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HEALTH PHYSICS

ENVIRONMENTAL MONITORING

Semiannual Report,

January through June 1962

February 1963

Works Technical Department

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E. I. du PONT de NEMOURS & COMPANY
EXPLOSIVES DEPARTMENT - ATOMIC ENERGY DIVISION
SAVANNAH RIVER PLANT

[redacted]

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Written and approved December 1962;
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E. I. du Pont de Nemours and Company
Explosives Department - Atomic Energy Division
Savannah River Plant

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Contents

Abstract

Radioactivity in the environs of the Savannah River Plant was measured during the six-month period ending June 30, 1962. Fallout from nuclear weapons testing was evident in nearly all phases of the regional monitoring program. Atmospheric samples showed no filterable beta activity above levels attributable to bomb fallout. Releases of radioactive materials to the atmosphere and to Separations Areas seepage basins increased slightly. Increases from Reactor Area to Plant streams were associated with a fuel element failure and the recognition of sulfur-35 in releases during routine reactor discharges. Radioiodine releases resulting from discharge of the failed element were detectable for a short time in the Savannah River.

Introduction

Under a program established by the Du Pont Company in June 1951, the Savannah River Plant site and surrounding region are systematically monitored for radioactivity. Results of the environmental monitoring program provide information useful both as a measure of the effectiveness of Plant controls and as an authoritative record of environmental conditions.

Period Covered: January through June 1962.

Data Reporting

Survey data were averaged for the 6-month period and compared with the previous 6-month averages ("Health Physics Regional Monitoring Semiannual Report," DPSP 62-25-9, May 1962). "Avg" or "Total" refers to the average or total for the current period and "Prev Avg" or "Prev Total" refers to the average or total for the preceding 6-month period. Unless otherwise specified, "Max" refers to the greatest concentration observed in a single sample collected during the report period.

Sensitivity and Standard Deviation of Laboratory Analyses

Sensitivity of laboratory analyses refers to the minimum amount of radioactivity that can be detected by radiochemical analytical techniques used. It is based on statistical counting error (90% confidence level) and is influenced by sample size, counter efficiency, and counter background. No self-absorption corrections have been applied to the alpha and nonvolatile beta results. The standard deviations shown in the table on page 2 were calculated from spike recovery values. They apply to the 6-month averages of data in this report.

Where samples were analyzed by gamma spectrometry, the lower level of detection of a given isotope varied with: (1) background of each individual channel grouping and (2) geometry and volume of sample analyzed. For this reason, no average sensitivities are given. Furthermore, no differentiation was made between nuclides emitting gamma rays of nearly the same energy. Thus, data are reported as $Ru^{103,106}$, $Ce^{141,144}$, Fe^{59}/Co^{60}, etc but such notation does not mean that both isotopes were necessarily present. The differentiation between isotopes in most such groupings can be made, if required, by approximate age estimates of the radioactive material at the time of release, chemical separations, and decay and beta absorption studies.

Analysis	Samples	Sensitivity	Standard Deviation, %	Spike Value
Alpha	Water	0.22 ± 0.12 μμc/ℓ	9	45 μμc/ℓ
	Mud	0.22 ± 0.12 μμc/g	-	-
	Vegetation	0.11 ± 0.06 μμc/g	-	-
	Air	0.04 ± 0.02 × 10^{-2} μμc/m^3	-	-
Beta	Water	4.2 ± 0.3 μμc/ℓ	-	-
	Mud	4.2 ± 0.3 μμc/g	-	-
	Vegetation	2.1 ± 0.2 μμc/g	-	-
	Biological Specimens	2.0 ± 0.1 μμc/g*	-	-
	Air	0.6 ± 0.04 × 10^{-2} μμc/m^3	-	-
TBP Extraction	Water	0.26 ± 0.15 μμc/ℓ	20	45 μμc/ℓ
	Mud	0.34 ± 0.19 μμc/g	25	45 μμc/g
	Vegetation	0.03 ± 0.02 μμc/g	10	4.5 μμc/g
Radioiodine	Water	9.3 ± 0.7 μμc/ℓ	9	300 μμc/ℓ
	Vegetation	0.2 ± 0.02 μμc/g	-	-
	Air	1.8 ± 0.2 × 10^{-2} μμc/m^3	-	-
	Milk	2.2 ± 0.2 μμc/ℓ	10	200 μμc/ℓ
Tritium	Water	3000 ± 200 μμc/ℓ	3	2500 × 10^3 μμc/ℓ
	Air	60 μμc/m^3 **	-	-
Radiocesium	Water	4.3 ± 0.3 μμc/ℓ	9	600 μμc/ℓ
Radiostrontium	Water	6.4 ± 0.4 μμc/ℓ	7	230 μμc/ℓ
Strontium-90	Water	0.1 ± 0.01 μμc/ℓ	8	230 μμc/ℓ
	Milk	1.6 ± 0.1 μμc/ℓ	7	47 μμc/ℓ

* Approximate, sample size varied.
** Approximate, varied with absolute humidity.

Summary

The total radioactive waste released by the Savannah River Plant into the atmosphere, effluent streams, and earthen seepage basins during the 6-month period is shown in the following table. Radioactivity discharged to effluent streams does not reflect miscellaneous releases of tritium (ie, P-Area cooling water, heat exchanger leakage - moderator to cooling water, sump discharges, etc).

	Atmosphere	Effluent Stream	Seepage Basin
Alpha, mc	12.1	116.5	778
Nonvolatile beta, c	1.8	561.5	136
Radioiodine, c	7.3	82.1	3.5
Tritium, kc	454.2	25.3	16.6

Discharge of nonvolatile beta from F-Area stack increased 11-fold over the previous 6-month period due to resumption of the Purex process. Nonvolatile beta discharged from H-Area stack decreased 9-fold after suspension of the HM process and a decrease in the release of residual ruthenium, unusually high in 1961. The net increase over the previous 6-month period was 0.9 curies.

Sensitive indicators of environmental contamination (rain, air, vegetation, and milk) showed significant evidence of fallout from nuclear weapons testing. Unlike fallout from the Soviet tests in 1961 when sudden, substantial increases of nonvolatile beta and radioiodine were seen, fallout from U. S. atmospheric tests in May and June was detected as nonuniform, low-level I-131 concentrations in environmental samples. The estimated cumulative infant thyroid dose from consumption of iodine contaminated milk from local dairies was 3% of the annual limit of 500 mrem recommended by the Federal Radiation Council. Low-level radioiodine and tritium concentrations in air were detected on occasion in F and H Areas in conjunction with local releases. No nonvolatile beta concentrations above levels attributable to bomb fallout were detected in the atmosphere either on or off-Plant.

The disassembly basin discharge from the reactor areas to effluent streams (381 curies, exclusive of S-35 and tritium) represented a 3.4-fold increase, compared with July through December 1961. Sulfur-35, the predominant radionuclide (excluding T) in disassembly basin water, totaled 262 curies. The largest single release incident was in P Area during May, when 203 curies were released to Steel Creek following discharge of a failed fuel element. Radioiodine was readily detectable in stream and river water after the incident. Plant-released alpha activity had negligible effect on concentrations of alpha activity in stream water and was generally detectable only in low volume effluents from the 300, 700, and 200 Areas.

Fallout from nuclear tests was evident in river water throughout the report period. Plant-contributed radioactive materials in transport in the river at the Highway 301 crossing totaled 60 curies of nonvolatile beta and 30,300 curies of tritium.

Uptake of Plant-released radioactivity by Savannah River fish was generally confined to low level concentrations of radiostrontium in the bones. However, a few river fish also contained low level concentrations of Cs-137 and Zn-65 in both the bones and fleshy tissues. Higher concentrations of these radionuclides were present in reactor effluent fish. Waterfowl from Par Pond and terrestrial animals from the Plant site contained low level concentrations of nonvolatile beta emitters in the bones and fleshy tissues. Radioiodine from nuclear tests was detected in the thyroid glands of both waterfowl and terrestrial specimens.

Radioactivity Releases and Environmental Effects

Atmosphere

Releases of radioactive materials from individual Plant areas to the atmosphere during this period are compared to releases during the previous 6-month period in the following table. Individual isotopes comprising F and H-Area nonvolatile beta totals are in Appendix A, table 1.

Radioactivity Released to the Atmosphere

	Alpha, mc		Nonvolatile Beta, mc		Radioiodine, c		Tritium, c	
Area	Total	Prev Total	Total	Prev Total	Total	Prev Total	Total	Prev Total
F	10.3	4.4	1520	143	2.83	0.8	-	-
H	1.6	2.5	57.4	513	4.47	0.5	320,500	332,400
R	-	-	3.2	0.98	-	-	5,600	8,077
P	-	-	68	1.24	-	-	37,300	36,090
L	-	-	4.5	1.66	-	-	26,000	21,673
K	-	-	1.1	1.06	-	-	38,600	19,236
C	-	-	1.2	1.06	-	-	25,900	16,175
TNX	-	-	1.2	1.06	-	-	11	261
773-A	0.15	0.11	151.8	33	0.025	0.015	332	371
Total →	12.1	7.0	1808	695	7.32	1.3	454,243	434,283

Discharge of nonvolatile beta from F-Area stack increased by a factor of 11 over that during the preceding 6 months. This increase resulted from Purex process operation, January through June. Only aged SCRUP material was dissolved during the previous period. Eighty percent of the total release occurred during May and June in conjunction with the decrease in the effective age of the uranium dissolved near the end of the campaign. $Ru^{103,106}$ comprised 94% of the total 6-month release of nonvolatile beta emitters.

The total nonvolatile beta discharged from H-Area stack decreased by a factor of 9 from the preceding 6-month period primarily because of less ruthenium release (22 mc versus 420 mc). Unusual releases of ruthenium (primarily Ru-106) occurring in the latter half of 1961 was attributed to residual deposits in the dissolver off-gas system. Reduction in releases of other nonvolatile beta isotopes resulted from the suspension of HM material dissolving.

Stack releases of nonvolatile beta from L, K, and C Areas (primarily $Ce^{141,144}$, $Ru^{103,106}$, and $Zr\text{-}Nb^{95}$) were attributed to migration of fallout into ventilation systems. Releases from R and P Areas (predominantly $Ru^{103,106}$) were attributed to the effects of work on moderator piping during reactor containment outages.

Samples of airborne radioactivity were collected continuously at the 20 air monitoring stations shown in figure 1 and from stations at Macon and Savannah, Georgia and Greenville and Columbia, South Carolina.

Weekly analyses were made for:

- Total alpha and filterable beta (collected on HV 70 filter paper).
- Radioiodine (collected on charcoal cartridges).
- Tritium (in water vapor collected on silica gel columns).

Except for tritium, no airborne radioactivity detected outside the Plant perimeter could be attributed to Plant releases. The maximum weekly concentration of tritium in air (1600 $\mu\mu c/m^3$) occurred at H Area. As a result of nuclear tests, filterable beta in air at all sampling locations averaged 3.9 $\mu\mu c/m^3$. (3.7 during the preceding report period.) Following resumption of Soviet nuclear tests (September through December 1961) this concentration averaged 5.5 $\mu\mu c/m^3$ of air. With the exception of radioiodine, no increase in beta radioactivity in the atmosphere was discernable following the U. S. nuclear test series which began in April 1962. Low-level concentrations of radioiodine, first detected in the air during the week ending May 17, continued throughout the report period. Concentrations of radioactive materials in air are summarized in Appendix B, table 1.

Gamma Radiation Levels

A summary of environmental gamma dose rate measurements, made with Landsverk L-65 pocket chambers and a modified L-60 electrometer, is given in Appendix B, table 2. No significant radiation levels due to Plant operations were observed at the individual area perimeters or at the constant air monitor buildings. The highest average dose rate observed was 0.66 mr/24 hrs at 300/700 Area. Differences in values shown are within the variation due to instrument response characteristics and normal background fluctuations.

