemical oxygen demand, pH, alkalinity, and chloride analyses, the quality of these results is dependent on the standardization of standards and instrument calibration. Evaluations of the stability of reagents are determined. Some standards must be standardized daily; however, other standards are stable for varying but known amounts of time. Stability has been improved by storing in dark bottles or away from light. Standardization is done before significant changes occur.

Samples sometime require digestion in order to break down organic compounds which may contain the element of interest in their chemical structure. Unless the organic molecule is fragmented by digestion, this element may not exhibit the chemical properties which indicate its presence. The efficiency of the digestion process for samples is evaluated by digesting prepared standard organic compounds.

TABLE A-1
SENSITIVITY AND STANDARD DEVIATIONS OF LABORATORY ANALYSES

Analysis	Sample Type	Length of Count, Minutes	Standard Aliquot	Sensitivity and Precision (95% Confidence Level)	Units
			Zinc Sulfide Alpha Counters		
Gross alpha	Water	20	1 l	0.25 ± 0.13	pCi/l
	Vegetation	20	2 g	0.12 ± 0.06	pCi/g
	Rain (collection pan)	20	0.37 m^2	0.07 ± 0.04	nCi/m^2 E-02 (0.0007 ± 0.0004 nCi/m^2
	Air	20	∿800 m^3	0.03 ± 0.02	pCi/m^3 E-02 (0.0003 ± 0.0002 pCi/m^3
Uranium or plutonium (alpha)	Food	20	100 g	0.002 ± 0.001	pCi/g
			Gas Flow Proportional Beta Counters		
Gross beta	Water	10	1 l	7.1 ± 0.39	pCi/l
	Vegetation	10	2 g	3.5 ± 0.20	pCi/g
	Air	10	∿800 m^3	0.88 ± 0.05	pCi/m^3 E-02 (0.0088 ± 0.0005 pCi/m^3
$^{89,90}Sr$	Bone	10	2 g	4.5 ± 0.25	pCi/g
	Rain	10	0.37 m^2	0.02 ± 0.001	nCi/m^2
	Air composites				
	Plant perimeter	10	∿19,500 m^3	0.10 ± 0.001	pCi/m^3 E-02 (0.0010 ± 0.00001 pCi/m^3
	25-mile radius	10	∿18,000 m^3	0.11 ± 0.001	pCi/m^3 E-02 (0.0011 ± 0.00001 pCi/m^3
	100-mile radius	10	∿6,000 m^3	0.33 ± 0.02	pCi/m^3 E-02 (0.0033 ± 0.0002 pCi/m^3
			Low Background Beta Counter		
^{90}Sr	River water	50	20 l	0.02 ± 0.002	pC
	Milk	50	0.5 l	1.10 ± 0.12	pC
	Food	50	20 g	0.02 ± 0.002	pC
	Rain	50	0.37 m^2	0.004 ± 0.0004	nCi
			Liquid Scintillation Counters		
Tritium	Drinking water	300	4 ml	300 ± 10	pCi/l (0.30 ± 0.01 pCi/
	River water	300	4 ml	300 ± 10	pCi/l (0.30 ± 0.01 pCi/
	Rainwater	300	4 ml	300 ± 10	pCi/l (0.30 ± 0.01 pCi/
	Milk	300	4 ml	300 ± 10	pCi/l (0.30 ± 0.01 pCi/
	Air (atmospheric moisture)	300	4 ml (water)	300 ± 10	pCi/l (0.30 ± 0.01 pCi/ (x avg abs humidity = ∿4 pCi/m^3 of a
	Food	20	3 ml	1 ± 0.05	pCi/ml (free wat
	Vegetation	20	3 ml	1 ± 0.05	pCi/ml (free wat
			Alpha Spectrometer Surface Barrier Detectors		
^{238}Pu	Air composites				
	Plant perimeter	72[a]	∿19,500 m^3	0.36	aCi
	25-mile radius	72[a]	∿18,000 m^3	0.39	aCi
	100-mile radius	72[a]	∿6,000 m^3	1.18	aCi
	Rain composites				
	Plant perimeter	72[a]	4.8 m^2	0.0020	pCi
	25-mile radius	72[a]	4.4 m^2	0.0022	pCi
	Soil	24[a]	10 g	0.001	pC
^{239}Pu	Air composites				
	Plant perimeter	72[a]	∿19,500 m^3	0.35	aCi
	25-mile radius	72[a]	∿18,000 m^3	0.38	aCi
	100-mile radius	72[a]	∿6,000 m^3	1.12	aCi
	Rain composites				
	Plant perimeter	72[a]	4.8 m^2	0.0019	pCi
	25-mile radius	72[a]	4.4 m^2	0.0021	pCi
	Soil	24[a]	10 g	0.001	pC
			Na(I) Detector (9 x 9 in.)		
^{131}I	Milk	200	3.8 l	1.0 ± 0.5	pC
	Vegetation	10	50 g	0.2 ± 0.01	pC
^{137}Cs	Milk	200	1.8 l	3 ± 2	pC

[a] Hours

TABLE A-2

INTERLABORATORY COMPARISON OF ANALYTICAL RESULTS

Analysis and Sample Date	Number of Labs Participating	Reported Values pCi/Unit EML	SRP	Mean of All Labs	Ratio: % SRP/EML x 100	Percent of Participating Labs Within ±20% of EML
Air						
^{7}Be						
April	11	1,600	1,010	1,300	63	13
October	8	1,470	1,410	1,680	96	70
^{54}Mn						
October	17	54	58	55	107	88
^{57}Co						
January	19	116	190	134	164	79
^{58}Co						
July	23	279	303	283	109	61
^{60}Co						
October	23	135	130	143	96	83
^{95}Zr						
April	8	87.8	75.5	89.6	86	47
October	19	252	260	288	103	70
^{90}Sr						
January	12	13.5	18.0	14.0	133	46
October	10	10.1	13.0	13.2	128	29
^{106}Ru						
January	15	175	314	209	180	56
July	17	500	720	704	144	20
^{125}Sb						
January	17	749	808	723	108	65
October	20	1,460	2,120	1,570	145	75
^{134}Cs						
January	15	98.5	151	108	153	67
July	24	288	340	345	118	63
^{137}Cs						
April	16	132	131	151	99	42
July	24	347	330	336	95	83
October	23	130	145	155	112	71
^{144}Ce						
October	21	2,940	3,250	3,590	111	64
^{238}Pu						
July	14	2.97	3.0	3.08	101	93
^{239}Pu						
January	17	0.53	0.52	0.60	98	58
April	11	0.640	0.669	0.699	105	57
July	16	2.43	2.60	2.84	107	75
October	18	0.60	0.62	0.64	103	84
Water						
^{3}H						
January	18	12.4	14.0	12.8	113	77
April	18	24.5	23.0	25.1	94	80
July	17	30.4	34.0	33.4	112	76
October	18	13.4	14.0	14.4	105	78
^{54}Mn						
January	18	0.737	0.82	0.76	111	89
^{57}Co						
October	19	0.67	1.0	0.84	148	50
^{60}Co						
January	21	0.871	0.97	0.866	111	86
April	16	1.21	1.18	1.22	98	94
October	19	1.24	1.30	1.27	105	80
^{65}Zn						
July	12	2.32	2.51	2.51	108	85
^{90}Sr						
January	11	0.23	0.26	0.237	113	47
^{134}Cs						
April	15	1.17	1.28	1.23	109	93
July	17	1.13	1.33	1.28	118	65
^{137}Cs						
January	22	0.98	1.10	1.05	112	82
April	15	1.21	1.29	1.23	107	87
July	14	1.52	1.60	1.60	105	81
October	20	1.24	1.20	1.20	97	97
^{144}Ce						
April	14	20.4	23.1	22.9	113	79
^{238}Pu						
April	7	0.009	0.0071	0.0063	79	0
July	11	0.009	0.0079	0.0085	88	91
October	11	0.0104	0.0073	0.0086	70	31
^{239}Pu						
January	12	0.0023	0.0016	0.00225	70	35
April	7	0.009	0.0072	0.0065	80	9
July	12	0.0081	0.0069	0.0086	85	75

TABLE A-2 (cont'd)
INTERLABORATORY COMPARISON OF ANALYTICAL RESULTS

Analysis and Sample Date	Number of Labs Participating	Reported Values pCi/Unit EML	SRP	Mean of All Labs	Ratio: % SRP/EML x 100	Percent of Participating Labs Within ±20% of EML
Soil						
^{40}K						
January	15	21.6	23.0	21.0	106	87
April	3	2.8	1.04	3.0	37	11
July	8	2.45	2.65	2.97	108	36
October	12	7.93	8.8	9.61	111	43
^{60}Co						
July	15	0.668	0.66	0.726	99	73
^{90}Sr						
January	13	0.20	0.23	0.215	115	85
April	7	0.225	0.43	0.27	191	30
^{137}Cs						
January	17	0.24	0.25	0.246	104	67
April	11	0.577	0.619	0.593	107	69
July	14	60.8	56.0	60.5	92	80
^{226}Ra						
October	8	0.69	0.62	0.697	90	63
^{238}Pu						
April	6	0.006	0.006	0.0068	100	50
July	10	0.032	0.028	0.0326	84	36
^{239}Pu						
January	13	0.81	0.75	0.742	93	69
April	11	1.88	1.70	1.91	90	73
July	13	0.60	0.50	0.552	83	85
Vegetation						
^{40}K						
January	11	225	260	214	116	82
April	10	167	182	189	109	36
October	10	215	210	241	98	55
^{90}Sr						
October	9	3.4	3.3	2.8	98	60
^{137}Cs						
January	9	0.256	0.33	0.276	129	64
April	10	0.28	0.23	0.266	114	42
October	12	0.27	0.30	0.325	111	50
^{226}Ra						
October	8	0.10	0.11	0.122	110	63
Tissue						
^{40}K						
January	8	8.4	9.3	9.62	111	75
July	4	1.4	3.3	1.81	236	0
^{90}Sr						
April	11	3.37	2.67	3.76	79	36
July	9	2.33	3.0	2.42	129	67
^{238}Pu						
April	3	0.001	0.002	0.0018	200	0
^{239}Pu						
January	7	0.0034	0.0032	0.0033	94	25
April	6	0.021	0.023	0.022	110	57

