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FINAL
ENVIRONMENTAL IMPACT STATEMENT

L-Reactor Operation
Savannah River Plant

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APPENDIX A

NEED FOR DEFENSE NUCLEAR MATERIALS, PLANNED PRODUCTION ACTIVITIES, AND PRODUCTION ALTERNATIVES

This appendix is classified because it contains information specifically determined by the Atomic Energy Act to be kept secret in the interest of national defense. This appendix has been prepared for review by the DOE decisionmaker to assure that he has access to all pertinent information when he makes the decision. This appendix is being safeguarded and restricted from public dissemination in accordance with the CEQ Regulations for Implementing the Procedural Provisions of NEPA [40 CFR 1507.3(c)] and DOE's guidelines for complying with NEPA (45 FR 20694).

APPENDIX B

RADIATION DOSE CALCULATION METHODS AND ASSUMPTIONS FOR NORMAL L-REACTOR OPERATION

The normal operation of L-Reactor and its support facilities will result in releases of radioactive materials. This appendix describes the methods and assumptions used to determine the radiological impacts expected from these normal releases.

Radioactive materials released to the environment generally become involved in a complex series of physical, chemical, and biological processes. The principal pathways by which radioactivity released from a facility can reach people are (1) exposure to nuclides in the air, in the water, or on the ground, (2) the inhalation of radioactivity, and (3) the ingestion of radioactivity in food and water. Figure B-1 shows these pathways.

The calculations of radiological doses to members of the public from these various pathways are based on methods recommended by the U.S. Nuclear Regulatory Commission (NRC) for licensing power reactors. The estimates of doses are based on detailed analyses of the sources and rates of radioactive releases, and the pathways by which dispersed radioactive materials can result in exposure to people. The NRC methods are adopted to the specific Savannah River Plant (SRP) conditions.

Radiation doses are calculated for the maximally exposed individual, for the regional population within 80 kilometers of the Savannah River Plant, and to the population being served by the Beaufort-Jasper County and Cherokee Hill (Port Wentworth) water-treatment plants. To determine the expected L-Reactor impacts, the calculations were made for both the first and tenth years of L-Reactor operation. The first year was considered because the doses from remobilized cesium-137 are highest in that year; the tenth year was considered because it will take approximately 10 years before the tritium inventory in the reactor, and the resulting releases, reach equilibrium. Also, radioactive liquid releases from the migration of radionuclides from seepage basins to surface streams via ground water will not occur until 4.4 years after L-Reactor operations are resumed. The calculations were made on the basis of continuous exposure to the radionuclides released from the L-Reactor and its support facilities during these years.

The radiation doses have been calculated for a set of reference-case alternatives that consist of once-through cooling with and without seepage basins. A number of other alternatives with different cooling systems that operate with and without seepage basins have been evaluated in the main text of this EIS. The doses associated with these additional alternatives, including the preferred alternative, have been derived from the reference-case analysis presented in this appendix. TC

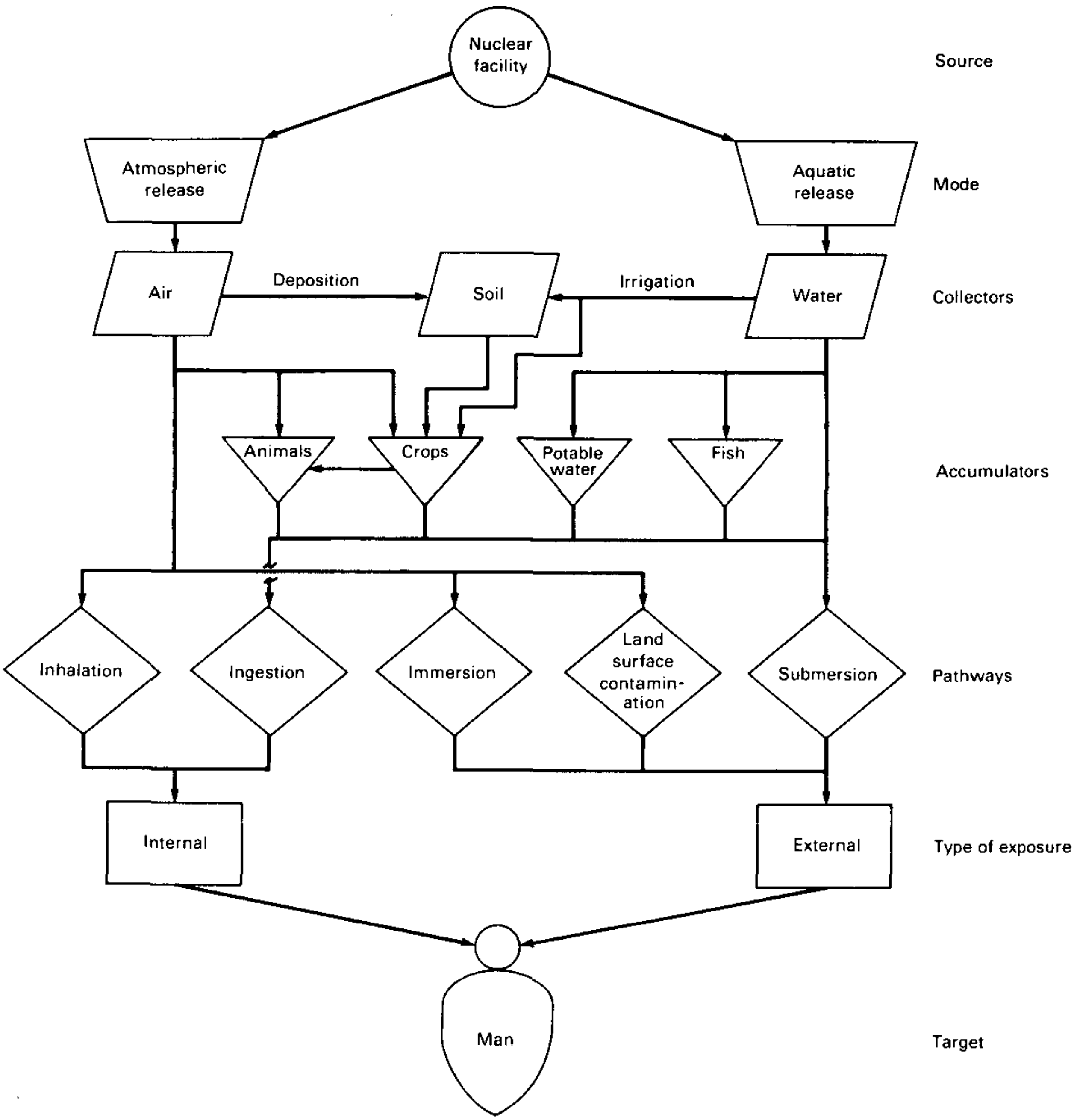

Figure B-1. Exposure pathways considered in radiological impact assessments.

B.1 ATMOSPHERIC RELEASES

For airborne releases, annual average air concentration and ground deposition per unit release (χ/Q and D/Q, respectively) were calculated for each of 160 segments (16 wind direction sectors at 10 distances) within an 80-kilometer radius of the site and for the site boundaries, using the methods implemented in the NRC computer program XOQDOQ (Sagendorf and Gall, 1976). Site-specific meteorological data were used to generate joint-frequency distributions (JFDs) of wind speed, stability, and direction for input to XOQDOQ (Table B-1). These stability windrose statistics were derived by 1-hour averaging of data collected at the 61-meter level of the SRP H-Area meteorological tower during the 5-year period from 1975 to 1979. Stability class was determined from the observed azimuthal and vertical standard deviations (σ_θ and σ_ϕ). Values of χ/Q and D/Q by compass sector and radial increment from both elevated (61-meter) stack releases and ground-level releases (using the windspeed measured at a height of 61 meters) were calculated and are presented in Tables B-2 and B-3, respectively. TC Flat terrain was assumed; no credit was taken for plume rise induced by momentum or thermal effects.

The meteorological dispersion parameters obtained by running the XOQDOQ code are used as input to the NRC GASPAR code (Eckerman et al., 1980), which implements the radiological exposure models of Regulatory Guide 1.109 (NRC, 1977) to estimate doses from atmospheric exposure pathways. Population distribution data and milk, meat, and vegetable production distribution data (Table B-4) for the 16 wind direction sectors are also used as input to GASPAR for calculating the dose to the regional population; the term "regional population" refers to those individuals residing within 80 kilometers of the Savannah River Plant. Population projections for the year 2000 are used in this analysis.

Source terms input to the GASPAR code, and used in the calculation of doses to the maximally exposed individual and the regional population, are given in Table 4-8 for the L-Reactor only, and Table 5-11 for L-Reactor support facilities. Source terms are presented for the first and tenth years of L-Reactor operation.

To calculate doses to the population within 80 kilometers, compass-sector average values of χ/Q and D/Q are used. All atmospheric releases are assumed to occur at the center of the site; the population and agricultural production distributions were centered at the same points. These are reasonable assumptions, given the absence of high population densities near either L-Reactor or Separations (F and H) Areas release points. Population doses for each year of operation were calculated as the sum of the doses during that year of operation plus residual doses from radioactivity released during that year, for 100 years into the future. The calculated population dose is referred to as a 100-year environmental dose commitment (EDC) per year of operation. (The EDC concept is discussed later in this appendix.) The total dose received by the exposed offsite population as a result of releases from L-Reactor and its support facilities is calculated by adding the individual dose commitments in the population. Parameters used in calculating doses to the 80-kilometer population are summarized in Table B-5. TC

For the doses to the maximally exposed individual, the XOQDOQ code and the GASPAR code are combined into a computer procedure to determine the doses at the

Table B-1. Joint-frequency distribution of wind; H-area tower 1975-1979

Wind speed class m/sec	Atmosphere stability class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
0.0 - 2.0	A (very unstable)	0.39	0.32	0.39	0.33	0.32	0.38	0.41	0.40	0.37	0.36	0.40	0.40	0.56	0.61	0.46	0.39	6.49
2.1 - 4.0		0.31	0.28	0.31	0.42	0.59	0.64	0.68	0.48	0.48	0.45	0.49	0.44	0.56	0.63	0.53	0.34	7.62
4.1 - 6.0		0.04	0.05	0.05	0.08	0.18	0.15	0.08	0.08	0.09	0.13	0.17	0.12	0.09	0.09	0.14	0.08	1.64
6.1 - 8.0		0.01	0.00	0.01	0.01	0.03	0.01	0.01	0.00	0.06	0.06	0.01	0.02	0.03	0.02	0.03	0.01	0.31
8.1 - 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.09
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0 - 2.0	B (unstable)	0.09	0.10	0.17	0.13	0.17	0.18	0.14	0.11	0.15	0.11	0.11	0.22	0.22	0.23	0.19	0.13	2.46
2.1 - 4.0		0.19	0.14	0.27	0.39	0.38	0.41	0.36	0.26	0.29	0.26	0.29	0.29	0.37	0.44	0.31	0.28	4.92
4.1 - 6.0		0.05	0.05	0.07	0.26	0.27	0.21	0.13	0.12	0.21	0.24	0.18	0.17	0.16	0.28	0.27	0.18	2.85
6.1 - 8.0		0.02	0.02	0.01	0.04	0.03	0.02	0.00	0.03	0.06	0.05	0.03	0.04	0.05	0.02	0.07	0.03	0.53
8.1 - 12.0		0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.02	0.01	0.08
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0 - 2.0	C (slightly unstable)	0.12	0.11	0.21	0.19	0.18	0.17	0.16	0.13	0.14	0.16	0.16	0.13	0.25	0.29	0.15	0.18	2.75
2.1 - 4.0		0.20	0.19	0.39	0.62	0.69	0.58	0.45	0.47	0.29	0.36	0.40	0.38	0.66	0.60	0.49	0.35	7.11
4.1 - 6.0		0.11	0.10	0.18	0.50	0.55	0.46	0.23	0.24	0.37	0.44	0.32	0.42	0.47	0.49	0.46	0.23	5.58
6.1 - 8.0		0.01	0.02	0.04	0.18	0.14	0.02	0.06	0.08	0.07	0.11	0.11	0.15	0.18	0.18	0.37	0.19	1.92
8.1 - 12.0		0.01	0.01	0.01	0.01	0.02	0.00	0.00	0.03	0.01	0.02	0.05	0.03	0.10	0.11	0.26	0.09	0.76
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02
0.0 - 2.0	D (neutral)	0.11	0.10	0.17	0.18	0.17	0.14	0.18	0.18	0.17	0.17	0.16	0.23	0.31	0.32	0.22	0.15	2.98
2.1 - 4.0		0.31	0.34	0.58	0.79	1.02	0.98	0.66	0.70	0.51	0.49	0.82	0.68	0.79	0.88	0.77	0.54	10.87
4.1 - 6.0		0.16	0.16	0.33	0.82	0.78	0.68	0.57	0.62	0.62	0.93	0.73	0.73	0.83	1.14	1.22	0.41	10.73
6.1 - 8.0		0.06	0.04	0.06	0.15	0.08	0.06	0.12	0.17	0.20	0.23	0.23	0.27	0.36	0.50	0.83	0.21	3.56
8.1 - 12.0		0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02	0.04	0.05	0.08	0.08	0.24	0.37	0.47	0.15	1.53
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.05	0.02	0.00	0.11

Table B-1. Joint-frequency distribution of wind; H-area tower 1975-1979 (continued)