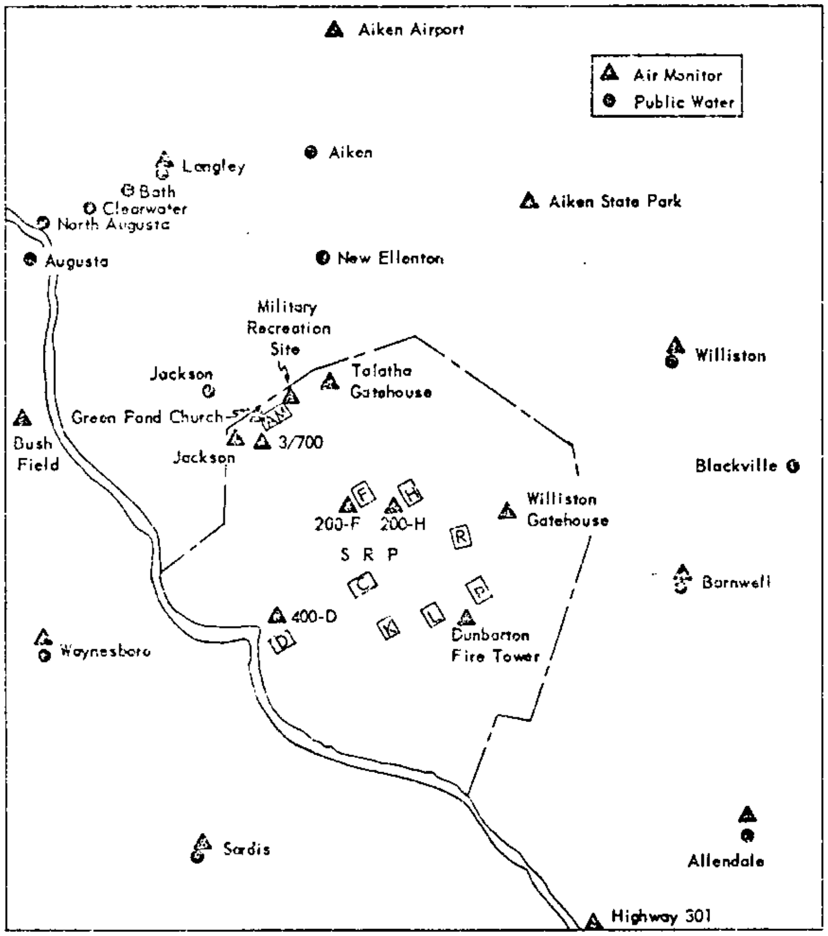

FIGURE 1. CONTINUOUS AIR MONITORING STATIONS AND PUBLIC WATER SAMPLING LOCATIONS

Rainwater

Radioactive materials in weekly rainwater samples collected continuously at monitoring stations shown in figure 1 are summarized in Appendix B, table 3. Radioactivity in rainwater consisted primarily of fallout (predominantly $Zr\text{-}Nb^{95}$, $Ru^{103,106}$ and $Ce^{141,144}$) from nuclear tests. Nonvolatile beta in rainwater during the 6-month period averaged 1300 $\mu\mu c/\ell$ at the Plant perimeter and the 25 mile radius stations; the maximum observed in rainwater was 4300 $\mu\mu c/\ell$. The average represents a 2.5-fold increase over the average during the previous 6 months. There was no significant increase in the concentration of nonvolatile beta emitters attributable to the U. S. tests.

Radioactive materials deposited on the Plant site in rainwater are shown in the following table. When no rain occurred, nonvolatile beta deposition was estimated from radioactivity collected in an open pan of water near Building 735-A. The increased deposition of fallout was due in part to more rainfall during the current period than in the fall and winter of 1961.

Radioactivity Deposition On Plant

	Nonvolatile Beta, mc/mi^2	Radioiodine, mc/mi^2	Cs^{137},* mc/mi^2	$Sr^{89,90}$,* mc/mi^2	Sr^{90},* mc/mi^2	Tritium c/mi^2
January	480	-	8.0	66	2.6	5.6
February	280	-	6.6	38	.8	4.7
March	470	-	13	74	3.7	8.0
April	320	-	13	43	4.3	7.5
May	350	11	10	40	4.2	4.0
June	200	21	6.4	13	2.4	5.0
Total →	2,100	32	57	274	18.0	34.8
Previous Total →	449	22	14	78	-	33.2

* Average cesium and strontium fallout in rainwater (collected by ion exchange) at the F-Area and Green Pond Church monitoring stations.

Vegetation

Concentrations of radioactive materials in vegetation samples, collected from locations shown in figures 2 and 3, are the result of fallout from the 1961 and 1962 nuclear tests. No influence due to Plant discharges of radioactivity was apparent. The average increase of nonvolatile beta emitters from 57 to 368 $\mu\mu c/g$ was consistent with increased rainfall. Radioactive materials in vegetation are summarized in Appendix B, table 4.

Milk

Milk samples were collected monthly from farms at Talatha, Snelling, and Pleasant Mount, and weekly from dairies at Aiken, North Augusta, Barnwell, Williston, Waynesboro, and Allendale. I-131 was detected in dairy milk in May and June as a result of U. S. nuclear tests. Maximum I-131 concentrations in farm and dairy milk were 52 $\mu\mu c/\ell$, and 43 $\mu\mu c/\ell$, respectively. (See Appendix B, table 5.) The calculated radiation dose to the thyroid of a child from local milk during the 6-month period (average of all samples) was 28 mrem from farm milk and 17 mrem from dairy milk. The adult thyroid dose, assuming the same 1 liter/day consumption rate, was one-tenth the dose for a child.

Plant Drinking Water

Samples of drinking water were collected monthly from operating areas and quarterly from other Plant domestic water systems. Results of analyses are summarized in Appendix B, table 6. Nonvolatile beta emitters in drinking water samples collected in L, K, and C Areas (maximum of 37 $\mu\mu c/\ell$) were attributed to fallout from nuclear tests. Domestic water for these Areas comes from the river. Barricade 2 drinking water had a maximum of 37 $\mu\mu c/\ell$ alpha and 69 $\mu\mu c/\ell$ nonvolatile beta activity which was natural radioactivity (Ra-226) in the water. Drinking water samples contained no detectable tritium.

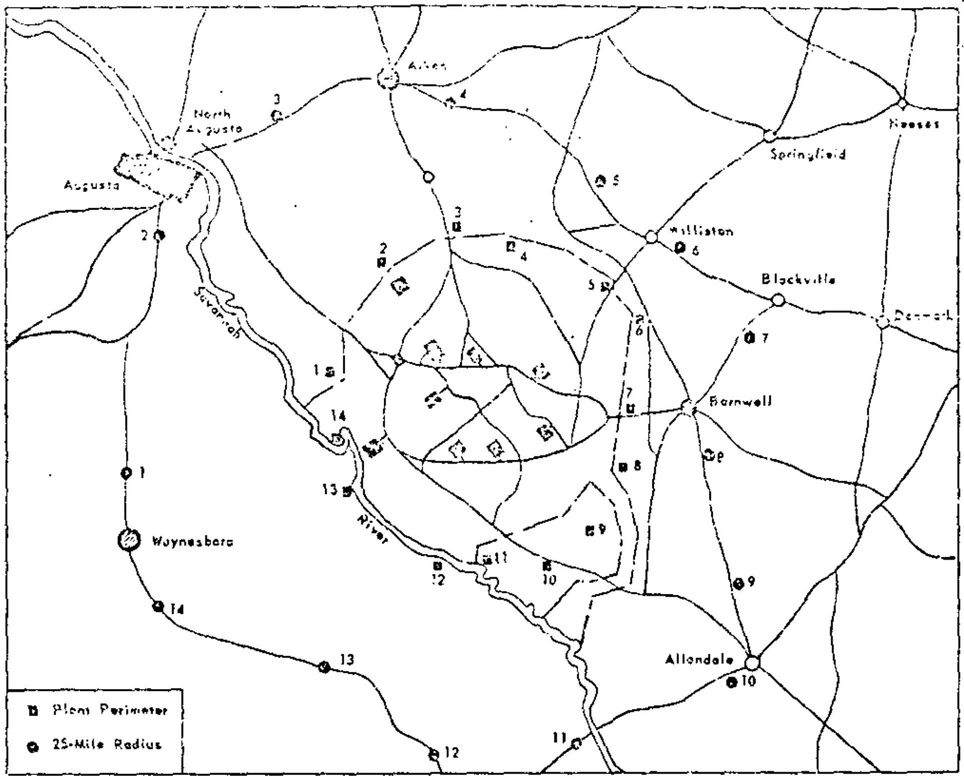

FIGURE 2. VEGETATION SAMPLE LOCATIONS

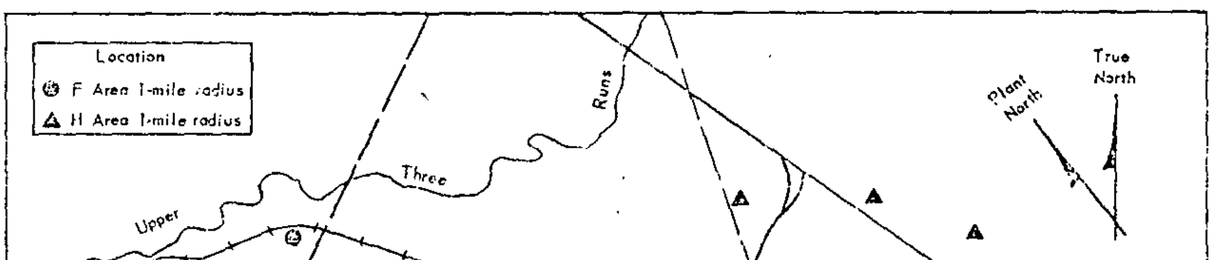

FIGURE 3. VEGETATION SAMPLE LOCATIONS IN F AND H AREAS

Public Water Supplies

Samples of public drinking water, collected monthly from the 14 towns shown in figure 1, contained no detectable tritium activity. Analytical results are summarized in Appendix B, table 7.

Streams and the Savannah River

Radioactive releases from individual Plant areas to effluent streams during the period are compared to those for the previous period in the following table. Individual radionuclide releases from the Reactor Areas are presented in Appendix A, table 2.

Radioactive Releases to Effluent Streams

	Alpha, mc**		Nonvolatile Beta, c		Radioiodine, c		Tritium, c	
Area	Total	Prev Total	Total	Prev Total	Total	Prev Total	Total	Prev Total
F	1.8	3.3	0.6	1.7	-	-	4	5
H	4.7	5.5	0.2	0.2	-	-	600	1,300
R*	-	-	78.3	35.9	2.9	7.5	4,300	6,900
P*	-	-	201.8	14.4	74.7	0.4	4,800	4,300
L*	-	-	61.7	17.8	0.6	0.5	3,400	3,600
K*	-	-	133.8	20.8	2.0	0.9	4,600	7,000
C*	-	-	85.1	13.8	2.0	0.8	7,600	5,300
300	110	34	-	-	-	-	-	-
Total →	116.5	42.8	561.5	104.6	82.2	10.1	25,300	28,400

* Includes only releases from disassembly basin weirs.

** Naturally occurring alpha emitters in Savannah River water pass through the Reactor Areas in cooling water. The total alpha discharged by the Reactor Area effluents during the period was estimated to be 400 millicuries. Since this activity did not originate from Plant operations, it is not included.

The principal source of radioactivity released from the Reactor Areas was disassembly basin water, purged at a rate of 1000 to 2000 gpm. Since its recognition in October 1961, sulfur-35 has been the predominant long-lived radionuclides (>15 day half life, excluding tritium) released in disassembly basin water. Sulfur-35 releases (approximately 262 curies) exceeded those of Cr-51 (the major long-lived component previously observed) by a factor of 2.6. Of the total beta activity (excluding tritium) released from all Reactor Areas, approximately 70% was due to radioisotopes having half lives greater than 15 days.

The rupture of Mark V-B experimental fuel slugs (a total of 7 in the Raw Materials Area during autoclave pressure test on May 10 and 11) released an estimated 90 lb of uranium to a settling sump in the 300 Area. The release was equivalent to the total uranium released to Tims Branch for the previous 6 months. No increased alpha activity was observed in subsequent 300-Area effluent samples. It is possible that the uranium oxide remained in the sump.