APPENDIX B

SURVEY DATA

TABLE B-1
RADIOACTIVITY IN AIR

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
	ALPHA , PCI/CU M E-2						
PLANT PERIMETER							
ALLENDALE GATE	49	0.13	±0.09	-0.06	±0.11	0.05	±0.06
A-14	53	0.21	±0.13	-0.01	±0.04	0.06	±0.08
BARNWELL GATE	53	0.15	±0.09	-0.02	±0.03	0.06	±0.08
D AREA	52	0.18	±0.12	-0.04	±0.16	0.06	±0.08
DARK HORSE	52	0.25	±0.15	-0.06	±0.12	0.07	±0.12
EAST TALATHA	53	0.22	±0.11	-0.05	±0.10	0.06	±0.08
GREENPOND	53	0.20	±0.11	-0.03	±0.12	0.08	±0.10
HIGHWAY 21/167	47	0.23	±0.10	-0.09	±0.10	0.07	±0.10
JACKSON	47	0.25	±0.17	0.00	±0.06	0.08	±0.10
PATTERSONS MILL	53	0.26	±0.12	-0.08	±0.10	0.06	±0.10
TALATHA GATE	53	0.16	±0.10	0.00	±0.07	0.06	±0.08
WEST JACKSON	49	0.16	±0.08	-0.01	±0.04	0.07	±0.08
WINDSOR ROAD	53	0.26	±0.16	-0.05	±0.10	0.08	±0.12
AVERAGE						0.06	±0.09
25 MILE RADIUS							
AIKEN AIRPORT	51	0.18	±0.09	-0.02	±0.02	0.06	±0.08
AIKEN STATE PARK	52	0.17	±0.08	-0.01	±0.04	0.07	±0.08
ALLENDALE	53	0.19	±0.09	0.00	±0.07	0.06	±0.08
AUGUSTA	52	0.25	±0.11	-0.02	±0.02	0.13	±0.10
HIGHWAY 301	50	0.21	±0.11	0.01	±0.06	0.08	±0.08
LANGLEY	52	0.39	±0.05	0.01	±0.04	0.09	±0.12
LEES	51	0.20	±0.10	0.00	±0.03	0.09	±0.08
OLAR	52	0.17	±0.10	0.00	±0.05	0.08	±0.08
PERKINS	52	0.32	±0.13	-0.01	±0.03	0.07	±0.12
SOUTH RICHMOND	52	0.22	±0.10	0.01	±0.03	0.09	±0.08
SPRINGFIELD	52	0.20	±0.10	0.01	±0.04	0.07	±0.08
WAYNESBORO	52	0.21	±0.09	-0.01	±0.05	0.08	±0.10
AVERAGE						0.08	±0.10
100 MILE RADIUS							
COLUMBIA	52	0.43	±0.18	0.03	±0.05	0.13	±0.14
GREENVILLE	46	0.31	±0.13	0.01	±0.05	0.10	±0.12
MACON	45	0.23	±0.10	-0.02	±0.05	0.09	±0.10
SAVANNAH	47	0.23	±0.12	0.00	±0.03	0.09	±0.10
AVERAGE						0.10	±0.12

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
	NONVOL BETA , PCI/CU M E-2						
PLANT PERIMETER							
ALLENDALE GATE	49	5.0	±1.0	-0.44	±1.2	2.2	±2.1
A-14	53	8.1	±1.5	0.52	±0.84	2.8	±2.7
BARNWELL GATE	53	4.4	±1.0	-0.13	±1.1	2.1	±2.0
D AREA	52	3.8	±1.3	0.19	±3.2	2.4	±1.9
DARK HORSE	52	4.6	±1.5	0.59	±0.85	2.5	±1.7
EAST TALATHA	53	4.8	±0.83	-0.16	±0.99	2.5	±1.9
GREENPOND	53	4.4	±1.1	0.00	±1.1	2.4	±1.8
HIGHWAY 21/167	47	4.9	±1.1	0.84	±0.86	2.6	±1.9
JACKSON	47	8.1	±2.8	0.02	±0.97	2.6	±2.8
PATTERSONS MILL	53	4.9	±1.0	-0.42	±0.76	2.3	±2.1
TALATHA GATE	53	4.9	±0.99	-0.28	±1.0	2.6	±2.0
WEST JACKSON	49	4.8	±0.98	0.19	±2.4	2.4	±1.9
WINDSOR ROAD	53	4.5	±1.6	-0.29	±0.67	2.2	±2.5
AVERAGE						2.4	±2.1
25 MILE RADIUS							
AIKEN AIRPORT	51	3.8	±0.96	0.19	±0.74	1.8	±1.4
AIKEN STATE PARK	52	4.9	±1.0	0.69	±0.84	2.5	±1.7
ALLENDALE	52	4.0	±1.1	0.46	±0.82	2.0	±2.0
AUGUSTA	52	3.7	±1.1	-0.28	±0.71	2.1	±1.7
HIGHWAY 301	50	5.0	±1.1	0.12	±0.85	2.4	±2.0
LANGLEY	52	4.3	±1.1	0.45	±0.77	2.3	±1.6
LEES	51	3.8	±0.83	0.64	±0.75	2.2	±1.5
OLAR	52	5.6	±1.0	0.28	±0.71	2.5	±2.1
PERKINS	52	5.2	±1.1	-0.32	±0.71	2.2	±1.9
SOUTH RICHMOND	52	4.3	±1.0	0.32	±0.74	2.3	±1.9
SPRINGFIELD	52	4.2	±0.97	0.26	±0.73	2.1	±1.6
WAYNESBORO	52	5.5	±1.2	0.73	±0.71	2.3	±2.0
AVERAGE						2.2	±1.8
100 MILE RADIUS							
COLUMBIA	52	5.3	±1.1	0.81	±0.66	2.6	±2.1
GREENVILLE	45	4.8	±1.4	1.1	±0.63	2.7	±1.8
MACON	44	4.7	±1.1	0.91	±0.93	2.4	±1.8
SAVANNAH	48	4.8	±0.84	-0.04	±0.68	2.2	±2.2
AVERAGE						2.5	±2.0

TABLE B-1 (Contd)
RADIOACTIVITY IN AIR

		BE-7 , PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	37	±4.6	5.3	±2.8	19	±17
25 MILE RADIUS	11	36	±4.4	2.7	±2.3	18	±20
100 MILE RADIUS	11	73	±9.9	10	±7.2	28	±39

		SR-89, 90 , PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	12	0.02	±0.05	-0.02	±0.06	0.00	±0.02
25 MILE RADIUS	11	0.05	±0.05	-0.03	±0.03	0.01	±0.04
100 MILE RADIUS COMP	12	0.10	±0.18	-0.06	±0.14	0.01	±0.08

		ZR-95, NB-95, PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	0.11	±0.17	0.00	±0.14	0.04	±0.08
25 MILE RADIUS	11	0.11	±0.18	0.00	±0.17	0.04	±0.08
100 MILE RADIUS	11	0.31	±0.50	0.00	±0.62	0.11	±0.24

		RU-106 , PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	1.6	±1.7	0.00	±1.8	0.80	±1.3
25 MILE RADIUS	11	1.0	±1.7	0.00	±1.7	0.37	±0.74
100 MILE RADIUS	11	3.7	±4.4	0.00	±5.1	1.3	±2.7

		I-131 , PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	0.71	±1.1	0.00	±0.55	0.12	±0.48
25 MILE RADIUS	11	0.18	±0.63	0.00	±0.51	0.02	±0.10
100 MILE RADIUS	11	2.2	±2.4	0.00	±1.3	0.37	±1.4

		CS-137 , PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	0.56	±0.24	0.13	±0.18	0.26	±0.28
25 MILE RADIUS	11	0.61	±0.20	0.06	±0.15	0.24	±0.38
100 MILE RADIUS	11	1.5	±0.59	0.06	±0.53	0.48	±0.88

		CE-144 , PCI/CU M E-2					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	0.58	±0.65	0.00	±0.60	0.23	±0.40
25 MILE RADIUS	11	0.76	±0.81	0.00	±0.73	0.22	±0.54
100 MILE RADIUS	11	1.8	±2.2	0.00	±2.6	0.36	±1.1

		PU-238 , ACI/CUBIC M					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	7.6	±2.6	0.16	±1.1	1.7	±4.4
25 MILE RADIUS	12	3.3	±3.8	0.32	±0.67	1.3	±2.1
100 MILE RADIUS COMP	11	1.8	±0.78	0.51	±0.37	1.1	±0.88

		PU-239 , ACI/CUBIC M					
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	11	17	±1.6	0.00	±0.31	8.1	±11
25 MILE RADIUS	12	15	±1.8	0.05	±0.25	8.0	±11
100 MILE RADIUS COMP	11	16	±6.5	0.40	±0.56	7.6	±10

TABLE B-1 (Contd)