Wind speed class m/sec	Atmosphere stability class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
0.0 - 2.0	E (slightly stable)	0.05	0.10	0.16	0.06	0.09	0.06	0.15	0.08	0.19	0.08	0.12	0.16	0.18	0.14	0.11	0.09	1.81
2.1 - 4.0		0.26	0.28	0.43	0.27	0.56	0.38	0.67	0.45	0.41	0.27	0.63	0.63	0.58	0.43	0.51	0.38	7.13
4.1 - 6.0		0.21	0.19	0.37	0.69	0.58	0.55	0.65	0.64	0.65	0.80	0.92	0.74	0.86	0.84	0.57	0.37	9.64
6.1 - 8.0		0.01	0.01	0.09	0.06	0.03	0.05	0.10	0.03	0.08	0.15	0.14	0.13	0.14	0.08	0.03	0.02	1.16
8.1 - 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.03
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0 - 2.0	F (stable)	0.03	0.01	0.03	0.02	0.02	0.03	0.03	0.02	0.03	0.02	0.02	0.01	0.02	0.01	0.00	0.01	0.30
2.1 - 4.0		0.15	0.08	0.11	0.02	0.10	0.03	0.22	0.09	0.08	0.05	0.09	0.09	0.10	0.12	0.03	0.07	1.44
4.1 - 6.0		0.13	0.15	0.24	0.30	0.22	0.08	0.23	0.13	0.14	0.06	0.16	0.14	0.16	0.18	0.05	0.05	2.42
6.1 - 8.0		0.01	0.00	0.03	0.03	0.01	0.01	0.03	0.02	0.02	0.02	0.04	0.00	0.03	0.02	0.00	0.01	0.29
8.1 - 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0 - 2.0	G (very stable)	0.00	0.01	0.01	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.14
2.1 - 4.0		0.00	0.07	0.26	0.01	0.01	0.01	0.10	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.50
4.1 - 6.0		0.00	0.00	0.07	0.01	0.00	0.01	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.18
6.1 - 8.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
8.1 - 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
> 12.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All classes	All classes	3.06	2.94	5.08	6.57	7.23	6.31	6.52	5.62	5.77	6.08	6.90	6.76	8.42	9.15	8.59	4.97	

Table B-2. Annual average meteorological dispersion/deposition parameters within 80 kilometers of SRP site center for elevated releases

Direction	Distance (km)									
from site	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE χ/Q, NO DECAY, UNDEPLETED (sec/m^3)					
N	1.657×10^{-7}	9.830×10^{-8}	6.035×10^{-8}	4.110×10^{-8}	3.030×10^{-8}	1.617×10^{-8}	6.688×10^{-9}	3.455×10^{-9}	2.246×10^{-9}	1.630×10^{-9}
NNE	1.715×10^{-7}	9.824×10^{-8}	5.792×10^{-8}	3.855×10^{-8}	2.800×10^{-8}	1.461×10^{-8}	5.878×10^{-9}	2.997×10^{-9}	1.938×10^{-9}	1.402×10^{-9}
NE	1.851×10^{-7}	1.140×10^{-7}	7.034×10^{-8}	4.786×10^{-8}	3.523×10^{-8}	1.870×10^{-8}	7.660×10^{-9}	3.931×10^{-9}	2.546×10^{-9}	1.843×10^{-9}
ENE	1.979×10^{-7}	1.186×10^{-7}	7.223×10^{-8}	4.881×10^{-8}	3.578×10^{-8}	1.891×10^{-8}	7.703×10^{-9}	3.936×10^{-9}	2.542×10^{-9}	1.837×10^{-9}
E	2.592×10^{-7}	1.492×10^{-7}	8.848×10^{-8}	5.922×10^{-8}	4.323×10^{-8}	2.278×10^{-8}	9.331×10^{-9}	4.829×10^{-9}	3.150×10^{-9}	2.294×10^{-9}
ESE	2.821×10^{-7}	1.583×10^{-7}	9.177×10^{-8}	6.061×10^{-8}	4.382×10^{-8}	2.274×10^{-8}	9.098×10^{-9}	4.628×10^{-9}	2.990×10^{-9}	2.162×10^{-9}
SE	2.365×10^{-7}	1.357×10^{-7}	7.860×10^{-8}	5.161×10^{-8}	3.711×10^{-8}	1.904×10^{-8}	7.490×10^{-9}	3.757×10^{-9}	2.407×10^{-9}	1.731×10^{-9}
SSE	1.609×10^{-7}	8.715×10^{-8}	5.018×10^{-8}	3.311×10^{-8}	2.394×10^{-8}	1.246×10^{-8}	5.017×10^{-9}	2.571×10^{-9}	1.669×10^{-9}	1.212×10^{-9}
S	9.942×10^{-8}	5.287×10^{-8}	3.174×10^{-8}	2.172×10^{-8}	1.615×10^{-8}	8.804×10^{-9}	3.772×10^{-9}	2.007×10^{-9}	1.329×10^{-9}	9.773×10^{-10}
SSW	9.513×10^{-8}	5.374×10^{-8}	3.282×10^{-8}	2.247×10^{-8}	1.669×10^{-8}	9.063×10^{-9}	3.867×10^{-9}	2.055×10^{-9}	1.360×10^{-9}	1.000×10^{-9}
SW	1.629×10^{-7}	9.250×10^{-8}	5.601×10^{-8}	3.832×10^{-8}	2.850×10^{-8}	1.560×10^{-8}	6.776×10^{-9}	3.661×10^{-9}	2.449×10^{-9}	1.815×10^{-9}
WSW	2.038×10^{-7}	1.107×10^{-7}	6.305×10^{-8}	4.144×10^{-8}	2.991×10^{-8}	1.553×10^{-8}	6.242×10^{-9}	3.200×10^{-9}	2.078×10^{-9}	1.508×10^{-9}
W	2.212×10^{-7}	1.229×10^{-7}	7.136×10^{-8}	4.735×10^{-8}	3.438×10^{-8}	1.800×10^{-8}	7.305×10^{-9}	3.760×10^{-9}	2.445×10^{-9}	1.777×10^{-9}
WNW	2.032×10^{-7}	1.085×10^{-7}	6.167×10^{-8}	4.047×10^{-8}	2.918×10^{-8}	1.515×10^{-8}	6.103×10^{-9}	3.132×10^{-9}	2.036×10^{-9}	1.480×10^{-9}
NW	1.796×10^{-7}	1.080×10^{-7}	6.754×10^{-8}	4.674×10^{-8}	3.492×10^{-8}	1.911×10^{-8}	8.213×10^{-9}	4.375×10^{-9}	2.897×10^{-9}	2.131×10^{-9}
NNW	1.648×10^{-7}	9.680×10^{-8}	5.825×10^{-8}	3.922×10^{-8}	2.870×10^{-8}	1.513×10^{-8}	6.167×10^{-9}	3.163×10^{-9}	2.049×10^{-9}	1.485×10^{-9}
					ANNUAL AVERAGE χ/Q, DECAY, UNDEPLETED, SITE ANNUAL DECAYED χ/Q (sec/m^3)					
N	1.653×10^{-7}	9.782×10^{-8}	5.987×10^{-8}	4.064×10^{-8}	2.987×10^{-8}	1.580×10^{-8}	6.384×10^{-9}	3.194×10^{-9}	2.012×10^{-9}	1.416×10^{-9}
NNE	1.711×10^{-7}	9.781×10^{-8}	5.751×10^{-8}	3.818×10^{-8}	2.765×10^{-8}	1.431×10^{-8}	5.644×10^{-9}	2.797×10^{-9}	1.758×10^{-9}	1.237×10^{-9}
NE	1.846×10^{-7}	1.135×10^{-7}	6.986×10^{-8}	4.741×10^{-8}	3.481×10^{-8}	1.833×10^{-8}	7.366×10^{-9}	3.679×10^{-9}	2.319×10^{-9}	1.634×10^{-9}
ENE	1.974×10^{-7}	1.181×10^{-7}	7.168×10^{-8}	4.831×10^{-8}	3.530×10^{-8}	1.850×10^{-8}	7.377×10^{-9}	3.658×10^{-9}	2.294×10^{-9}	1.610×10^{-9}
E	2.586×10^{-7}	1.484×10^{-7}	8.779×10^{-8}	5.858×10^{-8}	4.263×10^{-8}	2.227×10^{-8}	8.914×10^{-9}	4.466×10^{-9}	2.822×10^{-9}	1.990×10^{-9}
ESE	2.813×10^{-7}	1.575×10^{-7}	9.108×10^{-8}	5.998×10^{-8}	4.324×10^{-8}	2.225×10^{-8}	8.716×10^{-9}	4.304×10^{-9}	2.700×10^{-9}	1.896×10^{-9}
SE	2.359×10^{-7}	1.351×10^{-7}	7.808×10^{-8}	5.113×10^{-8}	3.666×10^{-8}	1.868×10^{-8}	7.199×10^{-9}	3.511×10^{-9}	2.187×10^{-9}	1.529×10^{-9}
SSE	1.604×10^{-7}	8.673×10^{-8}	4.979×10^{-8}	3.276×10^{-8}	2.362×10^{-8}	1.218×10^{-8}	4.799×10^{-9}	2.384×10^{-9}	1.501×10^{-9}	1.057×10^{-9}
S	9.914×10^{-8}	5.259×10^{-8}	3.148×10^{-8}	2.147×10^{-8}	1.591×10^{-8}	8.596×10^{-9}	3.597×10^{-9}	1.853×10^{-9}	1.188×10^{-9}	8.459×10^{-10}
SSW	9.485×10^{-8}	5.345×10^{-8}	3.254×10^{-8}	2.221×10^{-8}	1.643×10^{-8}	8.841×10^{-9}	3.683×10^{-9}	1.894×10^{-9}	1.213×10^{-9}	8.643×10^{-10}
SW	1.624×10^{-7}	9.201×10^{-8}	5.553×10^{-8}	3.787×10^{-8}	2.807×10^{-8}	1.523×10^{-8}	6.462×10^{-9}	3.384×10^{-9}	2.195×10^{-9}	1.578×10^{-9}
WSW	2.033×10^{-7}	1.103×10^{-7}	6.261×10^{-8}	4.105×10^{-8}	2.955×10^{-8}	1.523×10^{-8}	6.004×10^{-9}	2.997×10^{-9}	1.895×10^{-9}	1.340×10^{-9}
W	2.207×10^{-7}	1.224×10^{-7}	7.087×10^{-8}	4.690×10^{-8}	3.397×10^{-8}	1.765×10^{-8}	7.021×10^{-9}	3.515×10^{-9}	2.225×10^{-9}	1.573×10^{-9}
WNW	2.027×10^{-7}	1.080×10^{-7}	6.124×10^{-8}	4.008×10^{-8}	2.882×10^{-8}	1.485×10^{-8}	5.856×10^{-9}	2.918×10^{-9}	1.843×10^{-9}	1.301×10^{-9}
NW	1.791×10^{-7}	1.075×10^{-7}	6.703×10^{-8}	4.625×10^{-8}	3.445×10^{-8}	1.869×10^{-8}	7.863×10^{-9}	4.064×10^{-9}	2.612×10^{-9}	1.865×10^{-9}
NNW	1.644×10^{-7}	9.637×10^{-8}	5.783×10^{-8}	3.883×10^{-8}	2.833×10^{-8}	1.482×10^{-8}	5.917×10^{-9}	2.949×10^{-9}	1.857×10^{-9}	1.308×10^{-9}

Table B-2. Annual average meteorological dispersion/deposition parameters within 80 kilometers of SRP site center for elevated releases (continued)