Radioactivity is measured in weekly water samples collected continuously at the 18 stream locations and 7 river locations shown in figure 4. River mud samples, collected monthly at the 5 Plant perimeter locations and weekly from locations 10 and 11, were analyzed for TBP extractable alpha. Radioactivity of these samples is summarized in Appendix B, tables 8 through 10. Radioactive materials in transport at the Road A intersection of each reactor effluent stream are shown in the following table. Data for river water at the control location and 10 miles downstream from the Plant are also shown.

	Radioactivity in Water, curies/6 months					
Location	Nonvolatile Beta	Tritium	I^{131}	$Sr^{89,90}$	Sr^{90}	Cs^{137}
Four Mile Creek	18.3	7,100	0.6	1.2	0.37	1.9
Pen Branch	56.3	7,700	2.3	3.4	0.86	1.6
Steel Creek	39.6	14,000	36.7	5.9	1.87	5.7
Lower Three Runs	3.4	2,300	-	0.7	0.31	0.7
Total at Road A Locations	117.6	31,100	39.6	11.2	3.41	9.9
River 2 (Control)	240	7,900	-	-	5.50	-
River 10 (Downstream from Plant)	300	38,200	-	-	7.97	-

Apparent Plant Contribution →	Nonvolatile Beta	Tritium	Sr-90
At Road A Stream Loacations*	91	30,200	2.89
At River 10	60	30,300	2.47

* Compensated for river water used by the Plant.

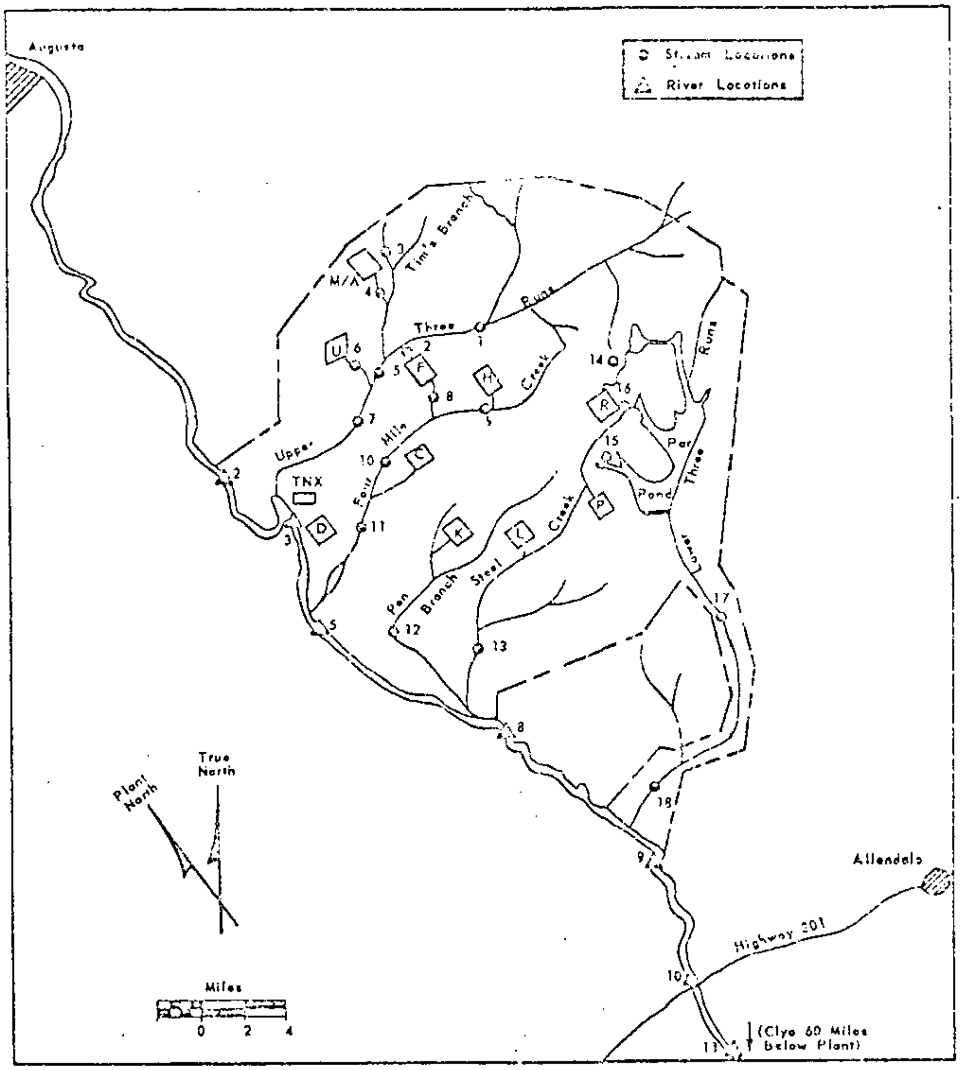

FIGURE 4. STREAM AND RIVER SAMPLE POINTS

Maximum concentrations of both nonvolatile beta and tritium in Four Mile Creek, Pen Branch, and Steel Creek at Road A coincided with fuel element discharge operations. Comparatively high levels of radioiodine were observed in Steel Creek as a result of the discharge of a failed fuel element during P-13-A outage.

While the total releases (excluding tritium) from P Area during this outage were high (202.7 curies of which 47.9 were radionuclides having half lives greater than 15 days), relatively small concentrations of radioactivity other than I-131 were observed in Steel Creek. Nonvolatile beta analyses of Steel Creek samples at Road A accounted for only 5% of the weir releases (excluding I-131 and S-35). When P-Area weir releases were high, no cooling water was discharged to Steel Creek. The nonvolatile beta activity at Road A was higher after cooling water was returned to Steel Creek than it was during the period of highest weir activity.

The maximum alpha (1900 $\mu\mu c/\ell$) and nonvolatile beta (4400 $\mu\mu c/\ell$) concentrations in the F-Area storm sewer effluent were attributed to the A-Line facility; however, the exact origin was not identified.

Fallout contamination from nuclear tests was evident in river water throughout the period. The concentration of nonvolatile beta activity (93 $\mu\mu c/\ell$) in the river at the upstream control location during the week ending March 13 was the highest observed since July through December 1957 (140 $\mu\mu c/\ell$ maximum). Gamma spectroanalysis of 34 gallons of river water collected at the control location revealed photopeaks identified as $Ce^{141,144}$, $Ru^{103,106}$, and $Zr\text{-}Nb^{95}$.

Seepage Basins

Radioactivity discharged to earthen seepage basins are compared to the previous 6-month discharges in the following table. Isotopic distribution of the nonvolatile beta discharged to the F and H-Area basins is shown in Appendix A, table 3.

Radioactivity Discharged to Seepage Basins

Area	Alpha, mc Total	Alpha, mc Prev Total	Nonvolatile Beta, c Total	Nonvolatile Beta, c Prev Total	Radioiodine, c Total	Radioiodine, c Prev Total	Tritium, c Total	Tritium, c Prev Total
F	521	68	110.1	29.5	3.4	0.3		
H	237	144	15.2	29.5	0.1	0.2		
R	-	-	0.5	-	-	-	1	-
P	-	-	7.6	14.5	-	-	84	13
L*	-	-	0.03	-	-	-	12	32
K	-	-	-	-	-	-	-	-
C	-	-	2.8	3.2	-	-	746	1,134
3/700	20	19	0.04	.04	-	-	-	-
Total →	778	231	136.27	76.74	3.5	0.5	16,601	13,066

* 1795 curies of tritium and 8.5 curies of nonvolatile beta activity were released to the oil and chemical disposal pit in L Area. Essentially all of this came from the C-Area heat exchanger decontamination facility.

$Ru^{103,106}$ and Cs^{137} were the major gamma emitting radionuclides released to the F-Area seepage basin and were associated with waste from Building 211-F and increased 242-F evaporator operations, respectively. The maximum release of nonvolatile beta activity (22.6 curies during two weeks in June) coincided with the diversion of water from the 281-5F delaying basin to the seepage basin following the contamination of the cooling water systems in F Area on June 14. This activity (primarily $Ru^{103,106}$) was attributed to repairs to the 9.3E high activity waste evaporator in Building 221-F.

A computer program was used to determine the amount of tritium introduced daily into the F-Area dissolvers during the period. The calculation was based on a fission-to-tritium ratio established by SRL, and all uranium charged to the Separations Process from January 7 through June 30, 1962, with the exception of a small number of off-Plant elements for which no reactor excuries. These results appeared to be in good agreement since experimental studies by SRL on HNO_3 dissolutions of spent uranium fuel indicated that approximately 50% of the tritium charged would be evolved as a gas and released from the 291-F stack.

Liquid volume input and seepage rates for the F and H-Area basins are shown in the following table.

	F Area	H Area
Liters/Day		
Waste Input	10.1×10^5	3.0×10^5
Rain Input	0.8×10^5	0.7×10^5
Seepage Rate	8.0×10^5	3.9×10^5

The radioactivity in Separations, 700, and TNX Areas seepage basins is shown in Appendix B, table 11.

The major sources of radioactivity released to the Reactor Area seepage basins were the handling of Chalk River reactor components in P Area and the decontamination of heat exchangers in C Area. The maximum concentrations of radioactivity in Reactor Area seepage basin water, observed in C Area basin 1, were as follows: alpha 50 μμc/ℓ; nonvolatile beta, 4.3×10^5 μμc/ℓ; and tritium, 688×10^6 μμc/ℓ.

Ground Water

Ground water was monitored by analysis of samples collected from wells surrounding F, H, and R-Area seepage basins (figures 5 and 6), wells near F and H Areas (Z and ZW Wells, figures 7 and 8), and wells at the burial ground (figure 9). The maximum nonvolatile beta concentration in samples collected from the R-Area seepage basin wells was 140 μμc/ℓ in well C1, approximately 2800' west of back-filled basins 2 and 3. Analytical results of Z, ZW, and F and H-Area seepage basin well water are shown in Appendix B, tables 12 and 13.