RADIOACTIVITY IN AIR

	H-3, PCI/CU M						
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
PLANT PERIMETER							
ALLENDALE GATE	24	51	±2.1	8.0	±1.3	27	±28
A-14	15	120	±5.6	21	±1.9	60	±56
BARNWELL GATE	20	78	±2.4	16	±4.9	51	±40
D-AREA	20	270	±6.3	41	±3.9	110	±110
DARKHORSE	24	140	±5.4	11	±1.6	56	±74
EAST TALATHA	16	75	±3.8	3.3	±0.86	38	±44
GREENPOND	23	130	±5.6	6.6	±2.3	52	±59
HIGHWAY 21/167	21	110	±5.3	8.6	±1.4	52	±61
JACKSON	24	140	±5.5	4.1	±0.86	49	±69
PATTERSON'S MILL	24	79	±3.8	2.8	±1.0	35	±34
TALATHA GATE	25	280	±6.4	14	±3.0	69	±120
WEST JACKSON	16	210	±6.2	19	±3.2	61	±94
WINDSOR ROAD	19	110	±5.3	14	±4.9	54	±70
AVERAGE						55	±79
25 MILE RADIUS							
AIKEN AIRPORT	22	92	±5.4	4.0	±0.82	23	±44
AIKEN STATE PARK	23	66	±2.4	3.8	±2.8	21	±33
ALLENDALE	25	23	±3.0	2.2	±4.7	11	±13
AUGUSTA	24	77	±3.4	2.1	±1.0	21	±37
HIGHWAY 301	25	74	±4.9	2.8	±3.7	15	±32
LANGLEY	25	75	±5.2	3.4	±4.8	19	±31
LEES	20	56	±4.7	3.2	±3.7	19	±27
OLAR	24	45	±3.6	3.0	±0.85	18	±23
PERKINS	24	97	±5.1	2.0	±1.3	18	±44
SOUTH RICHMOND	19	140	±5.4	5.6	±0.86	26	±58
SPRINGFIELD	19	40	±4.7	3.8	±1.3	20	±24
WAYNESBORO	24	68	±5.2	0.00	±2.8	23	±36
AVERAGE						20	±35
100 MILE RADIUS							
COLUMBIA	2	16	±1.9	16	±4.9	16	-
GREENVILLE	4	27	±4.1	4.0	±4.6	11	-
MACON	4	4.8	±2.6	0.00	±3.4	1.6	-
SAVANNAH	3	18	±2.2	5.1	±1.3	12	-
AVERAGE						10	±16

\- INSUFFICIENT DATA

TABLE B-2

RADIOACTIVITY IN RAINWATER

	H-3, PCI/ML						
LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
PLANT PERIMETER							
ALLENDALE GATE	26	6.0	±0.31	0.00	±0.19	1.1	±2.4
A-14	24	10	±0.43	0.00	±0.23	3.7	±5.4
BARNWELL GATE	21	11	±0.31	0.77	±0.26	2.6	±4.9
D-AREA	20	13	±0.30	0.49	±0.30	4.1	±7.1
DARK HORSE	25	7.2	±0.32	0.87	±0.24	3.4	±3.2
EAST TALATHA	24	11	±0.44	0.10	±0.23	2.0	±4.8
GREEN POND	22	12	±0.44	0.10	±0.22	2.5	±5.0
HIGHWAY 21/167	21	4.0	±0.26	0.00	±0.23	1.6	±2.2
JACKSON	17	2.7	±0.28	0.10	±0.25	1.4	±1.7
PATTERSON'S MILL RD.	25	3.8	±0.26	0.12	±0.18	1.5	±1.9
TALATHA GATE	20	8.7	±0.41	0.00	±0.24	3.5	±5.7
WEST JACKSON	23	7.2	±0.43	1.2	±0.21	4.0	±3.3
WINDSOR ROAD	21	9.9	±0.43	0.13	±0.23	2.8	±4.7
AVERAGE						2.6	±4.7
25 MILE RADIUS							
AIKEN AIRPORT	21	5.2	±0.30	0.00	±0.20	1.4	±2.9
AIKEN STATE PARK	25	6.9	±0.68	0.03	±0.19	1.3	±3.2
ALLENDALE	24	1.1	±0.32	0.00	±0.19	0.42	±0.74
AUGUSTA	19	1.7	±0.24	0.00	±0.22	0.64	±1.1
HIGHWAY 301	13	5.8	±0.31	0.00	±0.19	0.94	±3.0
LANGLEY	25	5.9	±0.24	0.00	±0.19	1.2	±2.5
LEES	22	4.3	±0.22	0.20	±0.19	1.2	±2.3
OLAR	26	1.4	±0.24	0.00	±0.23	0.47	±0.74
PERKINS	21	3.1	±0.25	0.00	±0.19	0.66	±1.4
SOUTH RICHMOND	24	3.1	±0.22	0.00	±0.22	0.81	±1.8
SPRINGFIELD	23	3.1	±0.64	0.00	±0.20	0.71	±1.4
WAYNESBORO	15	2.4	±0.28	0.00	±0.23	0.65	±1.3
AVERAGE						0.86	±2.1

\- INSUFFICIENT DATA

TABLE B-2 (Contd)

RADIOACTIVITY IN RAINWATER

LOCATION	NO. OF SAMPLE	ALPHA (NCI/SQ M E-2)	NONVOL BETA (NCI/SQ M)	SR-90 (NCI/SQ M E-2)	ZR-95, NB-95 (NCI/SQ M)	BE-7 (NCI/SQ M)	CE-144 (NCI/SQ M)	CS-137 (NCI/SQ M)	I-131 (NCI/SQ M)	RU-106 (NCI/SQ M)
PLANT PERIMETER										
ALLENDALE GATE	13	0.71	3.3	50	<0.13	11	<0.30	<0.08	<0.18	<0.56
A-14	13	3.2	2.8	70	<0.08	13	<0.30	<0.08	<0.18	<0.56
BARNWELL GATE	13	0.72	2.4	69	<0.08	13	<0.30	<0.08	<0.18	<0.56
D-AREA	13	3.2	2.4	77	<0.08	7.5	<0.30	<0.08	<0.18	<0.56
DARK HORSE	13	4.3	2.9	61	<0.08	10	<0.30	0.08	<0.18	<0.56
EAST TALATHA	13	1.4	3.0	77	<0.08	12	<0.30	0.08	<0.18	<0.56
GREEN POND	13	<0.39	2.3	67	<0.08	12	<0.30	<0.08	<0.23	<0.57
HIGHWAY 21/167	13	3.4	3.2	82	<0.08	18	<0.30	<0.08	<0.19	<0.56
JACKSON	13	1.3	0.92	26	<0.08	2.9	<0.30	<0.08	<0.18	<0.56
PATTERSON'S MILL RD.	13	1.4	3.1	73	<0.08	16	<0.30	<0.08	<0.18	<0.56
TALATHA GATE	13	4.3	3.8	90	<0.08	15	<0.30	<0.08	<0.18	<0.56
WEST JACKSON	13	1.5	1.1	46	<0.08	2.0	<0.30	<0.08	<0.18	<0.56
WINDSOR ROAD	12	3.1	2.4	53	<0.08	13	<0.30	0.09	<0.18	<0.56
AVG ->		2.4	2.6	65		11		0.08		
2 STD DEV ->		±2.9	±1.6	±34		±9.5		±0.08		
25 MILE RADIUS										
AIKEN AIRPORT	13	1.8	3.2	69	<0.08	14	0.34	<0.08	<0.19	<0.56
AIKEN STATE PARK	13	3.9	1.4	51	<0.08	1.6	<0.30	<0.08	<0.18	<0.56
ALLENDALE	13	2.9	2.3	51	<0.08	8.2	<0.30	<0.08	<0.18	<0.56
AUGUSTA	13	3.5	1.6	48	<0.08	7.8	<0.30	<0.08	<0.18	<0.56
HIGHWAY 301	13	2.5	2.6	93	<0.08	13	<0.30	<0.09	<0.22	<0.57
LANGLEY	13	4.5	1.8	83	<0.08	10	<0.30	<0.08	<0.18	<0.56
LEES	13	1.6	1.5	41	0.10	5.5	<0.36	0.33	<0.19	<0.56
OLAR	13	2.7	3.0	74	<0.08	11	<0.30	<0.08	<0.18	<0.56
PERKINS	13	2.6	1.4	33	<0.08	3.1	<0.30	<0.08	<0.18	<0.56
SOUTH RICHMOND	13	1.3	1.4	40	<0.08	7.4	<0.30	<0.08	<0.18	<0.56
SPRINGFIELD	13	1.2	2.0	42	<0.08	8.4	<0.30	<0.08	<0.18	<0.56
WAYNESBORO	13	4.4	2.7	20	<0.08	12	<0.30	<0.08	<0.18	<0.56
AVG ->		2.7	2.1	62	0.10	8.6	0.34			
2 STD DEV ->		±2.3	±1.3	±52	±0.06	±7.8	±0.20			
100 MILE RADIUS										
COLUMBIA, SC	4	2.4	3.5	60	<0.07	13	0.31	0.31	<0.07	<0.56
GREENVILLE, SC	4	3.2	4.1	80	<0.08	14	<0.30	0.22	<0.10	<0.57
MACON, GA	4	3.2	2.0	42	<0.07	8.6	0.33	0.20	<0.08	<0.57
SAVANNAH, GA	4	2.5	2.5	58	<0.07	15	0.73	0.21	<0.10	<0.57
AVG ->		2.8	3.0	60		13	0.46	0.24		
2 STD DEV ->		±0.84	±1.9	±31		±5.6	±0.60	±0.10		

VALUE SHOWN WITH < SYMBOL IS THE MINIMUM DETECTABLE VALUE FOR A MONTHLY SAMPLE

PLUTONIUM IN RAINWATER

LOCATION	NO. OF SAMPLE	PU-238 (PCI/SQ M)	PU-239 (PCI/SQ M)
COMPOSITES			
PLANT PERIMETER COMP	13	0.73	1.1
25 MILE RADIUS COMP	12	0.43	1.3
AVG ->		0.58	1.2
2 STD DEV ->		±0.42	±0.28