Direction from site	Distance (km) 0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE χ/Q, DECAY, DEPLETED (sec/m^3)					
N	1.617×10^{-7}	9.484×10^{-8}	5.757×10^{-8}	3.886×10^{-8}	2.845×10^{-8}	1.493×10^{-8}	5.959×10^{-9}	2.962×10^{-9}	1.857×10^{-9}	1.294×10^{-9}
NNE	1.673×10^{-7}	9.451×10^{-8}	5.490×10^{-8}	3.613×10^{-8}	2.600×10^{-8}	1.328×10^{-8}	5.120×10^{-9}	2.494×10^{-9}	1.546×10^{-9}	1.069×10^{-9}
NE	1.807×10^{-7}	1.100×10^{-7}	6.711×10^{-8}	4.524×10^{-8}	3.305×10^{-8}	1.724×10^{-8}	6.824×10^{-9}	3.375×10^{-9}	2.112×10^{-9}	1.472×10^{-9}
ENE	1.931×10^{-7}	1.145×10^{-7}	6.882×10^{-8}	4.606×10^{-8}	3.349×10^{-8}	1.738×10^{-8}	6.820×10^{-9}	3.348×10^{-9}	2.084×10^{-9}	1.446×10^{-9}
E	2.528×10^{-7}	1.435×10^{-7}	8.396×10^{-8}	5.561×10^{-8}	4.024×10^{-8}	2.080×10^{-8}	8.195×10^{-9}	4.068×10^{-9}	2.554×10^{-9}	1.783×10^{-9}
ESE	2.750×10^{-7}	1.520×10^{-7}	8.673×10^{-8}	5.655×10^{-8}	4.046×10^{-8}	2.051×10^{-8}	7.833×10^{-9}	3.791×10^{-9}	2.342×10^{-9}	1.615×10^{-9}
SE	2.308×10^{-7}	1.304×10^{-7}	7.426×10^{-8}	4.809×10^{-8}	3.418×10^{-8}	1.711×10^{-8}	6.395×10^{-9}	3.040×10^{-9}	1.857×10^{-9}	1.270×10^{-9}
SSE	1.567×10^{-7}	8.367×10^{-8}	4.746×10^{-8}	3.095×10^{-8}	2.217×10^{-8}	1.129×10^{-8}	4.344×10^{-9}	2.119×10^{-9}	1.314×10^{-9}	9.085×10^{-10}
S	9.680×10^{-8}	5.077×10^{-8}	3.010×10^{-8}	2.041×10^{-8}	1.506×10^{-8}	8.068×10^{-9}	3.330×10^{-9}	1.702×10^{-9}	1.084×10^{-9}	7.636×10^{-10}
SSW	9.270×10^{-8}	5.176×10^{-8}	3.126×10^{-8}	2.122×10^{-8}	1.565×10^{-8}	8.362×10^{-9}	3.450×10^{-9}	1.767×10^{-9}	1.130×10^{-9}	7.988×10^{-10}
SW	1.587×10^{-7}	8.906×10^{-8}	5.332×10^{-8}	3.619×10^{-8}	2.674×10^{-8}	1.444×10^{-8}	6.092×10^{-9}	3.193×10^{-9}	2.075×10^{-9}	1.487×10^{-9}
WSW	1.985×10^{-7}	1.062×10^{-7}	5.949×10^{-8}	3.862×10^{-8}	2.760×10^{-8}	1.402×10^{-8}	5.392×10^{-9}	2.638×10^{-9}	1.642×10^{-9}	1.139×10^{-9}
W	2.156×10^{-7}	1.181×10^{-7}	6.755×10^{-8}	4.433×10^{-8}	3.190×10^{-8}	1.637×10^{-8}	6.379×10^{-9}	3.144×10^{-9}	1.965×10^{-9}	1.368×10^{-9}
WNW	1.980×10^{-7}	1.041×10^{-7}	5.819×10^{-8}	3.770×10^{-8}	2.690×10^{-8}	1.365×10^{-8}	5.239×10^{-9}	2.555×10^{-9}	1.585×10^{-9}	1.096×10^{-9}
NW	1.752×10^{-7}	1.042×10^{-7}	6.453×10^{-8}	4.431×10^{-8}	3.290×10^{-8}	1.775×10^{-8}	7.415×10^{-9}	3.830×10^{-9}	2.463×10^{-9}	1.751×10^{-9}
NNW	1.608×10^{-7}	9.323×10^{-8}	5.532×10^{-8}	3.684×10^{-8}	2.673×10^{-8}	1.382×10^{-8}	5.410×10^{-9}	2.659×10^{-9}	1.658×10^{-9}	1.151×10^{-9}
					ANNUAL AVERAGE D/Q (m^{-2})					
N	2.473×10^{-9}	9.109×10^{-10}	4.045×10^{-10}	2.331×10^{-10}	1.539×10^{-10}	6.845×10^{-11}	2.264×10^{-11}	1.049×10^{-11}	6.614×10^{-12}	4.729×10^{-12}
NNE	2.697×10^{-9}	1.011×10^{-9}	4.511×10^{-10}	2.602×10^{-10}	1.717×10^{-10}	7.626×10^{-11}	2.506×10^{-11}	1.151×10^{-11}	7.194×10^{-12}	5.100×10^{-12}
NE	2.740×10^{-9}	1.038×10^{-9}	4.647×10^{-10}	2.682×10^{-10}	1.770×10^{-10}	7.851×10^{-11}	2.569×10^{-11}	1.179×10^{-11}	7.421×10^{-12}	5.323×10^{-12}
ENE	2.811×10^{-9}	1.059×10^{-9}	4.737×10^{-10}	2.733×10^{-10}	1.804×10^{-10}	8.005×10^{-11}	2.625×10^{-11}	1.205×10^{-11}	7.565×10^{-12}	5.399×10^{-12}
E	3.650×10^{-9}	1.369×10^{-9}	6.114×10^{-10}	3.527×10^{-10}	2.327×10^{-10}	1.033×10^{-10}	3.394×10^{-11}	1.559×10^{-11}	9.764×10^{-12}	6.939×10^{-12}
ESE	4.124×10^{-9}	1.582×10^{-9}	7.110×10^{-10}	4.104×10^{-10}	2.708×10^{-10}	1.200×10^{-10}	3.908×10^{-11}	1.776×10^{-11}	1.100×10^{-11}	7.739×10^{-12}
SE	4.028×10^{-9}	1.575×10^{-9}	7.119×10^{-10}	4.113×10^{-10}	2.714×10^{-10}	1.200×10^{-10}	3.880×10^{-11}	1.747×10^{-11}	1.072×10^{-11}	7.461×10^{-12}
SSE	2.366×10^{-9}	8.707×10^{-10}	3.865×10^{-10}	2.228×10^{-10}	1.470×10^{-10}	6.541×10^{-11}	2.164×10^{-11}	9.996×10^{-12}	6.248×10^{-12}	4.412×10^{-12}
S	1.385×10^{-9}	4.897×10^{-10}	2.146×10^{-10}	1.235×10^{-10}	8.152×10^{-11}	3.642×10^{-11}	1.224×10^{-11}	5.765×10^{-12}	3.666×10^{-12}	2.631×10^{-12}
SSW	1.251×10^{-9}	4.481×10^{-10}	1.972×10^{-10}	1.136×10^{-10}	7.496×10^{-11}	3.344×10^{-11}	1.118×10^{-11}	5.246×10^{-12}	3.340×10^{-12}	2.407×10^{-12}
SW	1.979×10^{-9}	7.211×10^{-10}	3.191×10^{-10}	1.839×10^{-10}	1.213×10^{-10}	5.404×10^{-11}	1.796×10^{-11}	8.384×10^{-12}	5.355×10^{-12}	3.888×10^{-12}
WSW	3.024×10^{-9}	1.120×10^{-9}	4.979×10^{-10}	2.870×10^{-10}	1.894×10^{-10}	8.423×10^{-11}	2.780×10^{-11}	1.282×10^{-11}	8.021×10^{-12}	5.678×10^{-12}
W	3.342×10^{-9}	1.228×10^{-9}	5.447×10^{-10}	3.139×10^{-10}	2.072×10^{-10}	9.220×10^{-11}	3.052×10^{-11}	1.412×10^{-11}	8.852×10^{-12}	6.275×10^{-12}
WNW	3.053×10^{-9}	1.120×10^{-9}	4.969×10^{-10}	2.864×10^{-10}	1.890×10^{-10}	8.411×10^{-11}	2.785×10^{-11}	1.288×10^{-11}	8.043×10^{-12}	5.673×10^{-12}
NW	2.555×10^{-9}	9.364×10^{-10}	4.152×10^{-10}	2.393×10^{-10}	1.579×10^{-10}	7.028×10^{-11}	2.330×10^{-11}	1.085×10^{-11}	6.912×10^{-12}	5.008×10^{-12}
NNW	2.415×10^{-9}	9.062×10^{-10}	4.047×10^{-10}	2.334×10^{-10}	1.540×10^{-10}	6.840×10^{-11}	2.246×10^{-11}	1.032×10^{-11}	6.468×10^{-12}	4.602×10^{-12}

Table B-3. Annual average meteorological dispersion/deposition parameters within 80 kilometers of SRP site center for ground-level releases

Direction from site	Distance (km) 0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE χ/Q, NO DECAY, UNDEPLETED (sec/m^3)					
N	8.254×10^{-7}	2.524×10^{-7}	1.084×10^{-7}	6.403×10^{-8}	4.365×10^{-8}	2.117×10^{-8}	7.908×10^{-9}	3.881×10^{-9}	2.468×10^{-9}	1.769×10^{-9}
NNE	7.390×10^{-7}	2.245×10^{-7}	9.554×10^{-8}	5.606×10^{-8}	3.802×10^{-8}	1.827×10^{-8}	6.741×10^{-9}	3.291×10^{-9}	2.089×10^{-9}	1.495×10^{-9}
NE	9.494×10^{-7}	2.912×10^{-7}	1.251×10^{-7}	7.389×10^{-8}	5.035×10^{-8}	2.434×10^{-8}	9.042×10^{-9}	4.417×10^{-9}	2.800×10^{-9}	2.002×10^{-9}
ENE	9.499×10^{-7}	2.902×10^{-7}	1.241×10^{-7}	7.304×10^{-8}	4.966×10^{-8}	2.397×10^{-8}	8.882×10^{-9}	4.330×10^{-9}	2.742×10^{-9}	1.959×10^{-9}
E	1.227×10^{-6}	3.746×10^{-7}	1.605×10^{-7}	9.473×10^{-8}	6.453×10^{-8}	3.125×10^{-8}	1.167×10^{-8}	5.747×10^{-9}	3.666×10^{-9}	2.634×10^{-9}
ESE	1.156×10^{-6}	3.503×10^{-7}	1.486×10^{-7}	8.699×10^{-8}	5.889×10^{-8}	2.824×10^{-8}	1.039×10^{-8}	5.068×10^{-9}	3.216×10^{-9}	2.302×10^{-9}
SE	9.465×10^{-7}	2.866×10^{-7}	1.213×10^{-7}	7.079×10^{-8}	4.781×10^{-8}	2.282×10^{-8}	8.327×10^{-9}	4.029×10^{-9}	2.544×10^{-9}	1.814×10^{-9}
SSE	6.359×10^{-7}	1.918×10^{-7}	8.127×10^{-8}	4.757×10^{-8}	3.221×10^{-8}	1.548×10^{-8}	5.727×10^{-9}	2.813×10^{-9}	1.793×10^{-9}	1.288×10^{-9}
S	4.705×10^{-7}	1.433×10^{-7}	6.196×10^{-8}	3.681×10^{-8}	2.522×10^{-8}	1.236×10^{-8}	4.709×10^{-9}	2.353×10^{-9}	1.515×10^{-9}	1.095×10^{-9}
SSW	5.057×10^{-7}	1.551×10^{-7}	6.730×10^{-8}	4.009×10^{-8}	2.752×10^{-8}	1.351×10^{-8}	5.156×10^{-9}	2.576×10^{-9}	1.656×10^{-9}	1.197×10^{-9}
SW	9.776×10^{-7}	3.013×10^{-7}	1.313×10^{-7}	7.850×10^{-8}	5.404×10^{-8}	2.666×10^{-8}	1.025×10^{-8}	5.149×10^{-9}	3.322×10^{-9}	2.407×10^{-9}
WSW	8.207×10^{-7}	2.479×10^{-7}	1.048×10^{-7}	6.127×10^{-8}	4.144×10^{-8}	1.984×10^{-8}	7.307×10^{-9}	3.576×10^{-9}	2.276×10^{-9}	1.632×10^{-9}
W	9.536×10^{-7}	2.893×10^{-7}	1.230×10^{-7}	7.213×10^{-8}	4.892×10^{-8}	2.354×10^{-8}	8.718×10^{-9}	4.276×10^{-9}	2.722×10^{-9}	1.953×10^{-9}
WNW	7.890×10^{-7}	2.378×10^{-7}	1.007×10^{-7}	5.889×10^{-8}	3.987×10^{-8}	1.917×10^{-8}	7.106×10^{-9}	3.494×10^{-9}	2.229×10^{-9}	1.603×10^{-9}
NW	1.103×10^{-6}	3.407×10^{-7}	1.484×10^{-7}	8.866×10^{-8}	6.096×10^{-8}	2.997×10^{-8}	1.144×10^{-8}	5.699×10^{-9}	3.657×10^{-9}	2.638×10^{-9}
NNW	7.672×10^{-7}	2.342×10^{-7}	1.003×10^{-7}	5.907×10^{-8}	4.019×10^{-8}	1.939×10^{-8}	7.193×10^{-9}	3.517×10^{-9}	2.233×10^{-9}	1.598×10^{-9}
					ANNUAL AVERAGE χ/Q, DECAY, UNDEPLETED, SITE ANNUAL DECAYED χ/Q (sec/m^3)					
N	8.235×10^{-7}	2.513×10^{-7}	1.076×10^{-7}	6.334×10^{-8}	4.304×10^{-8}	2.070×10^{-8}	7.557×10^{-9}	3.592×10^{-9}	2.214×10^{-9}	1.538×10^{-9}
NNE	7.375×10^{-7}	2.236×10^{-7}	9.490×10^{-8}	5.553×10^{-8}	3.756×10^{-8}	1.791×10^{-8}	6.477×10^{-9}	3.073×10^{-9}	1.896×10^{-9}	1.320×10^{-9}
NE	9.476×10^{-7}	2.901×10^{-7}	1.243×10^{-7}	7.322×10^{-8}	4.976×10^{-8}	2.388×10^{-8}	8.701×10^{-9}	4.135×10^{-9}	2.552×10^{-9}	1.776×10^{-9}
ENE	9.479×10^{-7}	2.890×10^{-7}	1.232×10^{-7}	7.231×10^{-8}	4.902×10^{-8}	2.347×10^{-8}	8.514×10^{-9}	4.028×10^{-9}	2.477×10^{-9}	1.719×10^{-9}
E	1.224×10^{-6}	3.729×10^{-7}	1.593×10^{-7}	9.367×10^{-8}	6.361×10^{-8}	3.052×10^{-8}	1.113×10^{-8}	5.297×10^{-9}	3.268×10^{-9}	2.271×10^{-9}
ESE	1.154×10^{-6}	3.488×10^{-7}	1.476×10^{-7}	8.613×10^{-8}	5.815×10^{-8}	2.766×10^{-8}	9.970×10^{-9}	4.721×10^{-9}	2.909×10^{-9}	2.023×10^{-9}
SE	9.447×10^{-7}	2.856×10^{-7}	1.205×10^{-7}	7.014×10^{-8}	4.725×10^{-8}	2.238×10^{-8}	8.005×10^{-9}	3.764×10^{-9}	2.310×10^{-9}	1.602×10^{-9}
SSE	6.345×10^{-7}	1.910×10^{-7}	8.068×10^{-8}	4.708×10^{-8}	3.179×10^{-8}	1.515×10^{-8}	5.484×10^{-9}	2.611×10^{-9}	1.615×10^{-9}	1.125×10^{-9}
S	4.694×10^{-7}	1.427×10^{-7}	6.148×10^{-8}	3.641×10^{-8}	2.487×10^{-8}	1.208×10^{-8}	4.497×10^{-9}	2.175×10^{-9}	1.355×10^{-9}	9.491×10^{-10}
SSW	5.045×10^{-7}	1.544×10^{-7}	6.677×10^{-8}	3.965×10^{-8}	2.713×10^{-8}	1.321×10^{-8}	4.925×10^{-9}	2.382×10^{-9}	1.484×10^{-9}	1.039×10^{-9}
SW	9.755×10^{-7}	2.999×10^{-7}	1.303×10^{-7}	7.768×10^{-8}	5.332×10^{-8}	2.609×10^{-8}	9.816×10^{-9}	4.786×10^{-9}	2.999×10^{-9}	2.110×10^{-9}
WSW	8.191×10^{-7}	2.470×10^{-7}	1.042×10^{-7}	6.072×10^{-8}	4.096×10^{-8}	1.948×10^{-8}	7.038×10^{-9}	3.355×10^{-9}	2.080×10^{-9}	1.454×10^{-9}
W	9.518×10^{-7}	2.882×10^{-7}	1.221×10^{-7}	7.145×10^{-8}	4.833×10^{-8}	2.308×10^{-8}	8.379×10^{-9}	3.996×10^{-9}	2.475×10^{-9}	1.727×10^{-9}
WNW	7.874×10^{-7}	2.368×10^{-7}	9.997×10^{-8}	5.832×10^{-8}	3.937×10^{-8}	1.879×10^{-8}	6.819×10^{-9}	3.255×10^{-9}	2.017×10^{-9}	1.408×10^{-9}
NW	1.101×10^{-6}	3.392×10^{-7}	1.474×10^{-7}	8.774×10^{-8}	6.015×10^{-8}	2.932×10^{-8}	1.094×10^{-8}	5.287×10^{-9}	3.291×10^{-9}	2.303×10^{-9}
NNW	7.657×10^{-7}	2.332×10^{-7}	9.959×10^{-8}	5.851×10^{-8}	3.969×10^{-8}	1.901×10^{-8}	6.910×10^{-9}	3.283×10^{-9}	2.027×10^{-9}	1.411×10^{-9}