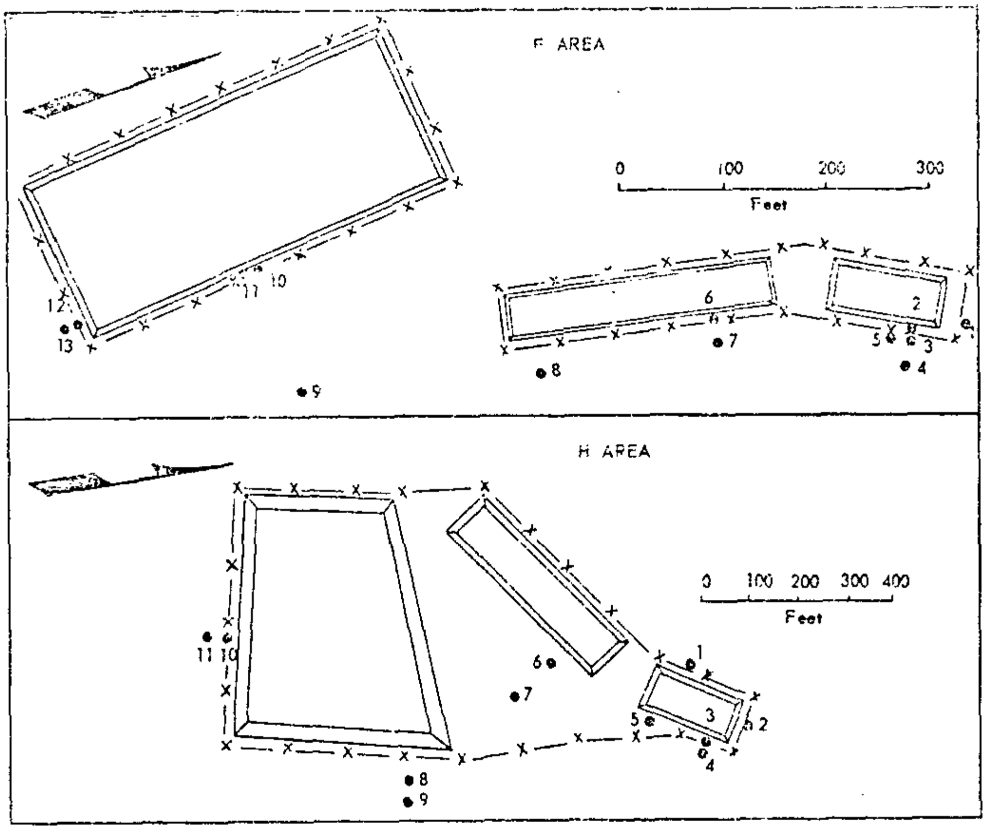

FIGURE 5. SEEPAGE-BASIN MONITORING WELLS IN F AND H AREAS

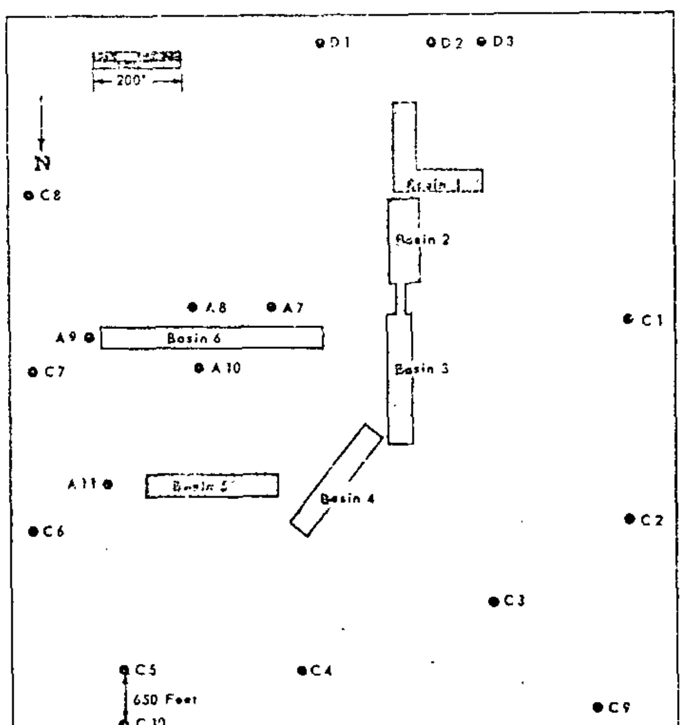

FIGURE 6. R-AREA SEEPAGE BASINS AND MONITORING WELLS

Backfilled Basins

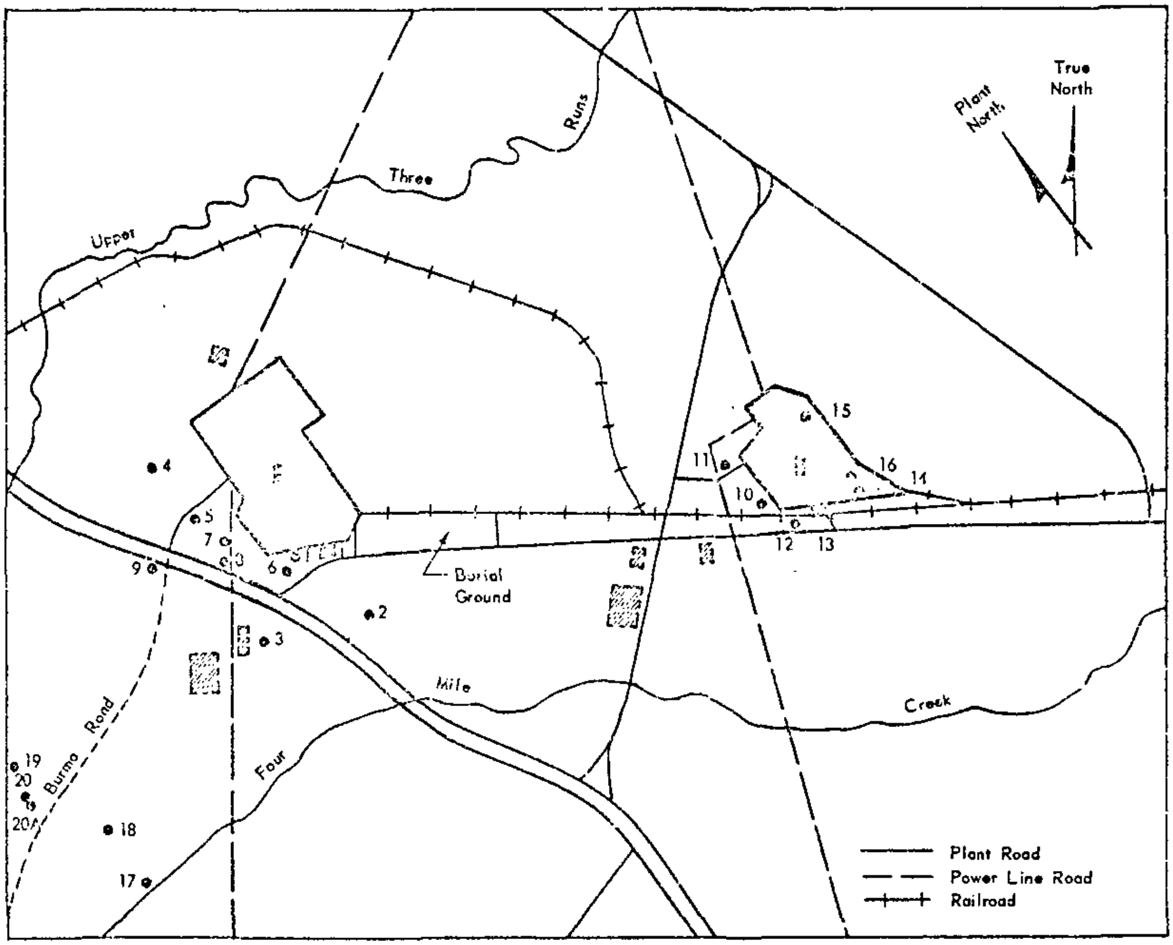

FIGURE 7. Z-WELL LOCATIONS

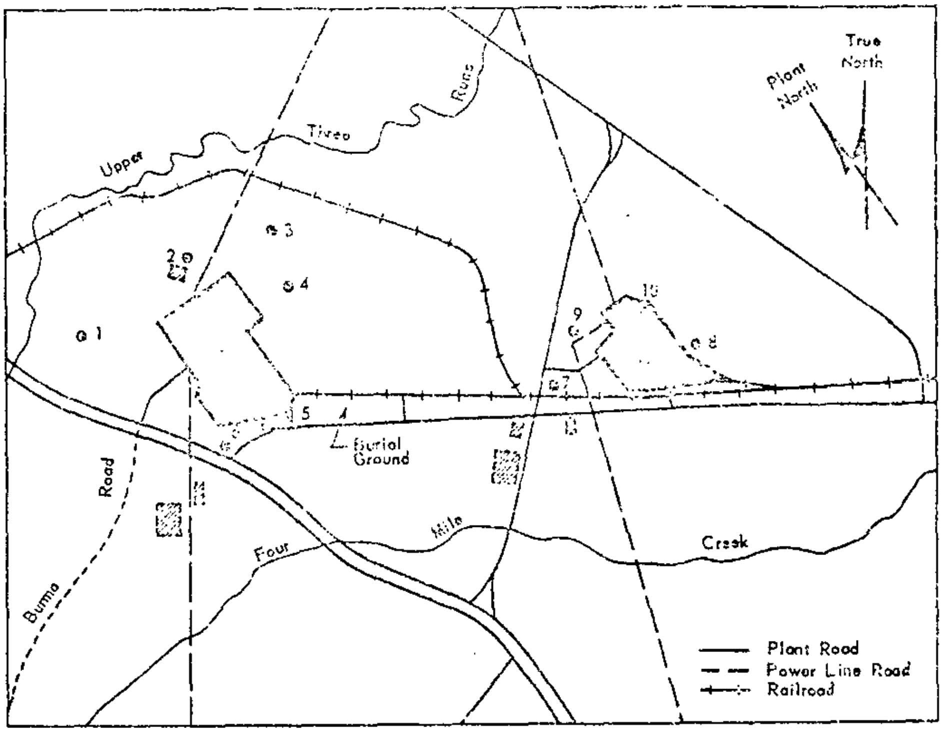

FIGURE 8. ZW WELLS, F AND H AREAS

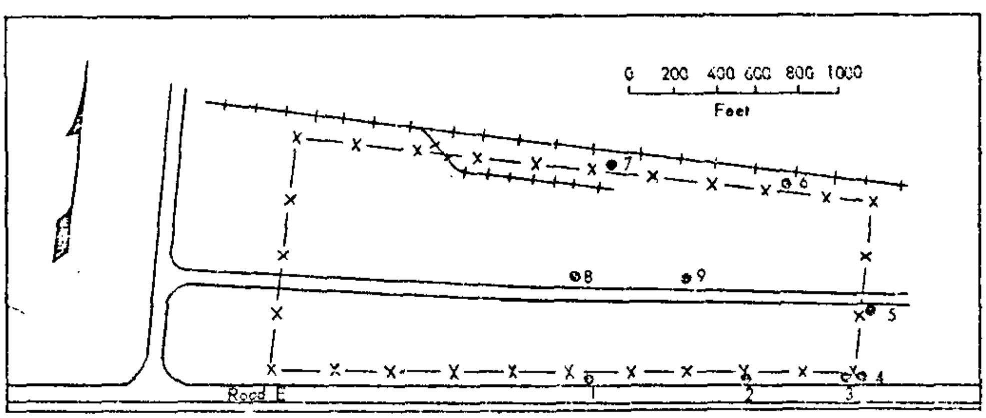

FIGURE 9. BURIAL GROUND WELLS

Well A57 in H Area is in a swamp bordering the H-Area effluent. It is in the zone of the most rapid movement of seepage basin water into the swamp. The tritium concentration in this well averaged 42×10^6 μμc/ℓ and nonvolatile beta was 170 μμc/ℓ. Practically all of this nonvolatile beta activity was strontium.

241-H Tank Farm

Nonvolatile Beta in Upper Tank Farm Wells, μμc/ℓ

	HPM Wells	HP1	HP5	HP8	TW3	TW4
Maximum	200	430	70	220	180,000	730
Average	54	300	52	140	62,000	330
Previous Average	30	340	110	220	200,000	350

The 12 HPM wells (shown in figure 10) are installed at unequal intervals at a distance of 15 feet from the outer edge of the Upper Tank Farm concrete pad, extending 10 feet below the pad. The HP wells were the initial wells which were drilled five feet away from the tank 16 encasement (down to the concrete pad) following the loss of radioactive materials from the annulus of tank 16 in September 1960. Wells TW3 and TW4 were installed during construction of the 241-H Upper Tank Farm. The comparatively high concentrations in TW3 are due to the pumping of the soil shrinkage system from Riser 5 (TA 5-6). This pumping caused ground water movement from the vicinity of tank 16 to the center of the system, the location of both Riser 5 and TW3. Negligible concentrations of nonvolatile beta activity were observed in water collected weekly from a pre-existing test well in the center of the Lower Tank Farm.