TABLE B-3
ENVIRONMENTAL GAMMA RADIATION

Location	TLD, mR/24 Hours							
	No. of Samples	Maximum	CT Error 95% CL	Minimum	CT Error 95% CL	Arithmetic Mean	Arithmetic 2 Std Dev	mR/Year
Plant perimeter								
Allendale Gate	2	0.16	±0.02	0.15	±0.02	0.16	-	58
A-14	2	0.19	±0.02	0.19	±0.02	0.19	-	69
Barnwell Gate	2	0.21	±0.02	0.20	±0.02	0.21	-	77
D-Area	2	0.20	±0.02	0.15	±0.02	0.18	-	66
Dark Horse	2	0.19	±0.02	0.17	±0.02	0.18	-	66
East Talatha	2	0.20	±0.02	0.16	±0.02	0.18	-	66
Green Pond	2	0.19	±0.02	0.18	±0.02	0.19	-	69
Highway 21/167	2	0.17	±0.02	0.16	±0.02	0.17	-	62
Jackson	2	0.22	±0.02	0.20	±0.02	0.21	-	77
Pattersons Mill	2	0.19	±0.02	0.18	±0.02	0.19	-	69
Talatha Gate	1	0.17	±0.02	0.17	±0.02	0.17	-	62
West Jackson	2	0.27	±0.02	0.23	±0.02	0.25	-	91
Windsor Road	2	0.20	±0.02	0.18	±0.02	0.19	-	69
Average						0.19	-	69
25-mile radius								
Aiken Airport	1	0.16	±0.02	0.16	±0.02	0.16	-	58
Aiken State Park	2	0.19	±0.02	0.17	±0.02	0.18	-	66
Allendale	1	0.20	±0.02	0.20	±0.02	0.20	-	73
Augusta	2	0.22	±0.02	0.18	±0.18	0.20	-	73
Highway 301	1	0.22	±0.02	0.22	±0.02	0.22	-	80
Langley	1	0.21	±0.02	0.21	±0.02	0.21	-	77
Lees	2	0.21	±0.02	0.17	±0.02	0.19	-	69
Olar	1	0.17	±0.02	0.17	±0.02	0.17	-	62
Perkins	2	0.19	±0.02	0.18	±0.02	0.19	-	69
South Richmond	2	0.20	±0.02	0.17	±0.02	0.19	-	69
Springfield	2	0.21	±0.02	0.18	±0.02	0.20	-	73
Waynesboro	1	0.15	±0.02	0.15	±0.02	0.15	-	55
Average						0.19	-	69
100-mile radius								
Columbia	4	0.22	±0.02	0.18	±0.02	0.20	-	73
Greenville	0	-	-	-	-	-	-	-
Macon	3	0.24	±0.02	0.22	±0.02	0.23	-	84
Savannah	3	0.18	±0.02	0.17-	±0.02-	0.18	-	66
Average						0.20	-	74

- Insufficient data.

TABLE B-4
RADIOACTIVITY IN VEGETATION

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
ALPHA, PCI/G							
PLANT PERIMETER							
PP 2 GREENPOND	13	0.80	±0.37	0.07	±0.21	0.26	±0.44
PP 3 AIKEN GATE	13	0.64	±0.35	0.00	±0.16	0.16	±0.36
PP 6 WILLISTON GATE	13	0.77	±0.37	0.03	±0.11	0.32	±0.38
PP 8 PATTERSONS MILL	13	0.58	±0.32	-0.07	±0.16	0.20	±0.40
PP 10 ALLENDALE GATE	13	0.59	±0.37	0.00	±0.16	0.19	±0.32
PP 12 NEAR 400-D	13	0.40	±0.28	-0.10	±0.15	0.15	±0.26
PP 14 NEAR 1G PUMP H	12	0.20	±0.23	-0.03	±0.18	0.06	±0.16
AVERAGE						0.19	±0.37
25 MILE RADIUS							
25 MR 2 AUGUSTA	13	0.26	±0.23	-0.03	±0.23	0.07	±0.20
25 MR 3 LANGLEY	13	0.57	±0.33	-0.03	±0.18	0.17	±0.40
25 MR 5 AIKEN ST PK	13	0.30	±0.28	0.00	±0.19	0.11	±0.20
25 MR 8 OLAR	13	0.43	±0.27	-0.03	±0.15	0.10	±0.28
25 MR 10 ALLENDALE	13	0.33	±0.33	-0.03	±0.15	0.15	±0.22
25 MR 12 PERKINS	13	0.33	±0.26	-0.07	±0.26	0.06	±0.20
25 MR 14 WAYNESBORO	13	0.43	±0.33	-0.03	±0.15	0.13	±0.28
AVERAGE						0.11	±0.26
100 MILE RADIUS							
COLUMBIA	4	0.23	±0.23	0.00	±0.30	0.09	-
GREENVILLE	2	0.20	±0.23	0.13	±0.21	0.17	-
MACON	4	0.23	±0.23	-0.07	±0.16	0.08	-
SAVANNAH	4	0.30	±0.26	0.03	±0.20	0.13	-
AVERAGE						0.11	±0.20

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
NONVOL BETA, PCI/G							
PLANT PERIMETER							
PP 2 GREENPOND	12	16	±3.4	3.1	±4.4	10	±7.8
PP 3 AIKEN GATE	13	23	±3.6	2.0	±1.7	13	±12
PP 6 WILLISTON GATE	13	29	±3.9	4.5	±1.8	15	±12
PP 8 PATTERSONS MILL	13	20	±3.7	3.3	±4.4	10	±8.6
PP 10 ALLENDALE GATE	13	26	±3.8	2.0	±1.7	12	±12
PP 12 NEAR 400-D	13	23	±3.8	3.2	±1.7	11	±12
PP 14 NEAR 1G PUMP H	12	24	±3.9	1.1	±4.2	10	±15
AVERAGE						12	±12
25 MILE RADIUS							
25 MR 2 AUGUSTA	13	40	±4.3	1.8	±4.3	12	±21
25 MR 3 LANGLEY	13	46	±4.4	4.0	±1.8	15	±23
25 MR 5 AIKEN ST PK	13	28	±4.0	4.3	±1.8	14	±12
25 MR 8 OLAR	13	43	±4.2	9.2	±3.2	17	±18
25 MR 10 ALLENDALE	13	18	±3.5	3.9	±1.8	12	±7.9
25 MR 12 PERKINS	13	29	±3.8	2.5	±1.7	10	±13
25 MR 14 WAYNESBORO	13	28	±3.8	3.3	±1.7	12	±15
AVERAGE						13	±17
100 MILE RADIUS							
COLUMBIA	4	23	±3.7	8.8	±4.0	16	-
GREENVILLE	2	27	±3.8	18	±3.5	23	-
MACON	4	16	±3.6	7.5	±4.0	12	-
SAVANNAH	4	33	±3.9	4.8	±4.0	16	-
AVERAGE						17	±16

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
H-3, PCI/ML (Free Water)							
PLANT PERIMETER							
PP 2 GREENPOND	10	11	±0.29	0.41	±0.19	4.1	±7.6
PP 3 AIKEN GATE	8	12	±0.32	0.77	±0.28	4.4	±8.3
PP 6 WILLISTON GATE	10	11	±0.31	0.41	±0.19	4.4	±7.0
PP 8 PATTERSONS MILL	8	10	±0.66	0.44	±0.19	2.6	±6.5
PP 10 ALLENDALE GATE	9	4.8	±0.75	0.35	±0.19	2.0	±3.3
PP 12 NEAR 400-D	11	31	±1.2	2.8	±0.28	13	±22
PP 14 NEAR 1G PUMP H	10	38	±3.2	1.3	±0.21	8.6	±21
AVERAGE						5.5	±15
25 MILE RADIUS							
25 MR 2 AUGUSTA	9	13	±1.6	0.51	±0.17	3.6	±8.9
25 MR 3 LANGLEY	10	10	±0.46	0.29	±0.19	3.0	±7.4
25 MR 5 AIKEN ST PK	10	8.0	±0.44	0.13	±0.20	1.9	±4.6
25 MR 8 OLAR	10	3.3	±0.22	0.00	±0.19	0.92	±1.9
25 MR 10 ALLENDALE	9	3.9	±0.23	0.00	±0.19	1.0	±2.8
25 MR 12 PERKINS	11	2.8	±0.22	0.52	±0.23	0.96	±1.3
25 MR 14 WAYNESBORO	9	3.3	±0.72	0.23	±0.19	1.6	±2.0
AVERAGE						1.9	±5.1
100 MILE RADIUS							
COLUMBIA	4	1.8	±0.19	0.15	±0.22	0.82	-
GREENVILLE	2	0.63	±0.19	0.33	±0.33	0.48	-
MACON	3	0.09	±0.23	0.00	±0.74	0.04	-
SAVANNAH	4	1.3	±0.24	0.32	±0.19	0.73	-
AVERAGE						0.51	±1.1

- INSUFFICIENT DATA

TABLE B-4 (Contd)
RADIOACTIVITY IN VEGETATION

BE-7, PCI/G

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	13	14	±6.5	1.8	±7.6	5.6	±8.4
25 MILE RADIUS	13	16	±7.2	1.9	±5.9	5.9	±8.7
COLUMBIA	4	3.9	±6.0	0.00	±6.7	1.8	-
GREENVILLE	2	3.6	±7.1	0.00	±4.0	1.8	-
MACON	4	14	±11	2.1	±4.3	5.5	-
SAVANNAH	4	3.6	±7.7	2.3	±4.9	2.9	-
AVERAGE						3.9	±8.1

K-40, PCI/G

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	13	14	±6.5	2.8	±5.7	5.8	±5.9
25 MILE RADIUS	13	14	±3.8	0.00	±5.5	7.1	±8.8
COLUMBIA	4	19	±6.2	10	±4.7	14	-
GREENVILLE	2	23	±7.6	8.8	±2.9	16	-
MACON	4	19	±5.0	4.5	±6.1	11	-
SAVANNAH	4	37	±5.7	4.4	±6.8	15	-
AVERAGE						11	±14

RU-103, 106, PCI/G

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	13	2.3	±4.6	0.00	±3.3	0.99	±1.6
25 MILE RADIUS	13	1.7	±5.1	0.00	±5.1	0.49	±1.2
COLUMBIA	4	1.9	±3.5	0.00	±4.3	0.75	-
GREENVILLE	2	2.4	±5.1	0.00	±2.0	1.2	-
MACON	4	1.2	±3.3	0.00	±6.4	0.48	-
SAVANNAH	4	0.96	±4.7	0.00	±5.3	0.48	-
AVERAGE						0.73	±1.5

I-131, PCI/G

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	13	5.2	±17	0.07	±0.65	0.90	±2.7
25 MILE RADIUS	13	6.0	±14	0.20	±1.1	1.2	±3.2
COLUMBIA	4	16	±18	0.13	±0.59	4.3	-
GREENVILLE	2	0.00	±5.9	0.00	±12	0.00	-
MACON	4	4.1	±5.9	0.15	±0.47	1.5	-
SAVANNAH	4	0.49	±2.2	0.00	±3.4	0.23	-
AVERAGE						1.4	±5.3