Table B-3. Annual average meteorological dispersion/deposition parameters within 80 kilometers of SRP site center for ground-level releases (continued)

Direction from site	Distance (km) 0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE χ/Q, DECAY, DEPLETED (sec/m^3)					
N	7.396×10^{-7}	2.154×10^{-7}	8.784×10^{-8}	4.988×10^{-8}	3.290×10^{-8}	1.496×10^{-8}	4.918×10^{-9}	2.112×10^{-9}	1.212×10^{-9}	7.949×10^{-10}
NNE	6.623×10^{-7}	1.916×10^{-7}	7.745×10^{-8}	4.369×10^{-8}	2.868×10^{-8}	1.293×10^{-8}	4.200×10^{-9}	1.795×10^{-9}	1.029×10^{-9}	6.749×10^{-10}
NE	8.508×10^{-7}	2.485×10^{-7}	1.014×10^{-7}	5.759×10^{-8}	3.798×10^{-8}	1.723×10^{-8}	5.635×10^{-9}	2.411×10^{-9}	1.381×10^{-9}	9.050×10^{-10}
ENE	8.512×10^{-7}	2.476×10^{-7}	1.006×10^{-7}	5.692×10^{-8}	3.744×10^{-8}	1.695×10^{-8}	5.530×10^{-9}	2.360×10^{-9}	1.349×10^{-9}	8.827×10^{-10}
E	1.100×10^{-6}	3.196×10^{-7}	1.301×10^{-7}	7.379×10^{-8}	4.864×10^{-8}	2.208×10^{-8}	7.253×10^{-9}	3.124×10^{-9}	1.796×10^{-9}	1.181×10^{-9}
ESE	1.036×10^{-6}	2.990×10^{-7}	1.204×10^{-7}	6.779×10^{-8}	4.441×10^{-8}	1.997×10^{-8}	6.472×10^{-9}	2.763×10^{-9}	1.583×10^{-9}	1.038×10^{-9}
SE	8.483×10^{-7}	2.447×10^{-7}	9.830×10^{-8}	5.518×10^{-8}	3.607×10^{-8}	1.615×10^{-8}	5.190×10^{-9}	2.199×10^{-9}	1.253×10^{-9}	8.190×10^{-10}
SSE	5.699×10^{-7}	1.637×10^{-7}	6.587×10^{-8}	3.706×10^{-8}	2.429×10^{-8}	1.094×10^{-8}	3.564×10^{-9}	1.532×10^{-9}	8.813×10^{-10}	5.798×10^{-10}
S	4.216×10^{-7}	1.223×10^{-7}	5.021×10^{-8}	2.868×10^{-8}	1.901×10^{-8}	8.734×10^{-9}	2.926×10^{-9}	1.280×10^{-9}	7.429×10^{-10}	4.918×10^{-10}
SSW	4.532×10^{-7}	1.323×10^{-7}	5.453×10^{-8}	3.123×10^{-8}	2.074×10^{-8}	9.548×10^{-9}	3.205×10^{-9}	1.401×10^{-9}	8.128×10^{-10}	5.378×10^{-10}
SW	8.761×10^{-7}	2.570×10^{-7}	1.064×10^{-7}	6.115×10^{-8}	4.074×10^{-8}	1.884×10^{-8}	6.374×10^{-9}	2.805×10^{-9}	1.634×10^{-9}	1.084×10^{-9}
WSW	7.355×10^{-7}	2.116×10^{-7}	8.499×10^{-8}	4.776×10^{-8}	3.126×10^{-8}	1.405×10^{-8}	4.555×10^{-9}	1.953×10^{-9}	1.123×10^{-9}	7.387×10^{-10}
W	8.547×10^{-7}	2.469×10^{-7}	9.967×10^{-8}	5.621×10^{-8}	3.690×10^{-8}	1.665×10^{-8}	5.431×10^{-9}	2.333×10^{-9}	1.341×10^{-9}	8.821×10^{-10}
WNW	7.071×10^{-7}	2.030×10^{-7}	8.159×10^{-8}	4.589×10^{-8}	3.007×10^{-8}	1.356×10^{-8}	4.425×10^{-9}	1.905×10^{-9}	1.097×10^{-9}	7.225×10^{-10}
NW	9.889×10^{-7}	2.907×10^{-7}	1.203×10^{-7}	6.907×10^{-8}	4.596×10^{-8}	2.118×10^{-8}	7.111×10^{-9}	3.103×10^{-9}	1.797×10^{-9}	1.187×10^{-9}
NNW	6.876×10^{-7}	1.999×10^{-7}	8.127×10^{-8}	4.604×10^{-8}	3.031×10^{-8}	1.372×10^{-8}	4.481×10^{-9}	1.919×10^{-9}	1.100×10^{-9}	7.215×10^{-10}
					ANNUAL AVERAGE D/Q (m^{-2})					
N	6.024×10^{-9}	1.861×10^{-9}	7.406×10^{-10}	4.047×10^{-10}	2.572×10^{-10}	1.105×10^{-10}	3.426×10^{-11}	1.358×10^{-11}	7.251×10^{-12}	4.488×10^{-12}
NNE	6.351×10^{-9}	1.962×10^{-9}	7.808×10^{-10}	4.267×10^{-10}	2.712×10^{-10}	1.165×10^{-10}	3.612×10^{-11}	1.432×10^{-11}	7.645×10^{-12}	4.732×10^{-12}
NE	7.209×10^{-9}	2.227×10^{-9}	8.863×10^{-10}	4.843×10^{-10}	3.078×10^{-10}	1.322×10^{-10}	4.100×10^{-11}	1.625×10^{-11}	8.678×10^{-12}	5.371×10^{-12}
ENE	7.064×10^{-9}	2.182×10^{-9}	8.684×10^{-10}	4.746×10^{-10}	3.016×10^{-10}	1.296×10^{-10}	4.017×10^{-11}	1.592×10^{-11}	8.503×10^{-12}	5.263×10^{-12}
E	8.791×10^{-9}	2.716×10^{-9}	1.081×10^{-9}	5.906×10^{-10}	3.754×10^{-10}	1.612×10^{-10}	5.000×10^{-11}	1.982×10^{-11}	1.058×10^{-11}	6.550×10^{-12}
ESE	9.561×10^{-9}	2.954×10^{-9}	1.175×10^{-9}	6.423×10^{-10}	4.083×10^{-10}	1.754×10^{-10}	5.438×10^{-11}	2.155×10^{-11}	1.151×10^{-11}	7.124×10^{-12}
SE	8.976×10^{-9}	2.773×10^{-9}	1.104×10^{-9}	6.030×10^{-10}	3.833×10^{-10}	1.646×10^{-10}	5.105×10^{-11}	2.023×10^{-11}	1.080×10^{-11}	6.688×10^{-12}
SSE	5.195×10^{-9}	1.605×10^{-9}	6.387×10^{-10}	3.490×10^{-10}	2.218×10^{-10}	9.528×10^{-11}	2.955×10^{-11}	1.171×10^{-11}	6.254×10^{-12}	3.871×10^{-12}
S	3.199×10^{-9}	9.884×10^{-10}	3.933×10^{-10}	2.149×10^{-10}	1.366×10^{-10}	5.868×10^{-11}	1.820×10^{-11}	7.212×10^{-12}	3.851×10^{-12}	2.384×10^{-12}
SSW	3.072×10^{-9}	9.491×10^{-10}	3.777×10^{-10}	2.064×10^{-10}	1.312×10^{-10}	5.634×10^{-11}	1.747×10^{-11}	6.925×10^{-12}	3.698×10^{-12}	2.289×10^{-12}
SW	5.308×10^{-9}	1.640×10^{-9}	6.525×10^{-10}	3.566×10^{-10}	2.266×10^{-10}	9.735×10^{-11}	3.019×10^{-11}	1.196×10^{-11}	6.389×10^{-12}	3.955×10^{-12}
WSW	6.867×10^{-9}	2.122×10^{-9}	8.443×10^{-10}	4.614×10^{-10}	2.932×10^{-10}	1.260×10^{-10}	3.906×10^{-11}	1.548×10^{-11}	8.267×10^{-12}	5.117×10^{-12}
W	7.555×10^{-9}	2.334×10^{-9}	9.288×10^{-10}	5.075×10^{-10}	3.226×10^{-10}	1.386×10^{-10}	4.297×10^{-11}	1.703×10^{-11}	9.094×10^{-12}	5.629×10^{-12}
WNW	6.595×10^{-9}	2.037×10^{-9}	8.108×10^{-10}	4.430×10^{-10}	2.816×10^{-10}	1.210×10^{-10}	3.751×10^{-11}	1.487×10^{-11}	7.938×10^{-12}	4.914×10^{-12}
NW	6.813×10^{-9}	2.105×10^{-9}	8.376×10^{-10}	4.577×10^{-10}	2.909×10^{-10}	1.250×10^{-10}	3.875×10^{-11}	1.536×10^{-11}	8.201×10^{-12}	5.076×10^{-12}
NNW	5.875×10^{-9}	1.815×10^{-9}	7.223×10^{-10}	3.947×10^{-10}	2.509×10^{-10}	1.078×10^{-10}	3.341×10^{-11}	1.324×10^{-11}	7.072×10^{-12}	4.377×10^{-12}

Table B-4. Population and annual food production within 80 kilometers of the SRP site center[a]

Direction	Distance (km) 0-8	8-16	16-32	32-48	48-64	64-80	0-80	
				POPULATION				
N	0	2.34×10^3	3.97×10^3	3.41×10^3	1.04×10^4	3.38×10^4	5.39×10^4	
NNE	0	--	1.02×10^3	3.80×10^3	4.96×10^3	2.45×10^4	3.42×10^4	
NE	0	--	1.30×10^3	5.79×10^3	9.53×10^3	2.01×10^4	3.68×10^4	
ENE	0	--	6.91×10^3	2.35×10^3	9.33×10^3	5.23×10^4	7.09×10^4	
E	0	--	3.56×10^3	1.43×10^4	7.17×10^3	8.91×10^3	3.39×10^4	
ESE	0	--	7.14×10^3	3.89×10^3	3.21×10^3	5.02×10^3	1.93×10^4	
SE	0	--	--	7.14×10^3	5.98×10^3	1.11×10^4	2.42×10^4	
SSE	0	--	7.23×10^2	7.65×10^2	5.66×10^2	7.05×10^3	9.10×10^3	
S	0	--	1.02×10^3	3.01×10^3	7.80×10^3	4.92×10^3	1.67×10^4	
SSW	0	--	2.87×10^2	2.44×10^3	7.03×10^3	3.08×10^3	1.28×10^4	
SW	0	--	1.04×10^3	2.95×10^3	2.07×10^3	2.50×10^3	8.56×10^3	
WSW	0	--	--	7.81×10^3	2.12×10^3	7.61×10^3	1.75×10^4	TC
W	0	--	2.35×10^3	9.71×10^3	3.05×10^3	1.31×10^4	2.83×10^4	
WNW	0	4.05×10^3	3.63×10^3	1.90×10^5	1.16×10^5	2.58×10^4	3.39×10^5	
NW	0	1.13×10^3	1.38×10^4	5.01×10^4	7.77×10^3	1.58×10^3	7.44×10^4	
NNW	0	3.97×10^3	3.86×10^4	1.25×10^4	1.33×10^4	4.56×10^3	7.29×10^4	
Total	0	1.15×10^4	8.54×10^4	3.20×10^5	2.10×10^5	2.26×10^5	8.52×10^5	
				MILK PRODUCTION (ℓ/yr)				TE
N	0	1.64×10^4	1.03×10^5	1.72×10^5	1.41×10^6	5.57×10^6	7.28×10^6	
NNE	0	1.31×10^4	1.03×10^5	1.72×10^5	3.68×10^5	6.06×10^5	1.26×10^6	
NE	0	5.73×10^3	1.22×10^5	1.33×10^6	2.15×10^6	1.39×10^6	4.99×10^6	
ENE	0	1.58×10^3	1.80×10^5	1.92×10^6	4.82×10^6	5.46×10^6	1.24×10^7	
E	0	1.85×10^3	1.80×10^5	1.74×10^6	4.15×10^6	5.76×10^6	1.18×10^7	
ESE	0	4.51×10	1.80×10^5	9.31×10^5	2.84×10^6	1.46×10^6	5.41×10^6	
SE	0	--	1.21×10^5	4.52×10^4	1.80×10^5	4.00×10^5	7.46×10^5	
SSE	0	--	9.38×10^4	2.41×10^5	3.52×10^5	5.64×10^5	1.25×10^6	