Biological Specimens

TERRESTRIAL

The reactor effluent systems (including Par Pond) and atmospheric fallout from nuclear tests were the primary sources of radioactivity in terrestrial animals. Slightly higher nonvolatile beta concentrations in the four species collected during this period were

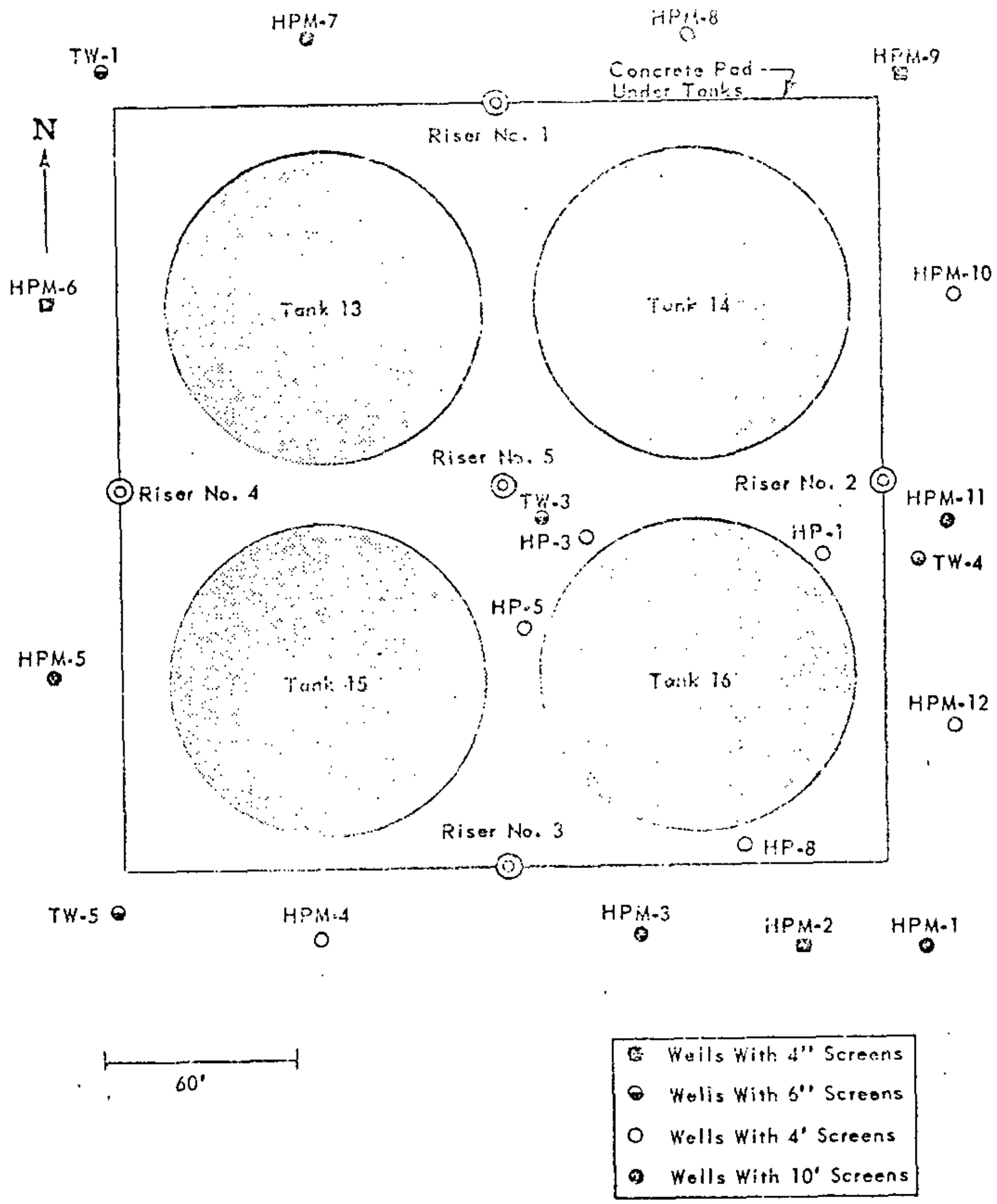

FIGURE 10. UPPER TANK FARM WELLS, 241-H

attributed primarily to fallout. Radiostrontium ($Sr^{89,90}$) was the primary radionuclide in the bones. Low level concentrations of radiocesium (Cs^{137}) were present in the fleshy tissues of some specimens. Comparative nonvolatile beta concentrations are presented in the following table.

Nonvolatile Beta in Terrestrial Animals, μμc/g (wet weight)

Species	No. of Samples	Bone Max	Bone Avg	Bone Prev Avg	Flesh Max	Flesh Avg	Flesh Prev Avg
Rabbit	3	75	45	20	15	8	4
Bobcat	2	7	6	7	16	12	7
Raccoon	1	-	20	10	-	6	9
Deer	1	-	13	7	-	6	4

The concentrations of I-131 in the thyroid glands of these terrestrial animals averaged 50 μμc/g (wet weight). Concentrations in the herbivore thyroids were slightly higher than those in the carnivore thyroids.

AVIAN

Forty-three migratory waterfowl (2 teal, 7 mallard, and 34 ring-neck ducks) and 2 coots were collected from Par Pond during the first three months of the period. The coots had the highest average concentrations of nonvolatile beta. They feed primarily on animal matter and inhabit Par Pond longer than the other waterfowl. The predominant isotopes in the bones were radiozinc (Zn^{65}), radiostrontium ($Sr^{89,90}$), and radiocesium ($Cs^{134,137}$). Radiozinc and radiocesium were the primary isotopes in fleshy tissues. Except for decreased concentrations in bones and fleshy tissues of teals, the nonvolatile beta in these specimens approximated that found during the first 6 months of 1961.

Nonvolatile Beta in Par Pond Waterfowl, μμc/g (wet weight)

Species	Samples	Bone Max	Bone Avg	Bone Prev Avg	Flesh Max	Flesh Avg	Flesh Prev Avg
Teal	2	10	10	25	6	6	20
Mallard	7	12	6	5	8	5	10
Ringneck	34	50	13	10	27	9	5
Coot	2	29	28	30*	21	19	20*

* Average of 2 specimens collected in December 1961.

The average I-131 thyroid gland concentration of Par Pond waterfowl collected in January was 125 μμc/g (wet weight). The maximum concentration, found in the thyroid gland of a teal, was 645 μμc/g. Radioiodine concentrations in specimens collected in February and March were less than 70 μμc/g (sensitivity of analysis).

The bones and fleshy tissues of a goose collected from 281-3F basin in June contained detectable concentrations of $Ce^{141,144}$ (bone 120 μμc/g, flesh 20 μμc/g, wet weight) and Cs^{137} (bone 30 μμc/g, flesh 15 μμc/g). $Sr^{89,90}$ concentration in fleshy tissues was less than the sensitivity of analysis. The concentration in the bones was 8 μμc/g (wet weight).

AQUATIC

A total of 638 aquatic samples (459 fish, 175 algae samples, and 4 clams) were collected from Plant effluents and the Savannah River. Samples from effluents were radioanalyzed for uptake of Plant-contributed radioactivity. River samples were analyzed to determine radionuclide concentrations in aquatic specimens accessible to the public.

Reactor Effluent Specimens. Fish and algae samples were routinely collected from the R-Area effluent system (Par Pond and Lower Three Runs) and from Steel Creek to monitor radioactivity uptake. Samples collected from Lower Three Runs at 1, 6, and 14-miles below Par Pond dam helped determine effects of dilution and streambed removal of radioactivity on the uptake of radionuclides by fish and algae.

Steel Creek fish are exposed to waste from two Reactor Areas and represent the maximum concentrations encountered.

Radiostrontium ($Sr^{89,90}$), though not concentrated significantly by the fleshy tissues, was the primary beta emitter identified in the bones of fish from Par Pond, Lower Three Runs, and Steel Creek. Radiozinc (Zn^{65}) and radiocesium ($Cs^{134,137}$) were the predominant gamma emitters in the bones and fleshy tissues, respectively. However, the dominance and magnitude of specific nuclides in fish tissues varied significantly between sample locations as shown in the following table.

Radionuclides in Effluent Fish, μμc/g (wet weight)

	$Sr^{89,90}$			Cs^{137}			Zn^{65}		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
Par Pond									
Bone	45	30	30	20	15	15	110	75	65
Flesh	*	*	*	45	35	30	25	20	15
Lower Three Runs									
Bone	120	35	40	25	10	15	30	5	*
Flesh	*	*	*	45	25	30	*	*	*
Steel Creek									
Bone	40	30	15	10	3	1	745	285	70
Flesh	*	*	*	15	10	5	40	20	10

* Less than sensitivity of analysis.

Algae is routinely monitored because it has a high sorption for radioactivity and is an important link in the food chain of fish and man. Since algae concentrate radioactivity from the water by factors up to 10^4, they are good qualitative indicators of the radionuclide content of water. Large algae samples (5 to 30 grams dry weight) were collected weekly in May and June for gamma spectrometry and radiostrontium analyses. Results are shown in the following table.

Radionuclides in Effluent Algae, μμc/g (dry weight)

Isotope	Par Pond Max	Par Pond Avg	Lower Three Runs Max	Lower Three Runs Avg	Steel Creek Max	Steel Creek Avg
$Ce^{141,144}$	840	515	115	75	2440	1050
Cr^{51}	900	360	65	15	5350	1720
$Ru^{103,106}$	500	295	135	50	1150	525
Cs^{137}	330	230	20	5	670	255
$Zr\text{-}Nb^{95}$	435	240	45	20	680	280
Mn^{54}	270	150	*	*	100	55
Zn^{65}	1300	730	*	*	1050	410
Fe^{59}/Co^{60}	515	200	*	*	230	135
$Ba\text{-}La^{140}$	285	70	*	*	1550	655
$Sr^{89,90}$**	90	55	20	15	80	50

* Less than sensitivity of analysis.
** Determined by radiochemical analysis.

Savannah River Specimens. Nuclear tests fallout caused nonvolatile beta concentrations in river algae collected above and below the Plant site to be twice as high as during the previous period.

Nonvolatile Beta in River Algae, μμc/g (dry weight)

River Location	Samples	Max	Avg	Prev Avg
3 Miles Above Plant	17	205	100	40
Steel Creek	19	1020	165	450
10 Miles Below Plant	19	315	135	65

The uptake of radioactivity by river fish collected above, adjacent to, and below the Plant site was generally confined to low level concentrations of radiostrontium ($Sr^{89,90}$) in the bones. There was no significant concentration of radiostrontium in fleshy tissues. An occasional fish contained trace concentrations of Cs-137 in the fleshy tissues.

Nonvolatile Beta in River Fish, μμc/g (wet weight)

Location	Samples	Bone Max	Bone Avg	Bone Prev Avg	Flesh Max	Flesh Avg	Flesh Prev Avg
3 Miles Above Plant	20	28	16	8	8	4	4
Steel Creek	23	72	20	20	10	6	6
10 Miles Below Plant	13	35	14	13	6	5	4

Chemical Quality Of Water

Savannah River

Water quality upstream (location 2) and downstream (location 10) from the Plant is shown in the following table. All data except those for dissolved oxygen and BOD represent the average analyses of water samples collected weekly. The dissolved oxygen and BOD values reflect the average of weekly determinations of oxygen at the time of collection. The data indicate that SRP operations have no effect on the chemical quality of the river.

Savannah River Chemical Quality of Water

	Upstream			Downstream		
	Max	Min	Avg	Max	Min	Avg
Color, APHA	55	15	34	50	15	33
pH	7.4	6.8	7.1	8.0	6.8	7.1
Methyl Orange, ppm $CaCO_3$	19	11	16	50	12	17
Dissolved Oxygen, ppm	12.4	7.7	9.6	11.2	6.7	9.1
Sulfide, ppm S	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hardness, ppm $CaCO_3$	17	10	13	16	9	13
Conductivity, μmhos	55	35	47	55	40	47
TDS, ppm	50	20	38	49	11	38
BOD, ppm	1.6	0	0.7	1.7	0	0.5
Lignin, ppm	6.6	0.7	3.6	7.0	2.2	3.8
Total Iron, ppm Fe	1.9	0.6	1.0	1.4	0.6	1.0
Chloride, ppm Cl	4.2	0.8	2.6	4.8	1.1	2.3
Nitrite, ppm N	0.004	0.001	0.002	0.025	0.001	0.003
Nitrate, ppm N	0.08	0.02	0.04	0.09	0.02	0.04
Sulfate, ppm SO_4	3.1	<2.0	<2.0	3.0	<2.0	<2.0
Phosphate, ppm PO_4	29.4	<0.3	4.8	23.5	<0.3	6.2
Surfactant, ppm	0.04	<0.02	<0.02	0.03	<0.02	<0.02

Lower Three Runs

Because Lower Three Runs Station at Road A is approximately one-half mile downstream from the effluent of a wool scouring plant, a control location was established three miles upstream from Road A. The chemical quality of the water at these two locations is shown in the following table. The data indicate that the mill effluent had no significant effect on chemical quality of Lower Three Runs water. However, aquatic insect collections above and below the mill effluent continue to indicate a depressed insect population downstream from the mill.