CS-134, 137, PCI/G

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	13	4.8	±0.56	0.09	±0.46	0.81	±2.5
25 MILE RADIUS	13	0.58	±0.75	0.00	±0.51	0.34	±0.38
COLUMBIA	4	0.24	±0.42	0.00	±0.55	0.14	-
GREENVILLE	2	0.69	±0.26	0.53	±0.67	0.61	-
MACON	4	0.73	±0.56	0.31	±1.1	0.50	-
SAVANNAH	4	0.41	±0.67	0.27	±0.70	0.36	-
AVERAGE						0.46	±1.5

CE-141, 144, PCI/G

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
SPECIFIC NUCLIDES							
PLANT PERIMETER	13	1.7	±2.7	0.00	±2.4	0.71	±1.0
25 MILE RADIUS	13	2.0	±3.1	0.00	±2.9	0.76	±1.3
COLUMBIA	4	1.6	±2.1	0.01	±2.5	1.1	-
GREENVILLE	2	1.0	±3.1	0.00	±1.3	0.50	-
MACON	4	1.1	±2.0	0.38	±5.0	0.76	-
SAVANNAH	4	0.90	±3.2	0.00	±2.3	0.52	-
AVERAGE						0.72	±1.1

- INSUFFICIENT DATA

TABLE B-5

RADIOACTIVITY IN MILK [a]

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
	H-3, PCI/ML						
MILK SAMPLES							
LANGLEY, SC KEYS	16	1.7	±0.21	0.36	±0.27	1.1	±0.78
WAYNESBORO, GA BOYCE	24	2.6	±0.26	0.00	±0.30	0.60	±1.2
WILLISTON, SC WINFLD	13	3.9	±0.65	0.45	±0.24	1.5	±1.9
BORDENS MAJOR DISTR	25	2.0	±0.24	0.00	±0.23	0.39	±0.82

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
	SR-90, PCI/L						
MILK SAMPLES							
LANGLEY, SC KEYS	4	12	±2.8	5.2	±5.3	8.6	-
WAYNESBORO, GA BOYCE	4	5.0	±2.5	0.58	±4.7	2.6	-
WINFIELD	3	9.1	±2.9	7.5	±2.8	8.5	-
BORDENS MAJOR DISTR	4	6.2	±6.9	3.6	±2.3	4.8	-

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
	CS-137, PCI/L						
MILK SAMPLES							
LANGLEY, SC KEYS	5	7.8	±2.3	0.43	±2.2	4.4	-
WAYNESBORO, GA BOYCE	6	7.8	±1.5	0.31	±2.1	4.2	-
WILLISTON, SC WINFLD	2	13	±2.5	0.09	±2.8	6.4	-
BORDENS MAJOR DISTR	6	20	±2.3	1.1	±1.7	8.5	-

- INSUFFICIENT DATA

[a] ^{131}I less than 1 pCi/l all samples

TABLE B-6

RADIOACTIVITY IN FOOD, pCi/g

(wet weight)

	No. of Samples	^{90}Sr Maximum	^{90}Sr Minimum	^{90}Sr Average	^{95}Zr, ^{95}Nb Maximum	^{95}Zr, ^{95}Nb Minimum	^{95}Zr, ^{95}Nb Average	^{106}Ru Maximum	^{106}Ru Minimum	^{106}Ru Average	^{131}I Maximum	^{131}I Minimum	^{131}I Average
Collards	14	a	a	a	<0.06	<0.06	<0.06	<0.40	<0.40	<0.40	<3.0	<3.0	<3.0
Plums	14	0.07	0.02	0.04	<0.05	<0.05	<0.05	<0.35	<0.35	<0.35	<2.6	<2.6	<2.6
Oats, rye, & wheat	10	0.29	0.10	0.16	<0.06	<0.06	<0.06	<0.40	<0.40	<0.40	<3.0	<3.0	<3.0
Corn	14	0.09	0.03	0.06	<0.04	<0.04	<0.04	<0.34	<0.34	<0.34	<0.3	<0.3	<0.3
Chicken	4	0.08	0.05	0.06	<0.03	<0.03	<0.03	<0.34	<0.34	<0.34	<0.1	<0.1	<0.1

	No. of Samples	^{137}Cs Maximum	^{137}Cs Minimum	^{137}Cs Average	$^{141,144}Ce$ Maximum	$^{141,144}Ce$ Minimum	$^{141,144}Ce$ Average	Tritium, pCi/ml, Free Water Maximum	Tritium, pCi/ml, Free Water Minimum	Tritium, pCi/ml, Free Water Average
Collards	14	0.10	<0.03	<0.03	<0.97	<0.97	<0.97	1.2	0.1	0.6
Plums	14	<0.03	<0.03	<0.03	<0.15	<0.15	<0.15	3.3	0.6	1.6
Oats, rye, & wheat	10	0.06	<0.03	<0.03	<0.18	<0.18	<0.18	2.7	0.2	0.9
Corn	14	<0.03	<0.03	<0.03	<0.15	<0.15	<0.15	4.1	0.8	2.0
Chicken	4	<0.03	<0.03	<0.03	<0.14	<0.14	<0.14	1.7	0.2	1.1

[a] No analysis.

TABLE B-7

RADIOACTIVITY AND MERCURY IN SAVANNAH RIVER FISH

^{137}Cs pCi/g (wet weight) - Mercury, μg/g (wet weight)

Location	No. of Fish Assayed			^{137}Cs (Whole Fish) Bass			Bream[a]			Catfish[b]			$^{89,90}Sr$ Bone[c]		
	Bass	Bream	Catfish	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Above SRP boundary	4	1	11	6.5	0.2	1.6	<0.2	<0.2	<0.2	<0.3	<0.3	<0.3	9.9	<6.2	5.0
Adjacent to SRP	1	3	6	<0.2	<0.2	<0.2	1.7	<0.3	0.8	<0.3	<0.3	<0.3	150.5	<8.3	17.8
Below SRP at Highway 301	0	0	3	-	-	-	-	-	-	<0.4	<0.4	<0.4	7.8	7.8	7.8

Location	No. of Fish Assayed			Tritium, pCi/ml (Free Water) Bass[c]			Bream[a,c]			Catfish[b,c]		
	Bass	Bream	Catfish	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Above SRP boundary	0	1	11	-	-	-	2.5	2.5	2.5	0.6	0.4	0.5
Adjacent to SRP	1	3	6	15.5	15.5	15.5	3.5	3.0	3.2	3.6	3.0	3.5
Below SRP at Highway 301	0	1	3	-	-	-	19	19	19	2.0	2.0	2.0

Location	Mercury No. of Fish Assayed			μg/g (Wet Weight)		
	Bass	Bream	Catfish	Bass	Bream	Catfish
Above SRP boundary	-	-	3	-	-	<0.2
Below SRP at Highway 301	-	-	3	-	-	<0.2
Clark Hill (control)	2	3	-	0.2	<0.2	-

\- No analysis.

a Shell cracker, bluegill, and redbreast (Leopomis).

b Predominantly yellow cat (Ictalurus).

c Bass, bream, and catfish composited monthly.

TABLE B-8

RADIOACTIVITY IN DEER AND HOGS

(wet weight)

No. of Animals	Species	pCi/g Flesh ^{137}Cs Max	Avg	Bone $^{89,90}Sr$ Max	Avg	fCi/g Bone ^{238}Pu Max	Avg	^{239}Pu Max	Avg
1,079	Deer	98	10	-	-	4	0.6	4	0.7
61	Hogs	7	2	-	-	-	-	-	-

\- No analysis.

TABLE B-9
RADIOACTIVITY IN SAVANNAH RIVER WATER

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
			ALPHA, PCI/L				
SAVANNAH RIVER							
R-2 DISSOLVED	50	0.60	±0.58	-0.20	±0.35	0.15	±0.34
R-2 SUSPENDED	50	0.40	±0.46	-0.27	±0.33	0.07	±0.28
R-4 ABOVE 4 MILE CK	52	0.60	±0.52	-0.20	±0.35	0.11	±0.30
R-8 BELOW STEEL CK	52	1.3	±0.63	-0.20	±0.35	0.24	±0.54
R-9 BELOW L3R CREEK	52	0.54	±0.54	-0.20	±0.35	0.10	±0.32
R-10 DISSOLVED	50	1.4	±0.65	-0.27	±0.38	0.18	±0.60
R-10 SUSPENDED	50	0.47	±0.48	-0.20	±0.30	0.06	±0.26
CONTROL							
EDISTO RIVER	52	2.0	±0.77	0.13	±0.32	0.80	±0.76

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
			NONVOL BETA, PCI/L				
SAVANNAH RIVER							
R-2 DISSOLVED	50	11	±6.2	-2.2	±6.0	1.3	±4.9
R-2 SUSPENDED	50	4.3	±5.9	-6.0	±5.6	0.48	±2.5
R-4 ABOVE 4 MILE CK	52	5.5	±5.7	-4.3	±5.6	1.4	±4.8
R-8 BELOW STEEL CK	52	5.9	±6.0	-5.0	±5.4	1.5	±4.2
R-9 BELOW L3R CREEK	52	7.4	±6.0	-5.1	±5.6	0.93	±4.3
R-10 DISSOLVED	50	9.8	±6.1	-5.4	±5.5	2.0	±5.2
R-10 SUSPENDED	50	3.2	±5.8	-5.8	±5.8	1.10	-
CONTROL							
EDISTO RIVER	53	8.9	±6.3	-3.9	±6.0	2.3	±5.1

LOCATION	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
			H-3, PCI/ML				
SAVANNAH RIVER							
R-2 ABOVE PLANT	51	1.4	±0.22	0.00	±0.23	0.38	±0.54
R-4 ABOVE 4 MILE CK	52	6.1	±0.24	0.00	±0.19	1.6	±2.7
R-10 HIGHWAY 301	52	6.2	±0.28	0.86	±0.20	3.1	±2.5
CONTROL							
EDISTO RIVER	52	1.5	±0.20	0.00	±0.25	0.46	±0.54