Table B-4. Population and annual food production within 80 kilometers of the SRP site center[a] (continued)

Direction	Distance (km) 0-8	8-16	16-32	32-48	48-64	64-80	0-80
			MILK PRODUCTION (ℓ/yr) (continued) TE				
S	0	--	3.31×10^5	5.74×10^5	7.70×10^5	9.97×10^5	2.67×10^6
SSW	0	--	3.58×10^5	1.89×10^6	6.40×10^6	7.61×10^6	1.63×10^7
SW	0	7.65×10^3	3.87×10^5	6.71×10^5	3.07×10^6	2.84×10^6	6.97×10^6
WSW	0	2.47×10^3	3.53×10^5	6.68×10^5	1.05×10^6	2.40×10^6	4.47×10^6
W	0	1.16×10^4	1.81×10^5	3.79×10^5	1.01×10^6	1.77×10^6	3.36×10^6
WNW	0	1.38×10^4	1.79×10^5	3.46×10^5	6.13×10^5	8.55×10^5	2.01×10^6
NW	0	1.75×10^4	1.03×10^5	4.24×10^5	1.16×10^6	7.81×10^5	2.49×10^6
NNW	0	1.79×10^4	1.03×10^5	2.95×10^5	1.48×10^6	3.14×10^6	5.04×10^6
Total	0	1.10×10^5	3.08×10^6	1.18×10^7	3.18×10^7	4.16×10^7	8.84×10^7
			MEAT PRODUCTION (kg/yr)				
N	0	8.32×10^4	5.24×10^5	8.73×10^5	1.41×10^6	3.15×10^6	6.05×10^6
NNE	0	6.63×10^4	5.24×10^5	8.73×10^5	2.29×10^6	4.06×10^6	7.81×10^6
NE	0	2.37×10^4	4.71×10^5	7.80×10^5	1.71×10^6	3.01×10^6	5.99×10^6
ENE	0	2.65×10^4	3.02×10^5	5.50×10^5	8.87×10^5	1.06×10^6	2.80×10^6
E	0	3.10×10^3	3.02×10^5	4.74×10^5	6.89×10^5	1.03×10^6	2.50×10^6
ESE	0	7.56×10^1	3.02×10^5	4.66×10^5	6.14×10^5	7.10×10^5	2.09×10^6
SE	0	--	2.74×10^5	3.82×10^5	6.56×10^5	1.00×10^6	2.31×10^6
SSE	0	--	2.35×10^5	4.35×10^5	6.19×10^5	9.88×10^5	2.28×10^6
S	0	--	1.75×10^5	4.58×10^5	7.32×10^5	1.02×10^6	2.39×10^6
SSW	0	--	1.57×10^5	3.93×10^5	1.13×10^6	1.58×10^6	3.26×10^6
SW	0	2.29×10^3	1.33×10^5	2.01×10^5	5.76×10^5	7.57×10^5	1.67×10^6
WSW	0	1.06×10^4	1.75×10^5	2.00×10^5	3.09×10^5	6.65×10^5	1.36×10^6
W	0	5.90×10^4	1.66×10^5	1.19×10^5	2.91×10^5	5.11×10^5	1.15×10^6
WNW	0	7.01×10^4	1.75×10^5	1.09×10^5	1.76×10^5	2.45×10^5	7.75×10^5

Table B-4. Population and annual food production within 80 kilometers of the SRP site center[a] (continued)

Direction	Distance (km) 0-8	8-16	16-32	32-48	48-64	64-80	0-80
				MEAT PRODUCTION (kg/yr) (continued)			
NW	0	8.86×10^{4}	5.24×10^{5}	6.98×10^{5}	5.83×10^{5}	7.01×10^{5}	2.60×10^{6}
NNW	0	9.11×10^{4}	5.24×10^{5}	8.20×10^{5}	7.14×10^{5}	1.45×10^{5}	3.60×10^{6}
Total	0	5.01×10^{5}	4.96×10^{6}	7.83×10^{6}	1.34×10^{7}	2.20×10^{7}	4.86×10^{7}
				VEGETABLE PRODUCTION (kg/yr)			
N	0	7.39×10^{4}	4.65×10^{5}	7.75×10^{5}	2.16×10^{6}	3.11×10^{6}	6.58×10^{6}
NNE	0	5.89×10^{4}	4.65×10^{5}	7.75×10^{5}	1.18×10^{6}	1.61×10^{6}	4.09×10^{6}
NE	0	4.13×10^{4}	9.71×10^{5}	1.08×10^{6}	1.59×10^{6}	1.93×10^{6}	5.61×10^{6}
ENE	0	2.25×10^{4}	2.57×10^{6}	2.89×10^{6}	2.21×10^{6}	2.78×10^{6}	1.05×10^{7}
E	0	2.64×10^{4}	2.57×10^{6}	3.01×10^{6}	2.72×10^{6}	3.03×10^{6}	1.14×10^{7}
ESE	0	6.44×10^{2}	2.57×10^{6}	3.82×10^{6}	3.44×10^{6}	9.66×10^{5}	1.08×10^{7}
SE	0	--	2.73×10^{6}	4.97×10^{6}	4.70×10^{6}	2.89×10^{6}	1.53×10^{7}
SSE	0	--	2.65×10^{6}	3.71×10^{6}	5.01×10^{6}	3.16×10^{6}	1.45×10^{7}
S	0	--	1.36×10^{6}	1.69×10^{6}	2.50×10^{6}	3.27×10^{6}	8.82×10^{6}
SSW	0	--	1.15×10^{6}	1.33×10^{6}	1.86×10^{6}	2.55×10^{6}	6.89×10^{6}
SW	0	1.51×10^{4}	9.20×10^{5}	1.33×10^{6}	1.81×10^{6}	1.97×10^{6}	6.04×10^{6}
WSW	0	1.01×10^{4}	7.21×10^{5}	1.31×10^{6}	1.86×10^{6}	2.41×10^{6}	6.31×10^{6}
W	0	5.23×10^{4}	1.86×10^{5}	3.17×10^{5}	1.18×10^{6}	2.77×10^{6}	4.51×10^{6}
WNW	0	6.22×10^{4}	1.94×10^{5}	1.70×10^{5}	4.89×10^{4}	1.36×10^{6}	1.83×10^{6}
NW	0	7.86×10^{4}	4.65×10^{5}	1.59×10^{6}	4.20×10^{6}	2.27×10^{6}	8.59×10^{6}
NNW	0	8.08×10^{4}	4.65×10^{5}	1.25×10^{6}	5.70×10^{6}	6.38×10^{6}	1.39×10^{7}
Total	0	5.23×10^{5}	2.05×10^{7}	3.00×10^{7}	4.22×10^{7}	4.24×10^{7}	1.36×10^{8}

[a]Adapted from Du Pont (1982).

Table B-5. Parameters and demographic data used in calculating doses to the 80-kilometer population

Average individual parameters[a]	Child	Teen	Adult
Inhalation (m^3/yr)	3,700	8,000	8,000
Ingestion[b]			
Cow's milk (ℓ/yr)	170	200	110
Meat (kg/yr)	37	59	95
Leafy vegetables (kg/yr)[c]	10	20	30
Fruits, vegetables, and grains (kg/yr)[d]	200	240	190
External exposure			
Transmission factor for shielding by residential structures	0.5	0.5	0.5
Demographic data, CY 2000[d]			
80-kilometer residential population (852,000) age-group distribution	20.8	11.8	67.4

TE

[a]Data are recommended values from Regulatory Guide 1.109 (NRC, 1977).

[b]Foodstuff obtained at large from the 80-kilometer agricultural production of man's foods; any insufficiency is assumed to be imported (uncontaminated). Crop yield and animal feeding data for the 80-kilometer vicinity are presented in Du Pont (1981).

[c]Data from Eckerman et al. (1980).

[d]1970-census data projected to the assumed midpoint of operations.

location of the maximum total-body dose rate (millirem per year of operation) to the age-specific individuals along the SRP buffer-zone boundary (the nearest possible approach of the residential population). Boundary locations are selected for each of the four support facilities (i.e., the 200-F and 200-H separations areas, the 300-M fuel fabrication area, and the 400-D heavy-water rework area) in each cardinal direction. For each location the doses from releases from L-Reactor and its support facilities are added to arrive at the total dose for that location. This method is used to determine the location at which a member of the public would receive the highest individual dose.

The maximally exposed individual is assumed to reside continuously at the location of highest potential exposure. All individual doses are 50-year dose commitments. Parameters used in calculating doses to maximally exposed individuals are summarized in Table B-6.

The response to radiation will vary with the age of the individual, or group of individuals, receiving the dose. Also, the stage of an individual's physical development and the chemical form of any radioactive material ingested will contribute to differences in its rate of uptake and internal deposition. For this reason, age-specific dose commitment factors were used to calculate dose. The age groups considered were infant (0 to 1 year old), child (1 to 11 years old), teen (11 to 17 years old), and adult (17 years and older). The dose factors used for exposure to noble gases are the factors in Table B-1 of Regulatory Guide 1.109 (NRC, 1977), plus lung exposure factors contained in the GASPAR code. The remainder of the dose factor library is that described in Appendix C of NUREG/CR-1276 (Simpson and McGill, 1980); for the inhalation and ingestion pathways, this incorporates the age-specific 50-year dose commitment factors of Hoenes and Soldat (1977) with NRC-approved corrections in actinide factors.

The following pathways and their descriptions were considered for the atmospheric dose assessment:

1. Plume--External dose from radioactive materials transported by the atmosphere.

2. Ground--External dose from radioactive material deposited on the ground.

3. Inhalation--Internal dose from inhalation of radioactive materials transported by the atmosphere.

4. Vegetation--Internal dose from consumption of vegetable food crops that are contaminated by radioactive material deposited from the atmosphere.

5. Milk--Internal dose from consumption of milk that is contaminated by radioactive material deposited from the atmosphere on vegetation.

6. Meat--Internal dose from consumption of meat products that are contaminated by radioactive material deposited from the atmosphere on vegetation.

The results of dose calculations to the maximally exposed individual and to the population within 80 kilometers of Savannah River Plant from atmospheric releases are contained in Tables B-7 through B-17. For releases from L-Reactor

Table B-6. Parameters used in calculating dose to maximally exposed individuals[a]

Parameter	Infant	Child	Teen	Adult
Inhalation (m^3/yr)	1,400	3,700	8,000	8,000
Ingestion[b]				
Cow's milk (ℓ/yr)	330	330	400	310
Meat (kg/yr)	0	41	65	110
Leafy vegetables (kg/yr)[c]	0	26	42	64
Fruits, vegetables, and grains (kg/yr)[d]	0	520	630	520
External exposure				
Transmission factor for shielding from buildings	0.7	0.7	0.7	0.7

TE

[a]Data are recommended values from Regulatory Guide 1.109 (NRC, 1977).

[b]Foodstuff produced at the reference family's location, except as noted, where exposure to the air-released radionuclides is at a maximum. Crop yield and animal feeding parameters are presented in Du Pont (1981).

[c]Seventy-five percent taken from reference family's garden (March-November growing season); remainder imported (uncontaminated).

[d]Seventy-six percent taken from reference family's crops (Regulatory Guide 1.109 recommended value) (NRC, 1977); remainder imported (uncontaminated).

Table B-7. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor with seepage basin in first year (in millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	3.97×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	5.65×10^{-3}	5.66×10^{-3}	6.65×10^{-3}	5.63×10^{-3}	5.63×10^{-3}	6.97×10^{-3}	5.63×10^{-3}	5.63×10^{-3}
Meat ingestion	1.10×10^{-3}	1.10×10^{-3}	2.14×10^{-3}	1.10×10^{-3}	1.10×10^{-3}	1.17×10^{-3}	1.10×10^{-3}	1.10×10^{-3}
Milk ingestion	2.05×10^{-3}	2.05×10^{-3}	2.36×10^{-3}	2.05×10^{-3}	2.05×10^{-3}	2.78×10^{-3}	2.05×10^{-3}	2.05×10^{-3}
Inhalation	3.79×10^{-3}	3.79×10^{-3}	1.42×10^{-5}	3.80×10^{-3}	3.80×10^{-3}	3.82×10^{-3}	3.80×10^{-3}	3.79×10^{-3}
Total	5.22×10^{-2}	5.22×10^{-2}	5.08×10^{-2}	5.22×10^{-2}	5.22×10^{-2}	5.44×10^{-2}	5.22×10^{-2}	7.77×10^{-2}
				TEENAGER				
Plume immersion	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	7.11×10^{-3}	7.11×10^{-3}	1.06×10^{-2}	7.08×10^{-3}	7.09×10^{-3}	8.20×10^{-3}	7.08×10^{-3}	7.08×10^{-3}
Meat ingestion	7.62×10^{-4}	7.62×10^{-4}	1.81×10^{-3}	7.62×10^{-4}	7.62×10^{-4}	8.12×10^{-4}	7.62×10^{-4}	7.62×10^{-4}
Milk ingestion	2.92×10^{-3}	2.92×10^{-3}	4.34×10^{-3}	2.92×10^{-3}	2.92×10^{-3}	4.08×10^{-3}	2.92×10^{-3}	2.92×10^{-3}
Inhalation	3.82×10^{-3}	3.82×10^{-3}	1.51×10^{-5}	3.82×10^{-3}	3.82×10^{-3}	3.85×10^{-3}	3.82×10^{-3}	3.82×10^{-3}
Total	5.42×10^{-2}	5.42×10^{-2}	5.64×10^{-2}	5.42×10^{-2}	5.42×10^{-2}	5.66×10^{-2}	5.42×10^{-2}	7.97×10^{-2}
				CHILD				
Plume immersion	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	1.27×10^{-2}	1.26×10^{-2}	2.52×10^{-2}	1.26×10^{-2}	1.26×10^{-2}	1.43×10^{-2}	1.26×10^{-2}	1.26×10^{-2}
Meat ingestion	1.16×10^{-3}	1.16×10^{-3}	3.40×10^{-3}	1.16×10^{-3}	1.16×10^{-3}	1.24×10^{-3}	1.16×10^{-3}	1.16×10^{-3}
Milk ingestion	5.37×10^{-3}	5.37×10^{-3}	1.07×10^{-2}	5.37×10^{-3}	5.38×10^{-3}	7.66×10^{-3}	5.37×10^{-3}	5.37×10^{-3}
Inhalation	3.38×10^{-3}	3.38×10^{-3}	1.27×10^{-5}	3.38×10^{-3}	3.38×10^{-3}	3.41×10^{-3}	3.38×10^{-3}	3.38×10^{-3}
Total	6.22×10^{-2}	6.22×10^{-2}	7.88×10^{-2}	6.21×10^{-2}	6.21×10^{-2}	6.62×10^{-2}	6.22×10^{-2}	8.76×10^{-2}