Lower Three Runs
Chemical Quality of Water

	Above Mill Effluent			Below Mill Effluent		
	Max	Min	Avg	Max	Min	Avg
Color, APHA	60	20	35	60	20	36
pH	7.7	7.0	7.2	7.5	6.9	7.2
Methyl Orange, ppm $CaCO_3$	31	15	24	33	12	24
Dissolved Oxygen, ppm	12.6	6.2	8.8	12.0	5.8	8.8
Sulfide, ppm S	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hardness, ppm $CaCO_3$	33	10	24	49	16	27
Conductivity, µmhos	72	44	59	76	43	61
TDS, ppm	60	18	42	68	21	43
BOD, ppm	1.3	0	0.6	1.2	0	0.5
Lignin, ppm	7.9	2.5	4.4	8.1	2.4	4.6
Total Iron, ppm Fe	1.0	0.2	0.5	1.7	0.2	0.7
Chloride, ppm Cl	2.6	0.5	1.5	3.0	0.5	1.6
Nitrite, ppm N	0.003	0.002	0.002	0.003	0.002	0.002
Nitrate, ppm N	0.05	0.02	0.03	0.04	0.02	0.03
Sulfate, ppm SO_4	<2.0	<2.0	<2.0	2.5	<2.0	<2.0
Phosphate, ppm PO_4	16.4	<0.3	3.6	9.8	<0.3	3.6
Surfactant, ppm	<0.02	<0.02	<0.02	0.04	<0.02	<0.02

DISSOLVED OXYGEN

Savannah River. Surveys from Butler Creek entry to Highway 301 bridge are made each quarter to obtain dissolved oxygen profiles. The following table compares data obtained on April 4 and June 13 under conditions of high and normal flows, respectively. River water temperatures were higher on June 13 than on April 4. The dissolved oxygen content during both periods was normal for a stream not adversely affected by pollution. The Spirit Creek data reflect oxygen content of a thin layer of undiluted creek water, sampled 100 yards downstream from the mouth of Spirit Creek. Three hundred yards downstream, the oxygen content of the creek and river water mixture was normal. River water oxygen content during both periods was slightly depressed adjacent to the Plant due to increased water temperatures. Sampling locations are shown in figure 11.

Location	Water Temp, °C		Dissolved Oxygen, ppm		% Saturation	
	4/4	6/13	4/4	6/13	4/4	6/13
Butler Creek	13	18	10.4	7.9	98	83
Spirit Creek	13	19	4.7	4.4	44	47
Silver Bluff	13	18	10.4	8.4	98	88
Gray's Landing	13	18	10.4	8.1	98	85
SR 2	14	18	10.1	8.2	97	86
Hancock Landing	14	19	9.3	7.5	89	80
Griffin's Landing	13	20	9.3	7.5	88	82
Brigham's Landing	13	20	9.0	7.5	85	82
Steel Creek	13	25	9.0	6.7	85	80
Little Hell Landing	18	27	7.1	7.5	75	91
Lower Three Runs	14	23	8.5	7.1	82	82
Johnson's Landing	14	23	8.3	7.1	80	82
U. S. 301	14	23	9.0	7.1	87	82

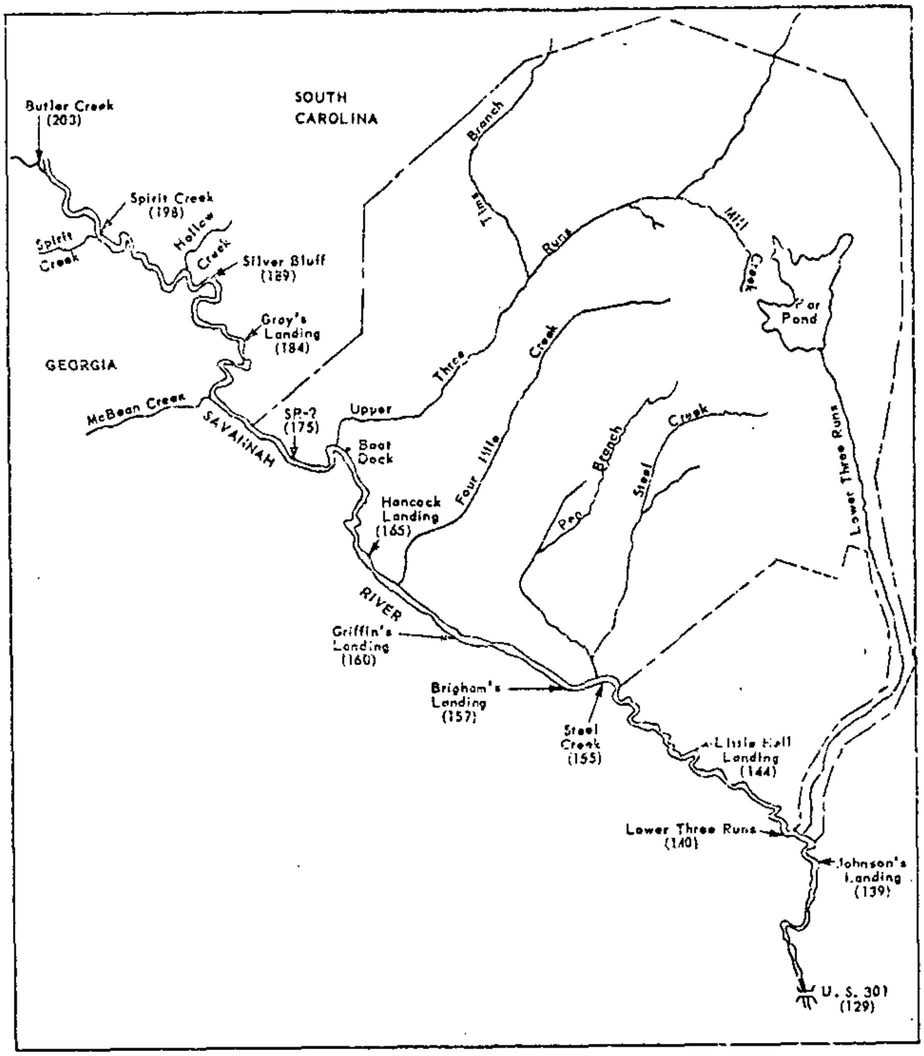

FIGURE 11. DISSOLVED OXYGEN SAMPLE POINTS ON THE SAVANNAH RIVER. Numbers in parentheses are river miles from Savannah, Georgia.

Reactor Effluents. Each Plant effluent is measured weekly at Road A to determine the minimum dissolved oxygen content of water returned to the river. Upper Three Runs is sampled as a control. The minimum dissolved oxygen content of water returned to the river was adequate to support diverse populations of aquatic life. Observations indicate an abundance of aquatic organisms in the lower reaches of the effluent streams and in the Savannah River.

Effluent	Dissolved Oxygen, ppm			Percent Saturation		
	Min	Avg	Prev Avg	Min	Avg	Prev Avg
Upper Three Runs	7.8	9.3	8.6	78	91	91
Four Mile Creek	4.5	6.1	5.7	76	93	91
Pen Branch	4.7	6.1	5.4	82	98	92
Steel Creek	4.6	6.7	5.6	84	98	93
Lower Three Runs	5.8	8.8	7.6	71	88	79

Appendix

APPENDIX A

RADIOACTIVE RELEASES

Table 1. Separations Areas Stack Releases

	Alpha, mc	Nonvolatile Beta, mc						Radioiodine, mc	Tritium, curies
		$Ru^{103,106}$	$Sr^{89,90}$	$Zr\text{-}Nb^{95}$	Cs^{137}	$Ce^{141,144}$	Total		
F Area									
January	1.3	46	0.5	6.6	0.7	4.6	58	97	-
February	1.1	109	0.5	8.5	0.4	3.2	122	16	-
March	1.2	60	0.4	4.2	0.5	2.6	68	40	-
April	1.1	53	0.5	5.4	0.7	2.6	62	58	-
May	2.3	504	2.2	11.2	1.0	6.8	525	914	-
June	3.3	663	2.7	8.1	0.6	10.6	685	1707	-
Total →	10.3	1435	6.8	44.0	3.9	30.4	1520	2832	-
H Area									
January	0.5	7.3	0.6	0.7	0.5	5.6	14.7	1034	40,500
February	.3	5.2	.2	1.1	.5	2.4	9.4	831	45,500
March	.2	3.4	.2	1.0	.5	1.8	6.9	1096	31,500
April	.2	1.8	.2	0.9	.4	3.6	6.9	1253	108,000
May	.2	3.2	.3	1.5	.8	2.6	8.4	146	42,700
June	0.4	1.5	0.2	0.4	0.6	8.4	11.1	111	52,300
Total →	1.6	22.4	1.7	5.6	3.3	24.4	57.4	4471	320,500*

APPENDIX A

Table 2. Reactor Areas Disassembly Basin Releases, curies

	Long-Lived Isotopes (Exclusive of Tritium)										Short-Lived Isotopes					
	Ce^{141}	Cr^{51}	Ru^{103}	$Zr\text{-}Nb^{95}$	Zn^{65}	Co^{60}	$Sr^{89,90}$	Cs^{137}	S^{35}	Total	Na^{24}	Np^{239}	I^{131}	$Ba\text{-}La^{140}$	Total	Tritium
R Area																
January	0.10	3.51	0.13	0.26	0.74	0.08	0.73	0.61	-	6.16	-	0.20	1.11	0.10	1.41	147
February	.15	7.69	.13	.35	1.07	.31	.13	0.41	13.30	23.54	0.05	2.59	0.58	.12	3.34	1412
March	.17	5.20	.13	.27	1.01	.37	.26	0.57	10.95	18.93	-	1.38	.32	.07	1.77	1707
April	.24	5.27	.19	.46	1.43	.24	.41	1.10	7.00	16.30	0.01	0.18	.76	.94	1.69	267
May	-	0.64	.05	.14	0.32	.09	.34	0.68	1.59	3.81	-	-	.07	-	0.07	176
June	0.11	0.21	-	0.05	1.02	0.18	0.22	0.70	0.73	3.22	-	0.63	0.01	0.04	0.68	530
Total →	0.77	22.52	0.59	1.53	5.59	1.27	2.09	4.07	33.56	71.09	0.06	4.98	2.85	1.27	8.16	4261
P Area																
January	0.06	1.35	0.03	0.09	0.21	0.09	0.07	0.19	11.29	13.36	0.04	1.91	0.12	0.10	2.17	2076
February	.02	0.50	.03	.08	.15	.11	.07	.30	0.56	1.82	-	0.15	0.03	0.01	0.19	62
March	.20	1.27	.01	.31	.53	.81	.23	.44	0.86	4.66	-	0.11	-	0.02	0.13	24
April	0.05	5.89	0.06	0.14	0.24	0.15	0.29	0.61	10.00	17.43	0.15	7.88	0.84	0.07	8.94	1345
May	8.72	3.23	3.74	7.62	1.50	3.97	9.65	3.43	7.03	48.89	-	31.31	73.43	50.09	154.83	127
June	0.65	11.99	0.12	0.11	0.51	0.17	0.35	0.44	7.18	21.52	-	2.12	0.27	0.12	2.51	1117
Total →	9.70	24.23	3.99	8.35	3.14	5.30	10.66	5.41	36.92	107.70	0.19	43.48	74.69	50.41	168.77	4751
L Area																
January	0.03	0.10	0.02	0.05	0.10	0.04	0.10	0.16	-	0.60	-	0.17	-	0.02	0.19	69
February	.20	6.14	.06	.20	.11	.24	.49	.10	44.49	52.05	0.26	.41	0.56	.66	1.53	2862
March	.06	0.47	.02	.12	.13	.19	.08	.04	1.64	2.75	-	.11	.01	.03	0.15	63
April	-	.16	.04	.16	.26	.08	.04	.15	1.50	2.39	-	.05	-	.01	.06	94
May	-	.10	0.04	.08	.10	.09	0.05	.05	0.48	1.00	-	.04	.05	.01	.08	369
June	0.02	0.00	-	0.01	0.35	0.06	-	0.04	0.43	1.00	-	0.15	0.03	0.01	0.19	113
Total →	0.3[illegible]	7.06	0.18	0.62	1.05	0.70	0.76	0.55	48.54	59.77	0.26	0.93	0.65	0.74	2.56	3400
K Area																
January	0.01	0.29	0.03	0.08	0.23	0.08	0.03	0.17	-	0.92	-	0.05	0.01	0.05	0.11	9
February	0.01	0.07	.02	.08	.09	.10	0.05	.12	0.07	0.61	-	0.32	-	.03	0.35	11
March	1.46	5.92	.28	.41	.64	.24	1.11	.26	43.20	53.52	0.13	1.39	1.22	.77	3.51	1846
April	0.05	0.26	.06	.16	.32	.10	0.16	0.20	2.41	3.80	-	0.07	0.01	.05	0.13	45
May	-	0.32	.06	.13	.11	.06	0.29	2.70	0.45	4.12	-	0.01	0.04	0.01	0.06	24
June	1.66	2.51	0.09	0.25	0.60	0.08	0.72	0.55	56.45	62.91	0.03	3.99	0.69	1.05	5.76	2711
Total →	3.19	9.37	0.54	1.11	1.99	0.66	2.36	4.08	102.58	125.88	0.16	5.83	1.97	1.96	9.92	4646
C Area																
January	0.04	2.32	0.05	0.10	0.24	0.06	0.02	0.05	9.91	12.79	0.10	0.19	0.14	0.04	0.47	1953
February	.02	0.83	.01	.11	.27	.11	.05	.19	0.45	2.04	-	.03	0.01	.02	0.11	7
March	-	17.06	.09	.24	.89	.30	.03	.04	8.55	27.20	.04	.25	1.00	.07	1.36	1769
April	-	5.66	.04	.17	.56	.22	.05	.12	8.37	15.19	-	.20	0.53	.06	0.79	1891
May	-	2.91	.02	.10	0.44	.10	.08	.13	0.89	4.67	-	.03	0.22	.01	0.26	34
June	0.09	7.38	-	0.04	1.38	0.29	0.08	0.23	12.01	21.50	0.02	0.53	0.05	0.11	0.71	1057
Total →	0.15	36.16	0.21	0.76	3.78	1.08	0.31	0.76	40.18	83.39	0.16	1.28	1.95	0.31	3.70	7020