- INSUFFICIENT DATA

TABLE B-10
RADIONUCLIDES IN SAVANNAH RIVER WATER

Radionuclide	Minimum Level of Detection	Concentration, pCi/l — 1 Mile Upstream from Upper Three Runs Creek R-2 (Control) Max	Min	Avg	8 Miles Downstream from Lower Three Runs Creek at Highway 301 R-10 Max	Min	Avg	% of CG at Highway 301
^{3}H	300	1,400	0.00	380	6,200	860	3,100	0.10
^{35}S	5.0	ND			ND			<0.01
^{51}Cr	4.3	ND			ND			<0.001
^{54}Mn	0.6	ND			ND			<0.0004
^{60}Co	4.0	ND			ND			<0.005
^{65}Zn	3.0	ND			ND			<0.001
^{89}Sr	0.3	ND			ND			<0.001
^{90}Sr	0.02	2.2	0.02	0.43	0.62	<0.41	0.32	0.11
^{95}Zr-^{95}Nb	0.5	ND			ND			<0.001
$^{103,106}Ru$	3.2	ND			ND			<0.03
^{131}I	0.2	ND			ND			<0.07
^{137}Cs	<0.01	ND			0.022	0.008	0.015	<0.001
^{140}Ba-^{140}La	1.6	ND			ND			<0.01
$^{141,144}Ce$	2.5	ND			ND			<0.02
^{239}Np	2.2	ND			ND			<0.002

ND = Less than minimum level of detection.

TABLE B-11
SAVANNAH RIVER WATER QUALITY

RIVER 2 ABOVE PLANT

PARAMETER	UNITS	NO. OF ANALYSES	MAXIMUM	MINIMUM	ARTHIMETIC MEAN	2 STD DEV
WATER VOLUME	LITERS		1.023E+13(TOTAL)			
TEMPERATURE	DEG C	12	24.5	8.5	17.2	±11.7
PH	PH	12	6.7	5.3		
DISSOLVED O	MG/L	12	11.7	7.4	9.7	±2.7
ALKALINITY	MG/L	12	19.1	6.7	14.1	±7.1
HARDNESS	MG/L	12	20.0	11.2	13.9	±4.4
CONDUCTIVITY	UMHOS	12	92.	8.	60.	±43.
SUSP SOLIDS	MG/L	12	115.	7.	33.	±68.
VOLTL SOLIDS	MG/L	12	95.	16.	30.	±41.
T DIS SOLIDS	MG/L	12	115.	31.	50.	±45.
FIXD RESIDUE	MG/L	12	31.	7.	19.	±17.
BOD	MG/L	12	4.	1.	2.	±2.
LIGNIN	MG/L	12	2.7	<1	1.3	±1.9
CHLORIDE CL	MG/L	12	9.0	2.6	5.9	±4.2
NITRITE N	MG/L	12	.02	<0.02	<0.02	±0.01
NITRATE N	MG/L	12	.84	<0.02	.45	±0.60
SULFATE SO-4	MG/L	12	6.5	<2	5.1	±3.5
SULFIDE S	MG/L	12	.2	<0.1	<0.1	±0.1
TOTL PHOSP P	MG/L	12	1.4	<0.02	.329	±0.7
ALUMINUM AL	MG/L	12	5.0	<0.5	.6	±3.3
AMMONIA NH-4	MG/L	12	<0.1	<0.1	<0.1	
CALCIUM CA	MG/L	12	2.6	1.2	2.0	±0.8
SODIUM NA	MG/L	12	12.5	3.6	6.6	±4.7
TOTL IRON FE	MG/L	12	2.0	<0.1	.3	±1.4

RIVER 5 AT 681-5G

PARAMETER	UNITS	NO. OF ANALYSES	MAXIMUM	MINIMUM	ARTHIMETIC MEAN	2 STD DEV
TEMP.(AIR)	DEG C	12	37	5	22	±19
TEMP.(WATER)	DEG C	12	24	9.0	17	±11
DISSOLVED OXYGEN	MG/L	12	12	6.4	8.8	± 3.7
TURBIDITY	JTU	12	23	5	13	±11
CONDUCTIVITY	MICROMHO	12	84	41	65	±27
BOD	MG/L	12	2.2	0.5	1.2	± 1.1
pH	SU	12	7.1	6.8		
ALKALINITY	MG/L	12	25	13	18	± 7
AMMONIA N	MG/L	12	0.37	0.04	0.18	± 0.24
NITRATE + NITRITE	MG/L	12	0.36	0.14	0.27	± 0.15
TOTL PHOSP	MG/L	11	0.12	0.05	0.07	± 0.07
TOTL ORG CARBON	MG/L	12	5.0	<1.0	2.7	± 2.6

RIVER 10 BELOW PLNT

PARAMETER	UNITS	NO. OF ANALYSES	MAXIMUM	MINIMUM	ARTHIMETIC MEAN	2 STD DEV
WATER VOLUME	LITERS		1.228E+13(TOTAL)			
TEMPERATURE	DEG C	12	24.5	8.5	17.5	±11.9
PH	PH	12	6.8	5.4		
DISSOLVED O	MG/L	12	11.7	8.3	9.7	±2.4
ALKALINITY	MG/L	12	18.0	9.0	14.3	±5.8
HARDNESS	MG/L	12	16.5	12.8	14.8	±2.6
CONDUCTIVITY	UMHOS	12	97.	42.	70.	±30.
SUSP SOLIDS	MG/L	12	86.	6.	26.	±51.
VOLTL SOLIDS	MG/L	12	90.	17.	30.	±38.
T DIS SOLIDS	MG/L	12	120.	28.	52.	±47.
FIXD RESIDUE	MG/L	12	30.	6.	21.	±17.
BOD	MG/L	12	4.	1.	2.	±1.
LIGNIN	MG/L	12	2.4	<1	1.3	±1.4
CHLORIDE CL	MG/L	12	8.0	2.8	5.8	±3.6
NITRITE N	MG/L	12	.02	<0.02	<0.02	±0.01
NITRATE N	MG/L	12	.80	<0.02	.38	±0.58
SULFATE SO-4	MG/L	12	10.6	3.8	6.2	±3.6
SULFIDE S	MG/L	12	.2	<0.1	<0.1	±0.1
T PHOSP PO-4	MG/L	12	1.3	<0.02	.25	±0.7
ALUMINUM AL	MG/L	12	3.6	<0.5	.5	±2.5
AMMONIA NH-4	MG/L	12	.5	<0.1	<0.1	±0.2
CALCIUM CA	MG/L	12	3.0	1.7	2.3	±0.8
SODIUM NA	MG/L	12	12.0	3.8	6.8	±4.2
TOTL IRON FE	MG/L	12	1.8	<0.1	.2	±1.3

TABLE B-12

RADIOACTIVITY IN DRINKING WATER

LOCATION	ALPHA , PCI/L						
	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
TOWN SOURCE							
AIKEN	2	1.3	±0.67	1.1	±0.63	1.2	-
ALLENDALE	2	0.94	±0.60	0.54	±0.50	0.74	-
AUGUSTA	2	1.3	±0.70	0.47	±0.48	0.87	-
BARNWELLN	2	0.20	±0.40	0.07	±0.35	0.14	-
BATH	2	0.74	±0.55	0.27	±0.46	0.51	-
BLACKVILLE	2	0.40	±0.46	0.20	±0.40	0.30	-
CLEARWATER	2	1.9	±0.80	0.67	±0.54	1.3	-
JACKSON	2	6.1	±1.3	0.27	±0.46	3.2	-
LANGLEY	2	0.27	±0.46	0.07	±0.35	0.17	-
NEW ELLENTON	2	1.5	±0.71	1.3	±0.64	1.4	-
NORTH AUGUSTA	2	1.5	±0.73	0.27	±0.42	0.87	-
SARDIS	2	0.20	±0.40	0.07	±0.40	0.14	-
WAYNESBORO	2	0.33	±0.44	0.13	±0.42	0.23	-
WILLISTON	2	1.0	±0.61	0.74	±0.55	0.87	-
AVERAGE						0.84	±2.3
TREATMENT PLANTS							
SAVANNAH RAW	12	1.4	±0.70	0.13	±0.57	0.68	±0.86
SAVANNAH FIN COMP	12	0.33	±0.44	-0.20	±0.41	0.06	±0.28
BEAUFORT RAW COMP	12	0.40	±0.44	-0.13	±0.18	0.10	±0.32

LOCATION	NONVOL BETA , PCI/L						
	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
TOWN SOURCE							
AIKEN	2	4.2	±6.1	1.0	±5.9	2.6	-
ALLENDALE	2	1.4	±5.9	0.82	±5.9	1.1	-
AUGUSTA	2	1.6	±5.9	0.00	±5.8	0.80	-
BARNWELLN	2	0.00	±6.0	-3.0	±5.8	2.50	-
BATH	2	3.6	±6.0	-0.46	±5.8	1.6	-
BLACKVILLE	2	3.8	±6.0	3.7	±6.1	3.8	-
CLEARWATER	2	6.6	±6.1	-1.6	±5.8	2.5	-
JACKSON	2	9.1	±6.4	-2.3	±5.7	3.4	-
LANGLEY	2	0.11	±5.8	-1.4	±5.7	0.63	-
NEW ELLENTON	2	3.5	±6.1	1.3	±6.1	2.4	-
NORTH AUGUSTA	2	4.1	±6.0	1.2	±5.9	2.7	-
SARDIS	2	0.46	±5.8	-1.1	±5.8	0.34	-
WAYNESBORO	2	0.23	±5.8	-0.68	±5.8	0.23	-
WILLISTON	2	1.5	±6.0	-0.35	±5.9	0.57	-
AVERAGE						1.3	±5.2
TREATMENT PLANTS							
SAVANNAH RAW	12	8.6	±6.5	-1.9	±5.8	3.7	±7.0
SAVANNAH FIN COMP	12	3.2	±6.2	-1.6	±6.1	0.74	±2.6
BEAUFORT RAW COMP	12	5.5	±6.1	-3.5	±6.2	1.2	±4.2