Table B-7. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor with seepage basin in first year (In millirems per year) (continued)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	9.36×10^{-3}	9.35×10^{-3}	2.08×10^{-2}	9.37×10^{-3}	9.37×10^{-3}	1.49×10^{-2}	9.35×10^{-3}	9.35×10^{-3}
Inhalation	1.94×10^{-3}	1.94×10^{-3}	5.09×10^{-6}	1.94×10^{-3}	1.94×10^{-3}	1.97×10^{-3}	1.94×10^{-3}	1.94×10^{-3}
Total	5.09×10^{-2}	5.09×10^{-2}	6.04×10^{-2}	5.09×10^{-2}	5.09×10^{-2}	5.65×10^{-2}	5.10×10^{-2}	7.64×10^{-2}

Table B-8. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor without seepage basin in first year (In millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	3.97×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	5.33×10^{-3}	5.33×10^{-3}	6.65×10^{-3}	5.31×10^{-3}	5.31×10^{-3}	6.64×10^{-3}	5.30×10^{-3}	5.30×10^{-3}
Meat ingestion	1.05×10^{-3}	1.05×10^{-3}	2.14×10^{-3}	1.05×10^{-3}	1.05×10^{-3}	1.12×10^{-3}	1.05×10^{-3}	1.05×10^{-3}
Milk ingestion	1.93×10^{-3}	1.93×10^{-3}	2.36×10^{-3}	1.93×10^{-3}	1.94×10^{-3}	2.67×10^{-3}	1.93×10^{-3}	1.93×10^{-3}
Inhalation	3.52×10^{-3}	3.52×10^{-3}	1.42×10^{-5}	3.52×10^{-3}	3.52×10^{-3}	3.54×10^{-3}	3.52×10^{-3}	3.52×10^{-3}
Total	5.15×10^{-2}	5.15×10^{-2}	5.08×10^{-2}	5.14×10^{-2}	5.14×10^{-2}	5.36×10^{-2}	5.15×10^{-2}	7.69×10^{-2}
				TEENAGER				
Plume immersion	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	6.73×10^{-3}	6.73×10^{-3}	1.06×10^{-2}	6.70×10^{-3}	6.71×10^{-3}	7.82×10^{-3}	6.70×10^{-3}	6.70×10^{-3}
Meat ingestion	7.33×10^{-4}	7.33×10^{-4}	1.81×10^{-3}	7.33×10^{-4}	7.34×10^{-4}	7.83×10^{-4}	7.33×10^{-4}	7.33×10^{-4}
Milk ingestion	2.77×10^{-3}	2.77×10^{-3}	4.34×10^{-3}	2.77×10^{-3}	2.78×10^{-3}	3.93×10^{-3}	2.77×10^{-3}	2.77×10^{-3}
Inhalation	3.54×10^{-3}	3.54×10^{-3}	1.51×10^{-5}	3.54×10^{-3}	3.54×10^{-3}	3.57×10^{-3}	3.55×10^{-3}	3.54×10^{-3}
Total	5.34×10^{-2}	5.34×10^{-2}	5.64×10^{-2}	5.34×10^{-2}	5.34×10^{-2}	5.57×10^{-2}	5.34×10^{-2}	7.89×10^{-2}
				CHILD				
Plume immersion	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	1.21×10^{-2}	1.20×10^{-2}	2.52×10^{-2}	1.20×10^{-2}	1.20×10^{-2}	1.37×10^{-2}	1.20×10^{-2}	1.20×10^{-2}
Meat ingestion	1.13×10^{-3}	1.13×10^{-3}	3.40×10^{-3}	1.13×10^{-3}	1.13×10^{-3}	1.20×10^{-3}	1.13×10^{-3}	1.13×10^{-3}
Milk ingestion	5.14×10^{-3}	5.13×10^{-3}	1.07×10^{-2}	5.14×10^{-3}	5.14×10^{-3}	7.43×10^{-3}	5.13×10^{-3}	5.13×10^{-3}
Inhalation	3.13×10^{-3}	3.13×10^{-3}	1.27×10^{-5}	3.13×10^{-3}	3.13×10^{-3}	3.16×10^{-3}	3.14×10^{-3}	3.13×10^{-3}
Total	6.11×10^{-2}	6.10×10^{-2}	7.88×10^{-2}	6.10×10^{-2}	6.10×10^{-2}	6.51×10^{-2}	6.11×10^{-2}	8.65×10^{-2}

Table B-8. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor without seepage basin in first year (In millirems per year) (continued)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.96×10^{-2}	3.97×10^{-2}	6.51×10^{-2}
Ground plane	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	2.54×10^{-7}	3.09×10^{-7}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	9.01×10^{-3}	9.00×10^{-3}	2.08×10^{-2}	9.01×10^{-3}	9.02×10^{-3}	1.46×10^{-2}	9.00×10^{-3}	9.00×10^{-3}
Inhalation	1.80×10^{-3}	1.80×10^{-3}	5.09×10^{-6}	1.80×10^{-3}	1.80×10^{-3}	1.83×10^{-5}	1.80×10^{-3}	1.80×10^{-3}
Total	5.04×10^{-2}	5.04×10^{-2}	6.04×10^{-2}	5.04×10^{-2}	5.04×10^{-2}	5.60×10^{-2}	5.05×10^{-2}	7.59×10^{-2}

Table B-9. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor with seepage basin in tenth year (In millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	6.70×10^{-2}	6.70×10^{-2}	9.79×10^{-3}	6.69×10^{-2}	6.69×10^{-2}	6.90×10^{-2}	6.69×10^{-2}	6.69×10^{-2}
Meat ingestion	1.03×10^{-2}	1.03×10^{-2}	3.12×10^{-3}	1.03×10^{-2}	1.03×10^{-2}	1.05×10^{-2}	1.03×10^{-2}	1.03×10^{-2}
Milk ingestion	2.35×10^{-2}	2.35×10^{-2}	3.43×10^{-3}	2.35×10^{-2}	2.35×10^{-2}	2.46×10^{-2}	2.35×10^{-2}	2.35×10^{-2}
Inhalation	5.49×10^{-2}	5.49×10^{-2}	2.05×10^{-5}	5.49×10^{-2}	5.49×10^{-2}	5.49×10^{-2}	5.49×10^{-2}	5.49×10^{-2}
Total	2.14×10^{-1}	2.14×10^{-1}	7.45×10^{-2}	2.14×10^{-1}	2.14×10^{-1}	2.17×10^{-1}	2.14×10^{-1}	2.51×10^{-1}
				TEENAGER				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	7.86×10^{-2}	7.86×10^{-2}	1.56×10^{-2}	7.86×10^{-2}	7.86×10^{-2}	8.03×10^{-2}	7.86×10^{-2}	7.86×10^{-2}
Meat ingestion	6.33×10^{-3}	6.33×10^{-3}	2.63×10^{-3}	6.33×10^{-3}	6.33×10^{-3}	6.40×10^{-3}	6.33×10^{-3}	6.33×10^{-3}
Milk ingestion	3.10×10^{-2}	3.10×10^{-2}	6.31×10^{-3}	3.10×10^{-2}	3.10×10^{-2}	3.28×10^{-2}	3.10×10^{-2}	3.10×10^{-2}
Inhalation	5.52×10^{-2}	5.52×10^{-2}	2.19×10^{-5}	5.52×10^{-2}	5.52×10^{-2}	5.52×10^{-2}	5.52×10^{-2}	5.52×10^{-2}
Total	2.29×10^{-1}	2.29×10^{-1}	8.27×10^{-2}	2.29×10^{-1}	2.29×10^{-1}	2.33×10^{-1}	2.29×10^{-1}	2.67×10^{-1}
				CHILD				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	1.25×10^{-1}	1.25×10^{-1}	3.69×10^{-2}	1.25×10^{-1}	1.25×10^{-1}	1.27×10^{-1}	1.25×10^{-1}	1.25×10^{-1}
Meat ingestion	7.99×10^{-3}	7.99×10^{-3}	4.94×10^{-3}	7.99×10^{-3}	7.99×10^{-3}	8.11×10^{-3}	7.99×10^{-3}	7.99×10^{-3}
Milk ingestion	5.01×10^{-2}	5.01×10^{-2}	1.55×10^{-2}	5.01×10^{-2}	5.01×10^{-2}	5.35×10^{-2}	5.01×10^{-2}	5.01×10^{-2}
Inhalation	4.88×10^{-2}	4.88×10^{-2}	1.83×10^{-5}	4.88×10^{-2}	4.88×10^{-2}	4.89×10^{-2}	4.88×10^{-2}	4.88×10^{-2}
Total	2.90×10^{-1}	2.90×10^{-1}	1.15×10^{-1}	2.90×10^{-1}	2.90×10^{-1}	2.96×10^{-1}	2.90×10^{-1}	3.27×10^{-1}

Table B-9. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor with seepage basin in tenth year (In millirems per year) (continued)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	7.78×10^{-2}	7.77×10^{-2}	3.02×10^{-2}	7.78×10^{-2}	7.78×10^{-2}	8.62×10^{-2}	7.77×10^{-2}	7.77×10^{-2}
Inhalation	2.81×10^{-2}	2.81×10^{-2}	7.38×10^{-6}	2.81×10^{-2}	2.81×10^{-2}	2.81×10^{-2}	2.81×10^{-2}	2.81×10^{-2}
Total	1.64×10^{-1}	1.64×10^{-1}	8.84×10^{-2}	1.64×10^{-1}	1.64×10^{-1}	1.72×10^{-1}	1.64×10^{-1}	2.01×10^{-1}

Table B-10. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor without seepage basin in tenth year (In millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	6.24×10^{-2}	6.24×10^{-2}	9.79×10^{-3}	6.24×10^{-2}	6.24×10^{-2}	6.44×10^{-2}	6.24×10^{-2}	6.24×10^{-2}
Meat ingestion	9.67×10^{-3}	9.67×10^{-3}	3.12×10^{-3}	9.67×10^{-3}	9.67×10^{-3}	9.77×10^{-3}	9.67×10^{-3}	9.67×10^{-3}
Milk ingestion	2.19×10^{-2}	2.19×10^{-2}	3.43×10^{-3}	2.19×10^{-2}	2.19×10^{-2}	2.30×10^{-2}	2.19×10^{-2}	2.19×10^{-2}
Inhalation	5.10×10^{-2}	5.10×10^{-2}	2.05×10^{-5}	5.10×10^{-2}	5.10×10^{-2}	5.11×10^{-2}	5.10×10^{-2}	5.10×10^{-2}
Total	2.03×10^{-1}	2.03×10^{-1}	7.45×10^{-2}	2.03×10^{-1}	2.03×10^{-1}	2.06×10^{-1}	2.03×10^{-1}	2.41×10^{-1}
				TEENAGER				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	7.33×10^{-2}	7.33×10^{-2}	1.56×10^{-2}	7.33×10^{-2}	7.33×10^{-2}	7.50×10^{-2}	7.33×10^{-2}	7.33×10^{-2}
Meat ingestion	5.92×10^{-3}	5.92×10^{-3}	2.63×10^{-3}	5.92×10^{-3}	5.92×10^{-3}	6.00×10^{-3}	5.92×10^{-3}	5.92×10^{-3}
Milk ingestion	2.89×10^{-2}	2.89×10^{-2}	6.31×10^{-3}	2.89×10^{-2}	2.89×10^{-2}	3.07×10^{-2}	2.89×10^{-2}	2.89×10^{-2}
Inhalation	5.13×10^{-2}	5.13×10^{-2}	2.19×10^{-5}	5.13×10^{-2}	5.13×10^{-2}	5.14×10^{-2}	5.13×10^{-2}	5.13×10^{-2}
Total	2.18×10^{-1}	2.18×10^{-1}	8.27×10^{-2}	2.18×10^{-1}	2.18×10^{-1}	2.21×10^{-1}	2.18×10^{-1}	2.55×10^{-1}
				CHILD				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	1.16×10^{-1}	1.16×10^{-1}	3.69×10^{-2}	1.16×10^{-1}	1.16×10^{-1}	1.19×10^{-1}	1.16×10^{-1}	1.16×10^{-1}
Meat ingestion	7.50×10^{-3}	7.50×10^{-3}	4.94×10^{-3}	7.50×10^{-3}	7.50×10^{-3}	7.62×10^{-3}	7.50×10^{-3}	7.50×10^{-3}
Milk ingestion	4.68×10^{-2}	4.68×10^{-2}	1.55×10^{-2}	4.68×10^{-2}	4.68×10^{-2}	5.03×10^{-2}	4.68×10^{-2}	4.68×10^{-2}
Inhalation	4.54×10^{-2}	4.54×10^{-2}	1.83×10^{-5}	4.54×10^{-2}	4.54×10^{-2}	4.54×10^{-2}	4.54×10^{-2}	4.54×10^{-2}
Total	2.74×10^{-1}	2.74×10^{-1}	1.15×10^{-1}	2.74×10^{-1}	2.74×10^{-1}	2.80×10^{-1}	2.74×10^{-1}	3.12×10^{-1}