APPENDIX A

Table 3. Separations Area Releases to Seepage Basins

	Alpha, mc	Nonvolatile Beta, curies						Radioiodine, c	Tritium, c
		Sr^{90}	$Cs^{134,137}$	$Ce^{141,144}$	$Ru^{103,106}$	$Zr\text{-}Nb^{95}$	Total		
F Area									
January	88.0	0.08	0.70	1.38	2.39	2.22	6.77	0.24	
February	57.9	.08	0.67	0.13	9.01	0.70	10.59	.06	
March	204.3	.19	9.51	.75	9.78	0.83	21.06	.20	
April	61.8	.14	10.69	.45	9.67	1.29	22.24	0.02	
May	51.8	.04	6.46	-	12.71	1.18	20.39	1.11	
June	56.9	0.08	8.64	0.24	17.61	2.49	29.06	1.80	
Total →	520.7	0.61	36.67	2.95	61.17	8.71	110.11	3.43	
H Area									
January	120.1	0.08	0.88	0.12	0.27	0.52	1.87	0.02	
February	45.7	.18	2.43	.46	0.53	.60	4.20	.05	
March	30.6	.06	0.60	.29	0.42	.58	1.95	.01	
April	16.6	.06	.32	.08	3.45	.21	4.12	-	
May	17.3	.01	.49	.01	1.48	.36	2.35	.01	
June	7.0	0.02	0.29	0.04	0.35	0.04	0.74	0.01	
Total →	237.3	0.41	5.01	1.00	6.50	2.31	15.23	0.10	

APPENDIX B

ENVIRONMENTAL RADIOACTIVITY

Table 1. Radioactivity in Air, μμc/m^3

Location	Alpha Max	Alpha Avg	Alpha Prev Avg	Filterable Beta Max	Filterable Beta Avg	Filterable Beta Prev Avg	Radioiodine Max	Radioiodine Avg	Radioiodine Prev Avg	Tritium Max	Tritium Avg	Tritium Prev Avg
F Area	19	14	8	5.8	3.9	3.7	.25	.07	.15	1690	600	650
H Area	20	10	6	6.0	3.9	3.5	.36	.08	.28	8400	1600	10,400
700 Area	14	7	6	5.6	3.7	3.5	.21	.05	.14	630	220	280
Talatha Gatehouse	15	6	6	6.8	4.2	4.2	.09	*	.15	2070	340	310
Williston Gatehouse	16	8	6	6.1	3.9	3.8	.18	.04	.16	780	330	360
Dunbarton Fire Tower	15	8	5	10.8	4.1	3.8	.12	*	.28	1100	310	280
400 Area	18	10	6	5.6	3.7	3.2	.35	.06	.11	940	270	270
Aiken Airport	20	9	7	6.2	3.7	4.4	.14	.04	.21	400	120	130
Allendale	17	8	7	7.0	4.0	3.8	.15	.04	.20	400	100	90
Waynesboro	17	8	6	7.1	4.0	3.5	.05	*	.10	180	80	120
Langley	20	10	7	6.3	3.7	3.3	.09	*	.08	240	70	80
Williston	18	8	5	9.9	4.0	3.2	.58	.08	.24	1180	180	160
Barnwell	21	9	5	6.9	3.8	3.5	.21	.04	.15	370	120	110
Sardis	17	9	6	9.9	4.1	3.6	.13	.04	.17	330	110	100
Bush Field	19	9	6	8.0	3.8	3.2	.47	.07	.30	310	100	90
Green Pond Church	38	10	8	6.1	3.6	3.1	.14	.04	.09	1210	230	210
Military Recreation Site	18	8	5	6.0	3.8	3.7	.10	*	.11	940	240	220
Jackson	17	8	6	6.1	3.5	3.2	.04	*	.08	780	260	220
Aiken State Park	13	7	6	7.7	3.9	3.4	.25	.07	.21	520	110	100
Highway 301	14	7	6	6.6	3.9	3.8	.15	*	.08	540	110	90
Columbia, S. C.	21	11	10	6.5	4.2	4.2	.03	*	-	-	-	-
Greenville, S. C.	29	9	6	7.1	4.0	1.7	.11	*	-	-	-	-
Macon, Ga.	20	9	8	7.3	3.6	3.7	.05	.04	-	-	-	-
Savannah, Ga.	15	12	8	6.9	3.9	5.5	*	*	-	-	-	-

* Less than sensitivity of analysis.

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Table 2. Gamma Radiation Levels

	Dose Rate, mr/24 hours	
	Avg	Prev Avg
F Area	0.56	0.53
H Area	.65	.59
R Area	.55	.45
P Area	.50	.38
L Area	.56	.42
K Area	.54	.47
C Area	.50	.41
TC Area	.58	.34
300/700 Area	.66	.45
Talatna Gatehouse	.46	.30
Williston Gatehouse	.41	.32
Dunbarton Fire Tower	.40	.37
400 Area	.57	.49
Green Pond Church	.42	.33
Military Recreation Site	.39	.34
Jackson	.24	.21
Aiken Airport	.40	.26
Allendale	.59	.31
Waynesboro	.52	.46
Bush Field	.42	.40
Langley	.35	.34
Williston	.41	.36
Barnwell	.55	.33
Sardis	.33	.33
Aiken State Park	.33	.59
Highway 301	0.46	0.46

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Table 3. Radioactivity in Rainwater, μμc/ℓ

Location	Alpha			Nonvolatile Beta			Radioiodine			Tritium*		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
F Area	1.2	0.2	0.2	3600	690	-	58	20	21	160	34	88
H Area	6.6	.8	.4	4000	1300	630	68	16	15	850	150	130
700 Area	1.5	.3	.4	4300	1400	640	68	18	18	160	20	14
Talatha Gatehouse	1.4	.4	.4	2800	1300	970	66	14	17	84	13	13
Williston Gatehouse	0.7	.3	.4	3800	1200	490	120	20	22	24	11	22
Dunbarton Fire Tower	1.4	.3	.4	2700	1400	650	170	30	27	120	22	30
400 Area	1.4	.5	.3	3200	1500	490	43	13	13	50	15	16
Aiken Airport	1.3	.4	.2	3800	1300	550	44	15	20	22	6	5
Allendale	0.7	.3	.4	2800	1200	290	57	16	17	15	5	3
Waynesboro	0.8	.3	.3	3500	1300	480	53	15	16	20	6	5
Langley	1.4	.4	.9	3000	1300	670	70	18	21	57	9	5
Williston	1.4	.4	.3	3500	1300	450	80	22	25	21	8	5
Barnwell	1.3	.4	.1	3100	1400	260	59	19	21	160	14	5
Sardis	1.1	.3	.3	2800	1300	460	38	15	15	21	6	5
Bush Field	1.1	.3	.2	2500	1300	500	65	26	36	16	7	6
Aiken State Park	1.1	.3	.2	2500	1200	550	61	21	19	19	7	15
Highway 301	0.8	.2	.4	3600	1200	460	92	20	21	15	5	4
Green Pond Church	1.8	.5	.6	2700	1100	510	77	19	47	99	14	18
Military Recreation Site	1.2	.2	.3	4300	1100	760	67	23	22	62	14	10
Jackson	0.7	0.3	0.3	2600	1400	560	109	22	36	21	8	13

* Multiply by 10^3.

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Table 4. Radioactivity in Vegetation, μμc/g

Location	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg	Radioiodine Max	Radioiodine Avg	Radioiodine Prev Avg
F Area (at 1 mile radius)	0.6	0.3	0.1	1100	350	23	8	6	3
H Area (at 1 mile radius)	.6	.3	.1	1100	510	50	12	7	3
Plant Perimeter	.9	.2	.1	1000	290	77	12	7	4
25 Mile Radius	0.8	0.2	0.1	1800	320	77	10	7	3

Table 5. Radioactivity in Milk, μμc/ℓ

	Radioiodine Max	Radioiodine Avg	Radioiodine Prev Avg	Tritium Max	Tritium Avg	Tritium Prev Avg
Farm Cow						
Pleasant Mount	52	10	210	10,000	5000	*
Snelling	51	15	88	14,000	8000	6000
Talatha	22	8	130	8,000	6000	6000
Dairy						
Aiken	30	8	80	12,000	4000	*
Allendale	12	6	-	11,000	4000	-
Barnwell	43	9	-	9,000	4000	-
North Augusta	17	7	54	9,000	4000	4000
Waynesboro, Ga.	30	7	-	11,000	4000	-
Williston	9	6	-	10,000	4000	-

Sr^{90} in Milk (average), μμc/ℓ

	February	March	April	May	June
Farm Cow	29	38	55	65	55
Small Dairy	12	16	21	21	19
Major Distributor	16	17	21	24	19

* Less than sensitivity of analysis.

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Table 6. Radioactivity in Plant Drinking Water, $\mu\mu c/\ell$

Location	Alpha			Nonvolatile Beta		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg
F Area	14	7.4	5.7	35	23	20
H Area	8.0	5.9	7.1	27	18	21
3/700 Area	1.6	1.0	1.2	14	8	5
400 Area	2.5	1.9	1.4	32	14	10
CMX	3.7	1.8	1.0	16	10	11
Pump House 1	1.0	0.7	0.3	6	6	14
Pump House 2	0.6	0.5	0.6	6	4	7
R Area	0.7	0.4	0.3	12	5	5
P	1.0	0.7	0.8	14	7	6
L	0.3	*	*	33	16	5
K	0.3	0.2	0.3	37	16	5
C	0.4	0.2	0.2	24	17	7
Par Pond - Pump House	0.5	0.3	0.2	9	5	9
TC Area	9.7	3.9	4.4	22	13	14
Classification Yards	1.2	0.9	0.9	8	5	5
Central Shops	0.8	0.5	0.8	7	5	4
Barricade 1	1.9	1.2	1.4	10	8	13
2	37	32	34	69	55	50
3	0.4	0.4	0.2	8	7	4
4	4.0	4.0	4.0	13	12	8
5	*	*	*	10	7	*
Robbins Station	0.5	0.4	0.4	10	6	4
Donora Station Well	0.4	0.2	0.4	11	4	5

* Less than sensitivity of analysis.