LOCATION	H-3 , PCI/ML						
	NO. OF SAMPLES	MAXIMUM	CT ERR 95% CL	MINIMUM	CT ERR 95% CL	ARITHMETIC MEAN	2 STD DEV
TOWN SOURCE							
AIKEN STREAM & WELL	2	0.52	±0.22	0.42	±0.28	0.47	-
ALLENDALE WELL	2	0.19	±0.28	0.18	±0.22	0.19	-
AUGUSTA RIVER	2	0.47	±0.23	0.35	±0.28	0.41	-
BARNWELL WELL	2	0.55	±0.22	0.10	±0.28	0.33	-
BATH WELL	2	0.32	±0.28	0.22	±0.23	0.27	-
BLACKVILLE WELL	2	0.16	±0.23	0.10	±0.28	0.13	-
CLEARWATER LAKE	2	0.49	±0.22	0.26	±0.28	0.38	-
JACKSON WELL	2	0.38	±0.28	0.31	±0.22	0.35	-
LANGLEY WELL	2	0.45	±0.28	0.34	±0.22	0.40	-
NEW ELLENTON WELL	1	0.45	±0.28	0.45	±0.28	0.45	-
NORTH AUGUSTA RIVER	2	0.61	±0.28	0.28	±0.22	0.45	-
SARDIS WELL	2	0.40	±0.22	0.35	±0.28	0.38	-
WAYNESBORO STREAM	2	0.51	±0.20	0.00	±0.22	0.26	-
WILLISTON WELL	2	0.25	±0.23	0.06	±0.28	0.16	-
AVERAGE						0.33	±0.32
TREATMENT PLANTS							
SAVANNAH RAW	12	5.1	±0.24	0.42	±0.24	2.1	±2.7
SAVANNAH FIN COMP	12	4.0	±0.24	1.5	±0.24	2.4	±1.4
BEAUFORT RAW COMP	12	2.9	±0.24	0.22	±0.24	1.3	±1.9

- INSUFFICIENT DATA

TABLE B-13
SAVANNAH RIVER SWAMP -- STEEL CREEK TO LITTLE HELL LANDING
RADIATION MEASUREMENTS (TLD, 1 METER ABOVE GROUND)

Location: River Mile	Location: Trail Number	Distance From River Meters	mR/Day: 1972	Aug 1974	June July 1975	Oct Nov 1975[a]	Aug. Sept 1976	June July 1977	June July 1978	Sept Oct 1979
141.5	1	0	0.27	0.30	0.23	0.21	0.26	0.30 ± 0.03	0.28 ± 0.03	0.27 ± 0.03
		178	0.35	0.35	0.29	0.17	.36	.36 ± .04	.39 ± .03	.35 ± .03
		358	0.58	0.51	0.44	0.31	.60	.54 ± .05	0.54 ± .04	.54 ± .04
		550	-	-	-	0.76	-	1.23 ± .09	1.26 ± .09	1.06 ± .09
		656	1.47	1.60	1.56	0.94	1.85	1.51 ± .11	1.56 ± .10	1.38 ± .10
		805	0.17	0.18	0.15	0.20	0.20	0.19 ± .02	0.16 ± .02	0.20 ± .02
140.8	2	0	0.19	0.22	0.20	0.22	.28	-----	.19 ± .02	-----
		207	0.21	0.26	0.20	0.24	.28	.27 ± .03	.25 ± .02	0.24 ± 0.02
		406	0.19	0.24	0.22	0.22	.27	.28 ± .03	.23 ± .02	.27 ± .02
		598	0.23	0.28	0.22	0.24	.26	-----	.24 ± .02	.24 ± .02
		798	0.29	0.37	0.28	0.27	.35	-----	.34 ± .03	.34 ± .03
		945	-	0.59	0.63	0.54	.58	.62 ± .06	.57 ± .04	.55 ± .04
		975	0.14	0.19	0.20	0.15	.20	.20 ± .02	-----	.18 ± .02
139.5 to 140.8	3	0		0.22		0.19	.23	.23 ± .02	.21 ± .02	0.24 ± .02
		281		0.23		0.17	-	.32 ± .03	.24 ± .02	.24 ± .02
		627		0.23		0.23	.23	.25 ± .03	-----	.23 ± .03
139	4	0		0.30		0.27	.31	.30 ± .03	.24 ± .02	0.29 ± 0.02
		293		0.31		0.25	.33	-----	.26 ± .02	.26 ± .02
		380		0.49		0.32	.46	-----	.37 ± .03	.36 ± .03
		515		0.45		0.26	.40	.46 ± .04	.35 ± .03	.36 ± .03
		580		0.99		0.79	.91	.83 ± .07	.78 ± .06	.72 ± .04
		729		0.22		0.20	.25	.25 ± .03	.19 ± .02	.73 ± .02
138.5	5	0		0.19		0.20	.22	.24 ± .02	.19 ± .02	0.25 ± .02
		534		0.36		0.30	.35	.34 ± .03	.28 ± .03	.31 ± .03
		573		0.61		0.55	.62	.58 ± .05	.51 ± .04	.54 ± .04
		640		1.09		1.03	1.22	1.00 ± .08	.91 ± .07	.87 ± .07
		773		0.24		0.21	0.24	0.26 ± .03	.21 ± .02	.26 ± .02
137	6	0		0.22		0.18	.30	.25 ± .03	.25 ± .02	0.23 ± .02
		549		0.30		0.29	.33	.38 ± .04	.31 ± .03	.32 ± .03
		701		0.84		0.43	.65	.74 ± .06	.68 ± .05	.61 ± .05
		772		0.85		0.62	.77	.94 ± .08	.85 ± .06	.73 ± .06
		817		0.26		0.21	.29	.28 ± .03	.24 ± .02	.23 ± .02
136.3	7	0		0.20		0.19	.21	.25 ± .03	.25 ± .02	0.26 ± .02
		579		0.19		0.16	.21	.24 ± .02	.24 ± .02	.24 ± .02
		793		0.90		0.91	.96	1.08 ± .08	.33 ± .03[b]	.36 ± .03
		823		0.24		0.24	.23	0.27 ± .03	.26 ± .02	.25 ± .02
135.7	8	0	0.20	0.22	0.19	0.19	.20	.27 ± .03	.24 ± .02	0.20 ± .02
		168	0.21	0.25	0.22	0.21	.26	.29 ± .03	.26 ± .02	.26 ± .02
		279	0.23	0.24	0.20	0.15	.23	.28 ± .03	.25 ± .02	.22 ± .02
		445	0.21	0.24	0.22	0.22	.28	.26 ± .03	.25 ± .02	.26 ± .02
		612	0.23	0.24	0.22	0.20	.24	.28 ± .03	.25 ± .02	.27 ± .02
		814	0.34	0.36	0.35	0.28	.39	.44 ± .04	.39 ± .03	.36 ± .03
		884	-	0.64	0.63	0.57	.62	.64 ± .06	.58 ± .04	.57 ± .04
		915	0.22	0.22	0.23	0.22	.23	.27 ± .03	.25 ± .02	.25 ± .02
135.5	9	0		0.22		0.20	.23	.28 ± .03	.25 ± .02	0.24 ± 0.02
		512		0.46		0.36	.44	.50 ± .04	.35 ± .03	.42 ± .03
		621		0.54		0.29	.57	.63 ± .06	.60 ± .05	.56 ± .05
		671		-		0.47	.75	.72 ± .06	.68 ± .05	.66 ± .05
		769		0.18		0.18	.20	.24 ± .02	.21 ± .02	.22 ± .02
134.4	10	0		-		0.18	-	-----	.28 ± .03	0.38 ± 0.03
		30		-		0.28	-	.26 ± .03	.39 ± .03	-----
		73		0.20		0.18	-	.45 ± .04	.20 ± .02	.20 ± .02
Green Pond, near 700 Area (Control)				0.16		0.18	0.17	.16 ± .02	0.17 ± 0.02	.20 ± .02

\- No Measurement.

[a] Lower results are attributed to shielding from higher water levels observed in swamp.

[b] Reason for decrease has not been determined.

± Error associated with the precision observed from known exposures of the same magnitude under similar conditions.

TABLE B-14

RADIOACTIVITY IN SOIL

(0.5 cm depth)

	Concentration, pCi/g (Dry Weight)				Deposition, mCi/km^2			
	^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu	^{90}Sr	^{137}Cs	^{238}Pu	^{239}
Plant Perimeter (5/2/79)								
Northeast	0.17 ± 0.02	0.9 ± 0.03	0.001 ± 0.001	0.019 ± 0.002	12.75 ± 1.50	68 ± 2	0.08 ± 0.08	1.42 ±
Northwest	0.04 ± 0.01	0.5 ± 0.02	0.001 ± 0.001	0.015 ± 0.002	3.00 ± 0.75	38 ± 2	0.08 ± 0.08	1.12 ±
Southeast	0.06 ± 0.02	0.8 ± 0.04	0.001 ± 0.001	0.014 ± 0.002	4.50 ± 1.50	60 ± 3	0.08 ± 0.08	1.05 ±
Southwest	0.10 ± 0.02	0.7 ± 0.02	0.002 ± 0.001	0.014 ± 0.003	7.50 ± 1.50	52 ± 2	0.15 ± 0.08	1.05 ±
Average[a]	0.09 ± 0.18	0.7 ± 0.3	0.001 ± 0.001	0.016 ± 0.004	6.94 ± 8.60	54 ± 26	0.10 ± 0.07	1.16 ±
100-Mile Radius								
Clinton, SC (5/2/79)	0.20 ± 0.02	0.6 ± 0.2	0.001 ± 0.001	0.003 ± 0.001	15.8 ± 1.50	45 ± 5	0.08 ± 0.08	0.30 ±
Savannah, GA (5/2/79)	0.03 ± 0.02	0.8 ± 0.03	0.001 ± 0.001	0.003 ± 0.001	2.25 ± 1.50	60 ± 2	0.08 ± 0.08	0.15 ±
Average[a]	0.11 ± 0.24	0.7 ± 0.3	0.001 ± 0.001	0.003 ± 0.001	8.62 ± 17.2	52 ± 21	0.08 ± 0.08	0.23 ±

[a] *Average and two standard deviations.*

APPENDIX C

METHODS FOR CALCULATING ENVIRONMENTAL RADIATION DOSE

Releases to the Atmosphere

Savannah River Plant operations are conducted in a manner that confines radioactivity as completely as practical rather than releasing it to the environment. Radiation dose to man in the vicinity of SRP is calculated for the radioactive gases and particulates that are released to the atmosphere. Although SRP has an extensive environmental monitoring system, a mathematical model is needed to estimate potential radiation dose commitment from the atmospheric releases. The mathematical model is needed because the majority of releases lead to very low concentrations not detectable (exception: tritium oxide) by current monitoring techniques.