Table B-10. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor without seepage basin in tenth year (In millirems per year) (continued)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	5.82×10^{-2}	9.56×10^{-2}
Ground plane	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	3.84×10^{-7}	4.66×10^{-7}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	7.28×10^{-2}	7.28×10^{-2}	3.02×10^{-2}	7.28×10^{-2}	7.28×10^{-2}	8.12×10^{-2}	7.28×10^{-2}	7.28×10^{-2}
Inhalation	2.61×10^{-2}	2.61×10^{-2}	7.38×10^{-6}	2.61×10^{-2}	2.61×10^{-2}	2.61×10^{-2}	2.61×10^{-2}	2.61×10^{-2}
Total	1.57×10^{-1}	1.57×10^{-1}	8.84×10^{-2}	1.57×10^{-1}	1.57×10^{-1}	1.65×10^{-1}	1.57×10^{-1}	1.94×10^{-1}

Table B-11. Eighty-kilometer population dose resulting from atmospheric releases from operation of L-Reactor with seepage basin in first year (In person-rem per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	1.60	1.60	1.60	1.60	1.60	1.60	1.60	2.99
Ground plane	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.45×10^{-5}
Vegetation ingestion	5.20×10^{-1}	5.20×10^{-1}	7.83×10^{-1}	5.19×10^{-1}	5.19×10^{-1}	7.68×10^{-1}	5.18×10^{-1}	5.18×10^{-1}
Meat ingestion	1.20×10^{-1}	1.20×10^{-1}	2.66×10^{-1}	1.20×10^{-1}	1.20×10^{-1}	1.24×10^{-1}	1.20×10^{-1}	1.20×10^{-1}
Milk ingestion	1.41×10^{-1}	1.41×10^{-1}	2.26×10^{-1}	1.41×10^{-1}	1.41×10^{-1}	1.66×10^{-1}	1.41×10^{-1}	1.41×10^{-1}
Inhalation	6.26×10^{-1}	6.26×10^{-1}	2.24×10^{-3}	6.26×10^{-1}	6.26×10^{-1}	6.30×10^{-1}	6.26×10^{-1}	6.26×10^{-1}
Total	3.00	3.00	2.88	3.00	3.00	3.28	3.00	4.40

Table B-12. Eighty-kilometer population dose resulting from atmospheric releases from operation of L-Reactor with seepage basin in tenth year (In person-rem per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	1.60	1.60	1.60	1.60	1.60	1.60	1.60	2.99
Ground plane	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.45×10^{-5}
Vegetation ingestion	3.94	3.94	7.83×10^{-1}	3.94	3.94	4.19	3.94	3.94
Meat ingestion	7.18×10^{-1}	7.18×10^{-1}	2.66×10^{-1}	7.18×10^{-1}	7.18×10^{-1}	7.23×10^{-1}	7.18×10^{-1}	7.18×10^{-1}
Milk ingestion	1.01	1.01	2.26×10^{-1}	1.01	1.01	1.04	1.01	1.01
Inhalation	6.26	6.26	2.24×10^{-3}	6.26	6.26	6.26	6.26	6.26
Total	1.35×10^{1}	1.35×10^{1}	2.88	1.35×10^{1}	1.35×10^{1}	1.38×10^{1}	1.35×10^{1}	1.49×10^{1}

Table B-13. Eighty-kilometer population dose resulting from atmospheric releases from operation of L-Reactor without seepage basin in first year (In person-rem per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	1.60	1.60	1.60	1.60	1.60	1.60	1.60	2.99
Ground plane	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.45×10^{-5}
Vegetation ingestion	4.95×10^{-1}	4.95×10^{-1}	7.83×10^{-1}	4.94×10^{-1}	4.94×10^{-1}	7.41×10^{-1}	4.93×10^{-1}	4.93×10^{-1}
Meat ingestion	1.15×10^{-1}	1.15×10^{-1}	2.66×10^{-1}	1.15×10^{-1}	1.15×10^{-1}	1.20×10^{-1}	1.15×10^{-1}	1.15×10^{-1}
Milk ingestion	1.35×10^{-1}	1.35×10^{-1}	2.26×10^{-1}	1.35×10^{-1}	1.35×10^{-1}	1.60×10^{-1}	1.35×10^{-1}	1.35×10^{-1}
Inhalation	5.85×10^{-1}	5.85×10^{-1}	2.24×10^{-3}	5.85×10^{-1}	5.85×10^{-1}	5.88×10^{-1}	5.85×10^{-1}	5.85×10^{-1}
Total	2.93	2.93	2.88	2.93	2.93	3.20	2.93	4.32

Table B-14. Eighty-kilometer population dose resulting from atmospheric releases from operation of L-Reactor without seepage basin in tenth year (In person-rem per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	1.60	1.60	1.60	1.60	1.60	1.60	1.60	2.99
Ground plane	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.01×10^{-5}	2.45×10^{-5}
Vegetation ingestion	3.69	3.69	7.83×10^{-1}	3.69	3.69	3.94	3.69	3.69
Meat ingestion	6.74×10^{-1}	6.74×10^{-1}	2.66×10^{-1}	6.74×10^{-1}	6.74×10^{-1}	6.78×10^{-1}	6.74×10^{-1}	6.74×10^{-1}
Milk ingestion	9.49×10^{-1}	9.49×10^{-1}	2.26×10^{-1}	9.49×10^{-1}	9.49×10^{-1}	9.73×10^{-1}	9.49×10^{-1}	9.49×10^{-1}
Inhalation	5.85	5.85	2.24×10^{-3}	5.85	5.85	5.85	5.85	5.85
Total	1.28×10^{1}	1.28×10^{1}	2.88	1.28×10^{1}	1.28×10^{1}	1.30×10^{1}	1.28×10^{1}	1.41×10^{1}

Table B-15. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor support facilities in first year[a] (In millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	2.66×10^{-3}	1.20×10^{-1}
Ground plane	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.84×10^{-4}
Vegetation ingestion	2.13×10^{-2}	2.27×10^{-2}	9.54×10^{-3}	2.10×10^{-2}	2.12×10^{-2}	4.44×10^{-1}	2.06×10^{-2}	2.06×10^{-2}
Meat ingestion	3.24×10^{-3}	1.03×10^{-2}	1.33×10^{-3}	3.22×10^{-3}	3.43×10^{-3}	1.73×10^{-2}	3.21×10^{-3}	3.21×10^{-3}
Milk ingestion	7.34×10^{-3}	7.26×10^{-3}	1.45×10^{-3}	7.29×10^{-3}	7.31×10^{-3}	7.81×10^{-2}	7.24×10^{-3}	7.24×10^{-3}
Inhalation	1.74×10^{-2}	1.68×10^{-2}	2.02×10^{-2}	2.08×10^{-2}	1.97×10^{-2}	1.82×10^{-2}	1.86×10^{-2}	1.68×10^{-2}
Total	5.04×10^{-2}	5.82×10^{-2}	3.37×10^{-2}	5.34×10^{-2}	5.28×10^{-2}	5.58×10^{-1}	5.24×10^{-2}	1.68×10^{-1}
				TEENAGER				
Plume immersion	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	2.66×10^{-3}	1.20×10^{-1}
Ground plane	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.84×10^{-4}
Vegetation ingestion	2.49×10^{-2}	2.68×10^{-2}	1.39×10^{-2}	2.48×10^{-2}	2.51×10^{-2}	3.46×10^{-1}	2.42×10^{-2}	2.42×10^{-2}
Meat ingestion	1.99×10^{-3}	6.37×10^{-3}	1.12×10^{-3}	1.98×10^{-3}	2.16×10^{-3}	7.48×10^{-3}	1.97×10^{-3}	1.97×10^{-3}
Milk ingestion	9.67×10^{-3}	9.59×10^{-3}	2.64×10^{-3}	9.65×10^{-3}	9.68×10^{-3}	7.03×10^{-2}	9.57×10^{-3}	9.57×10^{-3}
Inhalation	1.75×10^{-2}	1.69×10^{-2}	2.13×10^{-2}	2.12×10^{-2}	2.00×10^{-2}	1.78×10^{-2}	2.00×10^{-2}	1.69×10^{-2}
Total	5.52×10^{-2}	6.08×10^{-2}	4.01×10^{-2}	5.87×10^{-2}	5.81×10^{-2}	4.42×10^{-1}	5.86×10^{-2}	1.73×10^{-1}
				CHILD				
Plume immersion	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	2.66×10^{-3}	1.20×10^{-1}
Ground plane	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.84×10^{-4}
Vegetation ingestion	3.94×10^{-2}	4.06×10^{-2}	3.03×10^{-2}	3.95×10^{-2}	4.00×10^{-2}	3.45×10^{-1}	3.86×10^{-2}	3.86×10^{-2}
Meat ingestion	2.55×10^{-3}	5.20×10^{-3}	2.10×10^{-3}	2.53×10^{-3}	2.76×10^{-3}	6.61×10^{-3}	2.52×10^{-3}	2.52×10^{-3}
Milk ingestion	1.56×10^{-2}	1.56×10^{-2}	6.43×10^{-3}	1.57×10^{-2}	1.57×10^{-2}	7.51×10^{-2}	1.55×10^{-2}	1.55×10^{-2}
Inhalation	1.54×10^{-2}	1.49×10^{-2}	1.68×10^{-2}	1.81×10^{-2}	1.70×10^{-2}	1.55×10^{-2}	1.78×10^{-2}	1.49×10^{-2}
Total	7.42×10^{-2}	7.74×10^{-2}	5.68×10^{-2}	7.69×10^{-2}	7.66×10^{-2}	4.43×10^{-1}	7.72×10^{-2}	1.92×10^{-1}

Table B-15. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor support facilities in first year[a] (In millirems per year) (continued) TC

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	9.99×10^{-4}	2.66×10^{-3}	1.20×10^{-1}
Ground plane	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.28×10^{-4}	1.84×10^{-4}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	2.44×10^{-2}	2.43×10^{-2}	1.23×10^{-2}	2.46×10^{-2}	2.46×10^{-2}	1.69×10^{-1}	2.43×10^{-2}	2.42×10^{-2}
Inhalation	8.79×10^{-3}	8.58×10^{-3}	6.72×10^{-3}	9.84×10^{-3}	9.42×10^{-3}	9.12×10^{-3}	1.04×10^{-2}	8.58×10^{-3}
Total	3.43×10^{-2}	3.40×10^{-2}	2.01×10^{-2}	3.55×10^{-2}	3.51×10^{-2}	1.80×10^{-1}	3.74×10^{-2}	1.53×10^{-1}

[a]In the support facilities, only the doses resulting from L-Reactor operation are included. TC

Table B-16. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor support facilities in tenth year[a] (In millirems per year) TC

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
ADULT								
Plume immersion	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	1.89×10^{-3}	8.54×10^{-2}
Ground plane	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	2.19×10^{-4}
Vegetation ingestion	6.21×10^{-3}	7.90×10^{-3}	9.86×10^{-3}	5.83×10^{-3}	6.11×10^{-3}	5.07×10^{-1}	5.35×10^{-3}	5.34×10^{-3}
Meat ingestion	9.39×10^{-4}	9.28×10^{-3}	1.02×10^{-3}	9.08×10^{-4}	1.16×10^{-3}	1.76×10^{-2}	8.99×10^{-4}	8.99×10^{-4}
Milk ingestion	2.02×10^{-3}	1.92×10^{-3}	1.11×10^{-3}	1.95×10^{-3}	1.98×10^{-3}	8.60×10^{-2}	1.90×10^{-3}	1.90×10^{-3}
Inhalation	4.54×10^{-3}	4.13×10^{-3}	1.36×10^{-2}	6.82×10^{-3}	6.11×10^{-3}	5.09×10^{-3}	5.36×10^{-3}	4.12×10^{-3}
Total	1.46×10^{-2}	2.41×10^{-2}	2.64×10^{-2}	1.64×10^{-2}	1.62×10^{-2}	6.17×10^{-1}	1.55×10^{-2}	9.79×10^{-2}
TEENAGER								
Plume immersion	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	1.89×10^{-4}	8.54×10^{-2}
Ground plane	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	2.19×10^{-4}
Vegetation ingestion	7.24×10^{-3}	9.51×10^{-3}	1.41×10^{-2}	7.12×10^{-3}	7.48×10^{-3}	3.88×10^{-1}	6.43×10^{-3}	6.42×10^{-3}
Meat ingestion	6.02×10^{-4}	5.80×10^{-3}	8.56×10^{-4}	5.86×10^{-4}	7.95×10^{-4}	7.12×10^{-3}	5.78×10^{-4}	5.78×10^{-4}
Milk ingestion	2.69×10^{-3}	2.60×10^{-3}	2.01×10^{-3}	2.67×10^{-3}	2.70×10^{-3}	7.47×10^{-2}	2.58×10^{-3}	2.57×10^{-3}
Inhalation	4.59×10^{-3}	4.16×10^{-3}	1.43×10^{-2}	7.03×10^{-3}	6.25×10^{-3}	4.82×10^{-3}	6.27×10^{-3}	4.15×10^{-3}
Total	1.60×10^{-2}	2.29×10^{-2}	3.21×10^{-2}	1.83×10^{-2}	1.81×10^{-2}	4.75×10^{-1}	1.79×10^{-2}	9.93×10^{-2}
CHILD								
Plume immersion	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	1.89×10^{-4}	8.54×10^{-2}
Ground plane	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	2.19×10^{-4}
Vegetation ingestion	1.17×10^{-2}	1.30×10^{-2}	3.01×10^{-2}	1.17×10^{-2}	1.23×10^{-2}	3.74×10^{-1}	1.06×10^{-2}	1.06×10^{-2}
Meat ingestion	8.27×10^{-4}	3.97×10^{-3}	1.60×10^{-3}	8.04×10^{-4}	1.08×10^{-3}	5.65×10^{-3}	7.94×10^{-4}	7.93×10^{-4}
Milk ingestion	4.84×10^{-3}	4.38×10^{-3}	4.85×10^{-3}	4.53×10^{-3}	4.57×10^{-3}	7.51×10^{-2}	4.37×10^{-3}	4.36×10^{-3}
Inhalation	4.02×10^{-3}	3.67×10^{-3}	1.13×10^{-2}	5.78×10^{-3}	5.08×10^{-3}	4.07×10^{-3}	5.57×10^{-3}	3.67×10^{-3}
Total	2.19×10^{-2}	2.59×10^{-2}	4.87×10^{-2}	2.37×10^{-2}	2.39×10^{-2}	4.60×10^{-1}	2.34×10^{-2}	1.05×10^{-1}