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Table 7. Radioactivity in Public Drinking Water, μμc/l

Location	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg
Allendale	0.2	*	*	15	5	4
Sardis	0.2	*	*	11	6	5
Waynesboro	0.3	*	*	37	18	6
Augusta	0.3	*	0.2	15	11	7
North Augusta	0.4	0.2	0.2	17	13	9
Clearwater	0.5	0.2	0.2	22	14	8
Bath	4.3	3.4	2.3	17	12	10
Langley	2.1	2.0	1.9	17	11	9
Jackson	6.5	4.8	4.2	38	16	15
New Ellenton	1.7	0.9	0.7	13	5	6
Aiken	3.8	2.8	2.0	12	8	8
Williston	2.3	1.4	1.6	18	10	8
Blackville	0.8	0.3	0.2	11	5	5
Barnwell	0.5	0.2	0.2	15	6	7

* Less than sensitivity of analysis.

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Table 8. Radioactivity in Plant Stream Water, μμc/ℓ

Sample Point and Location	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg	Tritium* Max	Tritium* Avg	Tritium* Prev Avg
Tims Branch - Upper Three Runs									
1 Control	8.3	2.2	3	120	31	10	-	-	-
2 F-Area Storm Sewer	1900	110	13	4400	1400	650	-	-	-
3 700-Area Effluent	1300	140	48	3000	480	190	24	4	4
4 300-Area Effluent	600	280	170	1300	620	430	-	-	-
5 Road C	4.0	1.2	1	130	27	8	-	-	-
6 HWCTR Effluent, U Area	17	2.8	-	77	18	-	-	-	-
7 Road A	2.1	0.9	0.8	52	22	7	12	5	5
Four Mile Creek									
8 F-Area Effluent	17.9	3.7	6.7	4400	1200	3400	34	8	11
9 H-Area Effluent	2.6	1.2	1.4	120	45	53	310	160	330
10 Road C	2.3	0.7	0.6	530	69	180	500	200	-
11 Road A	0.6	0.3	0.3	710	120	230	380	48	100
Pen Branch									
12 Road A	0.6	**	0.2	5700	540	120	900	75	52
Steel Creek									
13 Road A	0.5	0.2	0.3	1300	210	160	290	66	59
Par Pond									
15 Pump House†	0.4	**	0.1	270	140	74	520	110	90
16 P-Area Cooling Water	0.3	0.2	0.2	130	140	73	92	85	75
Lower Three Runs									
17 Patterson's Mill	0.4	0.2	0.2	150	85	51	92	59	45
18 Road A	0.6	**	0.1	96	50	27	52	34	24

Location	Radioiodine Max	Radioiodine Avg	Radioiodine Prev Avg	Radiostrontium Max	Radiostrontium Avg	Radiostrontium Prev Avg	Radiocesium Max	Radiocesium Avg	Radiocesium Prev Avg
Four Mile Creek									
F-Area Effluent	-	-	-	47	24	160	1000	120	6
Road C	29	**	**	-	-	-	-	-	-
Road A	17	**	**	20	8	21	47	12	9
Pen Branch									
Road A	220	21	**	220	25	20	32	10	13
Steel Creek									
Road A	3000	190	**	110	26	18	66	26	10
Par Pond									
Pump House	-	-	-	110	23	5	42	29	19
P-Area Cooling Water	-	-	-	-	-	-	-	-	-
Lower Three Runs									
Patterson's Mill	-	-	-	25	12	7	65	21	15
Road A	-	-	-	20	11	5	28	11	7

* Multiply tritium values by 10^3.
** Less than sensitivity of analysis.
† 3-month average.

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Table 9. Radioactivity in Plant Stream Mud, μμc/g

Location	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg
Upper Three Runs						
Control	1.8	0.5	0.5	19	8	7
F-Area Storm Sewer	2.0	1.0	0.8	640	300	250
700-Area Effluent	20.4*	4.1*	81*	180	60	24
300-Area Effluent	13.0*	2.6*	95*	140	55	39
Road C	2.8	0.8	0.9	44	13	9
HWCTR Effluent, U Area	1.0	0.3	-	11	5	-
Road A	0.8	0.4	0.5	15	6	7
Four Mile Creek						
F-Area Effluent	2.2	0.5	0.5	400	130	300
H-Area Effluent	0.6	0.3	0.2	18	8	6
Road C	0.8	0.4	0.2	110	31	86
Road A	1.3	0.6	0.8	82	20	49
Pen Branch						
Road A	0.9	0.3	0.3	28	12	22
Steel Creek						
Road A	1.0	0.7	0.8	74	26	33
Par Pond						
R-Area Effluent	0.7	0.2	0.4	26	9	15
Pump House	0.3	**	0.2	11	6	4
P-Area Cooling Water Effluent	0.7	0.4	0.4	30	17	6
Lower Three Runs						
Patterson's Mill	0.7	0.3	0.3	11	7	5
Road A	0.6	0.2	0.2	10	6	4

* TBP extractable alpha.

** Less than sensitivity of analysis.

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Table 10. Radioactivity in Savannah River Water, μμc/l

	Alpha			Nonvolatile Beta			Tritium		
Location	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
2	0.9	0.3	0.2	93	36	8	9,000	2000	3,000
3	1.0	.2	.2	72	30	7	-	-	-
5	0.4	.2	*	210	37	15	-	-	-
8	.7	.2	.2	260	62	45	-	-	-
9	.6	.2	.2	97	52	29	-	-	-
10	.6	.2	.2	150	52	29	20,000	9000	14,000
11	0.9	0.2	0.3	160	48	28	23,000	9000	15,000

	Radioiodine			Radiostrontium			Radiocesium		
Location	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
2	-	-	-	-	-	-	-	-	-
8	-	-	-	24	8	*	13	5	*
9	-	-	-	20	9	*	12	4	*
10	180	11	*	19	7	*	19	8	*
11	-	-	-	14	7	*	10	5	*

Radioactivity in River Mud, μμc/g

	TBP Extractable Alpha			Nonvolatile Beta		
Location	Max	Avg	Prev Avg	Max	Avg	Prev Avg
2	3.8	2.5	1.3	29	18	15
3	4.7	2.3	1.5	69	21	14
5	2.7	2.0	1.4	40	23	17
8	3.0	2.3	1.5	35	16	15
9	3.0	2.2	2.0	25	15	13
10	4.4	2.1	2.1	42	20	15
11	4.9	2.0	1.1	16	6	7

* Less than sensitivity of analysis.

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Table 11. Radioactivity in Seepage Basin Water, μμc/ml

Basin No.	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg	Radioiodine Max	Radioiodine Avg	Radioiodine Prev Avg	Tritium Max	Tritium Avg	Tritium Prev Avg
F Area												
1	16.5	5.8	7.3	3100	1000	2400	36	15	56			
2	16.8	10.6	6.4	850	650	1200	17	10	110			
3	8.5	5.6	3.4	700	550	800	13	6	42			
H Area												
1	1.0	0.3	1.5	400	200	600	13	4	3			
2	1.2	0.6	2.0	300	200	750	8	4	3			
3	0.2	*	0.3	40	30	50	2	1	0.3			
A Area												
1	1.2	0.6	0.3	35	2	2.8	-	-	-	5,800	3,300	4,500
TNX												
1	11.3	5.3	2.8	67	19	10	-	-	-	140	48	13

* Less than sensitivity of analysis.

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Table 12. Radioactivity in Ground Water, $\mu\mu c/\ell$

ZW Wells

Well No.	Alpha 3/7	Alpha Prev Avg	Nonvolatile Beta 3/7	Nonvolatile Beta Prev Avg
1	0.6	0.6	5	7
2	0.6	.4	15	10
3	1.0	.5	8	7
4	1.0	.7	11	8
5	0.4	.6	12	7
6	.6	.3	7	7
7	.2	.4	8	7
8	.4	.4	7	5
9	.1	.2	7	*
10	0.4	0.7	6	11

Burial Ground Wells

Well No.	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg
1	0.9	0.4	0.2	14	9	8
2	0.5	.2	.3	10	8	11
3	0.4	.3	.2	17	7	7
4	1.3	.7	.4	11	8	10
5	0.7	.3	.2	12	8	6
6	0.6	.2	.3	46	12	11
7	0.2	.1	.2	26	13	9
8	1.4	.7	.7	20	9	15
9	0.8	.5	0.3	18	9	11
12	1.2	0.7	-	29	12	-
18	3.8	2.4	-	53	13	-

Tritium in Ground Water, $\mu\mu c/ml$

Well No.	Z Wells 3/7	Z Wells Prev Avg	ZW Wells 3/7	ZW Wells Prev Avg	Burial Ground Wells Max	Burial Ground Wells Avg	Burial Ground Wells Prev Avg
1	8	17	*	16	4	*	6
2	15	22	*	12	5	*	*
3	670	71	29	46	7	*	*
4	**	**	28	58	170	150	220
5	**	**	62	95	25	22	32
6	**	**	39	51	8	*	9
7	**	**	72	150	4	*	4
8	37	36	*	17	39	14	45
9	16	19	130	98	5	*	*
10	**	**	25	84			
11	28	44					
12	27	35			8	*	5
13	*	*					
14	**	**					
15	70	94					
16	**	**					
17	*	*					
18	13	20			37	30	42
19	*	*					
20	*	*					

* Less than sensitivity of analysis
** Water sample unobtainable.

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Table 13. Radioactivity in F and H-Area Seepage Basin Wells, μμc/liter

Well No.	Distance from Basin, ft	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg	Radiostrontium Max	Radiostrontium Avg	Radiostrontium Prev Avg	Tritium* Max	Tritium* Avg	Tritium* Prev Avg
						F Area							
1*	34	3300	930	780	300,000	100,000	88,000	67,000	23,000	6,200	50	47	97
2	5	1.5	0.8	0.4	190	140	200	-	-	-	44	35	38
3	29	0.7	0.4	0.4	990	280	420	-	-	-	64	56	75
4	73	0.4	0.2	0.2	1,100	830	490	-	-	-	54	50	110
5	24	0.5	0.4	1.6	2,600	2,200	2,100	-	-	-	60	59	61
6	6	580	410	660	90,000	63,000	77,000	41,000	20,000	22,000	120	68	130
7	46	750	470	620	61,000	27,000	120,000	42,000	14,000	43,000	76	37	85
8	63	1.0	0.8	0.8	76	50	31	-	-	-	10	8	8
9	150	0.9	0.6	0.5	35	17	11	-	-	-	2	2	4
10	9	7800	4200	380	53,000	41,000	450,000	50,000	22,000	130,000	110	75	71
11	9	1.9	1.2	1.1	240	110	38	-	-	-	23	14	6
12*	29	8000	4600	120	53,000	40,000	160,000	33,000	20,000	22,000	100	74	66
13*	58	1300	360	-	310,000	180,000	-	29,000	21,000	-	100	65	-
						H Area							
1	24	110	50	32	16,000	5,400	9,600	-	-	-	29	10	34
2	25	0.7	0.9	0.4	1,300	270	56	-	-	-	53	41	65
3	15	6.0	4.0	2.0	40,000	15,000	13,000	-	-	-	150	140	130
4	45	1.3	0.8	0.4	160	100	70	-	-	-	6	3	2
5	13	1100	422	310	280,000	84,000	190,000	3,600	1,000	83,000	160	130	180
6	6	3.2	1.1	0.3	400	150	120	-	-	-	75	63	72
7	66	0.5	0.3	0.4	85	50	55	-	-	-	12	6	2
8	18	0.3	0.1	*	380	120	110	-	-	-	19	17	21
9	78	0.5	0.2	0.2	420	110	38	-	-	-	13	12	15
10	19	0.3	0.1	0.2	110	75	72	-	-	-	13	11	10
11	79	0.3	0.2	*	150	79	130	-	-	-	35	18	18
A37	500	4.2	2.5	2.5	410	170	170	150	130	98	57	42	40

* Wells in perched water table.
** Multiply tritium values by 10^{3}.