The model is based on measured and calculated releases and on dispersion by measured meteorology. The meteorological data were obtained over a 2-year period (1966-1968) from instrumentation installed at 11 elevations on a 1,200-ft television transmitting tower 30 km (18.8 miles) northwest of the geometric center of SRP. Data collected at 3-minute intervals over the 2-year period provided information on wind speed, wind direction, wind variability, and thermal stability. Sufficient data were collected to include meteorological variations typical of the SRP site. Adequacy of this meteorological data base and calculational model is verified annually with measured dispersion of tritium released during normal operations to the atmosphere at SRP.

Annual averaged concentration factors in air and external gamma dose rate factors from a plume were calculated for each radionuclide individually by processing the meteorological data assuming a 1-Ci release for each data period (15-minutes averages). Ground level concentrations and external gamma dose were accumulated for each azimuth (16 sectors) and radial distance from the point of release for each meteorological data period according to a polar grid overlay of SRP and environs (see figure C-1). After all meteorological data for the 2-year period had been processed, the accumulated concentrations and gamma doses were divided by the total number of data periods represented. The result was a quantity representing a yearly integrated concentration (curie-seconds per cubic meter) and gamma dose associated with each grid point for a curie release over the year. These quantities were corrected for decay according to radionuclide and measured meteorology for each data period. For each of the 320 grid points, the integrated air concentration and gamma dose factor for a curie release is multiplied by the number of curies of each radionuclide released in a year to obtain integrated air concentrations and gamma cloud dose for subsequent calculations of dose commitment to individuals (and to the population).

The grid overlay was divided into sixteen 22.5^{o} sectors and twenty 5-km radial increments. Population distribution for each sector and radial increment was determined from the 1970 census and is shown in figure C-1. Integrated air concentration and gamma plume dose is calculated at the center of each areal increment and is assumed to be representative of average conditions for the increment. The integrated air concentration and gamma dose are used for calculating radiation dose commitment to all persons within the areal increment.

Major pathways of radiation exposure from radioactive materials released to the atmosphere are:

- External dose from radioactive materials in the atmosphere.
- External dose from radioactive materials deposited on earth's surface.
- Internal dose from inhalation of radioactive materials in the air.
- Internal dose from ingestion of food and water containing radioactive materials deposited from the atmosphere.

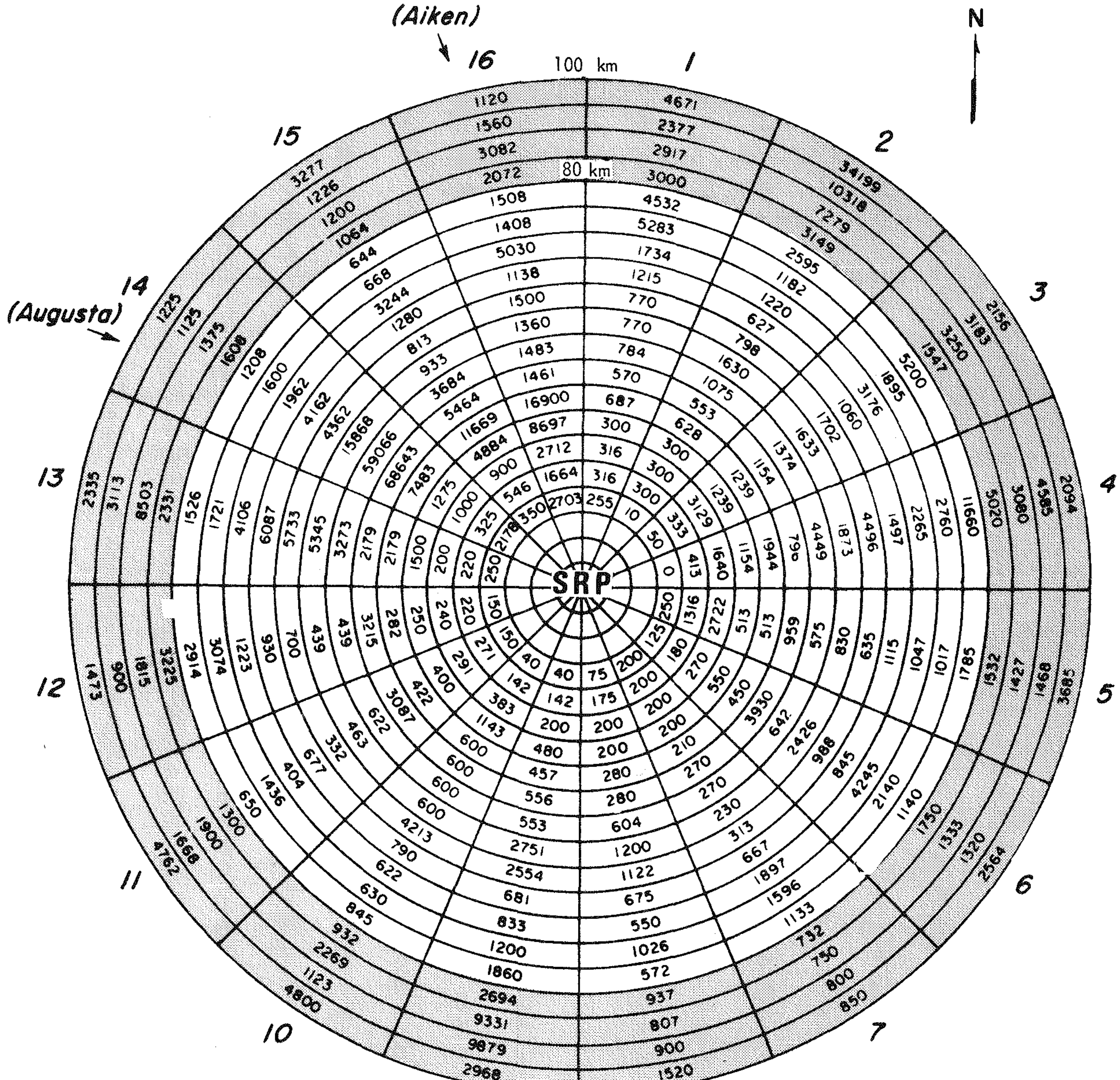

FIGURE C-1. DISTRIBUTION OF POPULATION IN REGION SURROUNDING SRP
(Radial Increments = 5 km, 22.5° Sector)
1970 Census

Factors were calculated for converting integrated air concentrations of each radionuclide to a 70-year lifetime dose commitment via each exposure pathway [19]. Techniques for calculating dose were patterned after methods used by the ICRP [2,12,16]. Standard man data were used for deriving dose factors for the general population; factors are also provided for calculating dose to infants when they are critical members of the population for specific pathways of exposure (example: iodine-131 in air + pasture grass + cow + milk + infant thyroid gland). Body dose, as calculated with dose factors, is summarized with gamma plume dose to obtain whole body dose.

Recycling of noble gases, carbon-14, and tritium oxide in the global environment is not included in the mathematical dose model. If noble gases and carbon-14 are assumed to be diluted by the world's atmosphere and tritium oxide is diluted by the world hydrological cycle, subsequent 70-year dose commitment to the population groups considered in this report will be a small fraction of 1% of the first pass dose from release of all radionuclides.

The external dose from gamma-emitting radionuclides deposited on the earth's surface are calculated assuming the nuclides are on the surface of soil and on surfaces of vegetation during the first year following release, and in succeeding years are distributed exponentially with depth in the soil as a result of washoff and infiltration into the soil with rainwater. Lifetime dose from these deposited nuclides is calculated with the assumption that each person is exposed throughout life only at the location of his residence. No corrections are made for surface runoff, surface roughness factors, or shielding by buildings.

Releases to the Savannah River

Radionuclides in liquid effluents from SRP are analyzed at the point of release, in surface streams on the SRP site before entry into the Savannah River swamp, and in the Savannah River upstream and downstream from SRP. Many radionuclides that are measurable at the point of release are below the analytical limit of sensitivity after being diluted with river water; only tritium oxide and trace amounts of ^{137}Cs and ^{90}Sr are routinely measurable in the river, and only tritium oxide at the two downstream water treatment plants. Dose commitments to downstream consumers of river water are based on the release inventory and the following assumptions.

- All radionuclides, as measured at the point of release, move down the Savannah River during the year of release.
- No depletion in the quantity of radionuclides occurs except for natural radioactive decay. Approximately 5 days elapse between time of release of radionuclides and entry into the two water treatment plants approximately 100 miles downstream. For the radionuclides released in 1979, no decay corrections were made.
- The flow rate of the river at the water treatment plants in 1979 averaged about 13,170 ft^3 per second (annual flow = 1.17×10^{16} ml).
- No allowance is made for removal of radionuclides in the water treatment plants.
- Dose commitment from tritium is based on measured concentrations at the water treatment plant.
- Individuals served by the water treatment plants consume an average of 1,200 ml of water per day (standard man).

Dose factors were calculated for converting concentrations of each radionuclides in water to a 70-year lifetime dose commitment. Techniques for calculating dose were patterned after methods used by the ICRP [2,12,16].

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