Table B-16. Annual dose to maximally exposed individual resulting from atmospheric releases from L-Reactor support facilities in tenth year[a] (In millirems per year) (continued) TC

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	7.11×10^{-4}	1.89×10^{-3}	8.54×10^{-2}
Ground plane	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	1.52×10^{-4}	2.19×10^{-4}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	7.31×10^{-3}	7.12×10^{-3}	9.12×10^{-3}	7.49×10^{-3}	7.46×10^{-3}	1.79×10^{-1}	7.11×10^{-3}	7.10×10^{-3}
Inhalation	2.25×10^{-3}	2.11×10^{-3}	4.50×10^{-3}	2.95×10^{-3}	2.67×10^{-3}	2.48×10^{-3}	3.30×10^{-3}	2.11×10^{-3}
Total	1.04×10^{-2}	1.01×10^{-2}	1.45×10^{-2}	1.13×10^{-2}	1.10×10^{-2}	1.83×10^{-1}	1.25×10^{-2}	9.48×10^{-2}

[a]In the support facilities, only the doses resulting from L-Reactor operation are included. TC

Table B-17. Eighty-kilometer population dose resulting from atmospheric releases from operation of L-Reactor support facilities in first or tenth year[a] (In person-rems per year) TC

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	1.48×10^{-1}	1.48×10^{-1}	1.48×10^{-1}	1.48×10^{-1}	1.48×10^{-1}	1.48×10^{-1}	4.89×10^{-1}	2.46×10^{1}
Ground plane	1.85×10^{-1}	1.85×10^{-1}	1.85×10^{-1}	1.85×10^{-1}	1.85×10^{-1}	1.85×10^{-1}	1.85×10^{-1}	2.91×10^{-1}
Vegetation ingestion	8.90×10^{-1}	9.91×10^{-1}	1.49	8.40×10^{-1}	8.98×10^{-1}	8.18×10^{1}	7.58×10^{-1}	7.56×10^{-1}
Meat ingestion	1.59×10^{-1}	1.00	2.03×10^{-1}	1.54×10^{-1}	1.86×10^{-1}	3.64	1.51×10^{-1}	1.51×10^{-1}
Milk ingestion	2.11×10^{-1}	2.00×10^{-1}	1.73×10^{-1}	2.08×10^{-1}	2.11×10^{-1}	8.40	2.00×10^{-1}	1.99×10^{-1}
Inhalation	1.21	1.10	3.74	1.84	1.64	1.31	1.51	1.10
Total	2.80	3.63	5.94	3.38	3.26	9.55×10^{1}	3.30	2.71×10^{1}

[a]In the support facilities, only the doses resulting from L-Reactor operation are included. TC

only, results are shown for the first- and tenth-year operation, as well as for operation with and without the use of the L-Area seepage basin. For support facility doses, maximum-individual doses are shown for the first and tenth year; the population dose will not change significantly between the first and tenth year.

Atmospheric releases containing tritium, carbon-14, krypton-85, and iodine-129 that will be released from L-Reactor and its support facilities will persist in the environment for long periods, and will be transported long distances. The population beyond 80 kilometers from the Savannah River Plant can receive radiation doses from these nuclides. Environmental transport and dose models have been adapted for each of these nuclides for this analysis. For each nuclide, the 100-year environmental dose commitment has been calculated. A constant U.S. population of 250 million for the year 2000 has been assumed (NCRP, 1975, 1979; Kocher, 1979; Killough, 1980). Table B-18 lists the results of these calculations. |TC

B.2 LIQUID RELEASES

The LADTAP II computer code (Simpson and McGill, 1980) was used to calculate radiation exposures due to liquid releases; LADTAP II implements the dose models recommended in NRC Regulatory Guide 1.109 (NRC, 1977). Both maximum-individual and population doses were calculated as functions of age group and pathway for the total body and appropriate body organs. Age-specific dose conversion factors were used for converting internal exposures to doses. The dose conversion factors are based on NUREG-0172 (Hoenes and Soldat, 1977), with revisions for some radionuclides (Simpson and McGill, 1980); the age groups considered were the same as those used for the atmospheric release calculations. The exposure to external radiation is the same for all age groups.

During routine operation of L-Reactor and its support facilities, radioactive materials will be discharged both to surface streams and to seepage basins. In this analysis, two alternatives have been considered for the discharge of L-Reactor liquid radioactive effluent. The first alternative is discharge both to Steel Creek and to the existing L-Reactor seepage basin and the second alternative is discharge directly to Steel Creek. All radioactive materials discharged from facility operations to surface streams ultimately discharge into the Savannah River. Radioactive materials discharged to seepage basins will move down to the ground water; gradually they will be transported laterally to outcrop areas along surface streams. After ground water containing radionuclides emerges at these outcrops, it is discharged to the Savannah River. Table B-19 lists ground-water velocities and the distances between the various seepage basins and their respective outcrops for operations associated with L-Reactor. The model for radionuclide transport in ground water uses a one-dimensional analytic solution for the mass transport of radionuclides and their decay products (Burkholder and Rosinger, 1979). Dispersion in the direction of travel was assumed to be zero. Some radioactive decay will occur during transit, thereby reducing the dose. The transport of nuclides can also be impeded by chemical interactions and the adsorptive and absorptive properties of the geologic media through which ground water flows. Radionuclide activities at the outcrops were simulated for periods as long as 39,000 years. This period was

Table B-18. 100-year environmental dose commitment to the U.S. population beyond 80 kilometers of Savannah River Plant from gaseous effluents from L-Reactor and its support facilities

Nuclide	Curies released per year of operation	Person-rem per year of operation	Organ
	L-REACTOR WITH SEEPAGE BASIN (FIRST YEAR)		
H-3	5,490	2.57	Total body
C-14	12	8.40	Total body
Kr-85	138	2.76×10^{-3}	Total body
I-129	0	0	Thyroid
	L-REACTOR WITH SEEPAGE BASIN (TENTH YEAR)		
H-3	54,900	25.7	Total body
C-14	12	8.40	Total body
Kr-85	138	2.76×10^{-3}	Total body
I-129	0	0	Thyroid
	L-REACTOR WITHOUT SEEPAGE BASIN (FIRST YEAR)		
H-3	5,170	2.42	Total body
C-14	12	8.40	Total body
Kr-85	138	2.76×10^{-3}	Total body
I-129	0	0	Thyroid
	L-REACTOR WITHOUT SEEPAGE BASIN (TENTH YEAR)		
H-3	51,700	24.2	Total body
C-14	12	8.40	Total body
Kr-85	138	2.76×10^{-3}	Total body
I-129	0	0	Thyroid
	SUPPORT FACILITIES		
H-3	9,390	4.39	Total body
C-14	8	5.60	Total body
Kr-85	201,800	4.04	Total body
I-129	0.07	1.73	Thyroid

Table B-19. Ground-water migration data for seepage basins

Parameter	L-Area (100-L)	Central shops (690-G)	Fuel fabrication (300-M)	Separations areas 200-F	Separations areas 200-H
Ground-water velocity (m/day)[a]	0.3[b]	0.3	0.3	0.2	0.3
Distance to outcrop (m)	490	365	1220	490	120-425
Ground-water travel time (yr)	4.4	3.3	[b]	6.7[c]	1.1-3.8[c]

[a]Based on Du Pont, 1983b.
[b]Assumed lateral ground-water velocity of 0.3 meter per day used in dose calculations; based on Root (1983) and Section F.2.10, a more realistic ground-water velocity is calculated to be 0.075 to 0.057 meter per day.
[c]3.8 years has been assumed for both the 200-F and 200-H areas.

TC

chosen so all nuclides (even those with retarded movement) emerged at the outcrop. However, liquid radioactive releases from this pathway reduce to insignificant levels after the L-Reactor operation period.

Liquid radioactive release source terms for L-Reactor are given in Table 4-9 for both first- and tenth-year operation. Source terms for the support facilities are given as annual average quantities discharged directly to surface streams, and to surface streams from seepage-basin/ground-water migration (Tables 5-8 through 5-10). TC

The following pathways and their descriptions were considered in the liquid dose assessments:

1. Drinking water--Internal dose from consumption of drinking water from the Savannah River and containing radioactive materials transported by the river.

2. Sport and commercial fish--Internal dose from consumption of fish of Savannah River origin.

3. Salt-water invertebrates--Internal dose from consumption of shellfish from estuaries of the Savannah River.

4. Recreation--External dose from recreational activities on and along the Savannah River; that is, shoreline activities, boating, and swimming.

All individual and population doses were based on the assumption that liquids discharged from L-Reactor and its support facilities are mixed completely in the river before reaching the potential exposure pathways. This assumption is supported by measurements that indicate complete mixing occurs prior to reaching the Highway 301 bridge. A dilution factor of 3 was applied to the shellfish dose calculation because a significant portion of the harvest would be from estuarine or ocean waters.

Individual and site parameters used in the calculations are summarized in Tables B-20 and B-21, respectively. The data on fish consumption, swimming, and boating are based on data from the region.

The individual who would receive the maximum potential dose from liquid releases was assumed to live near the Savannah River, downstream from the Savannah River Plant. This individual was assumed to use river water regularly for drinking, to consume river fish, and to receive external exposure from shoreline activities, swimming, and boating.

The total dose received by the offsite population as a result of liquid releases from L-Reactor and its support facilities is estimated by summing the doses to the individuals in the population. The population within an 80-kilometer radius uses no river water for domestic purposes downstream from Savannah River Plant; this population is assumed to use the river for recreational purposes and to consume fish and shellfish from the river and its estuary.

There is no known use of Savannah River water for human consumption to a distance of about 160 kilometers downstream from Savannah River Plant. At this distance, Beaufort and Jasper Counties, South Carolina, will pump water from the river for treatment and service to a population of about 117,000 people in the year 2000. Several kilometers farther downstream, the Cherokee Hill Water Treatment Plant draws water from the river to supply a business-industrial complex near Savannah, Georgia. This water is not used at present for normal domestic service, but it is assumed that about 200,000 people will use this water during the year 2000. Although these population groups are beyond the 80-kilometer radius, drinking-water doses for these groups have been included in this document. All population doses are 100-year environmental dose commitments.

The results of the calculations of doses to the maximally exposed individual and to populations from liquid radioactive releases from L-Reactor and its support facilities are presented in Tables B-22 through B-33. Maximum individual and population doses due to L-Reactor liquid radioactive releases for the first year, and after the tenth year, are presented in Tables B-22 through B-25 for the seepage-basin alternative. Similar results are presented in Tables B-26 through B-29 for the no-seepage-basin alternative. Results for the support facilities are presented in Tables B-30 through B-33. These results are not affected by the seepage-basin alternative used; they are presented as releases directly to surface streams and to streams by the seepage-basin/ground-water pathway.

B.3 RADIOACTIVE CESIUM AND COBALT REDISTRIBUTION

The reactivation of L-Reactor will cause a portion of the radioactive cesium and cobalt in the Steel Creek channel and floodplain to be resuspended and transported for both the reference case (defined in this appendix) and the

Table B-20. Individual parameters used in dose calculations

Parameters	Child	Teen	Adult
AVERAGE INDIVIDUAL			
Water consumption (ℓ/year)	260	260	370
Fish consumption (kg/yr)	3.6	8.5	11.3
Other seafood consumption (kg/yr)	0.33	0.75	1.0
Shoreline recreation (hr/yr)	9.5	47	8.3
Boating (person-hours)[a]	--	--	700,000
Swimming (person-hours)[a]	--	--	100,000
Shoreline recreation (person-hours)[a]	--	--	200,000
MAXIMUM INDIVIDUAL			
Water consumption (ℓ/yr)[b]	510	510	730
Fish consumption (kg/yr)	11.2	25.9	34
Other seafood consumption (kg/yr)	1.7	3.8	5
Shoreline recreation (hr/yr)	14	67	20
Swimming (hr/yr)	10	10	10
Boating (hr/yr)	60	60	60

[a]For population dose calculations.
[b]Drinking water consumption for an infant equals 330 liters per year.

Table B-21. Site parameters used in dose calculations

Parameters	Values
River flow rate (average m^3/s)	294
(low flow m^3/s)	173
River dilution in estuary	3
Transit time, L-Area to river (hr)	24
Transit time, SRP to water treatment plants (hr)	72
Water treatment time (hr)	24
Aquatic food harvest (kg/yr)	
Fish - sport	90,700
Fish - commercial	31,800
Invertebrates - salt water	299,000
Irrigation	None
Shore width factor	0.2
Population in year 2000[a]	
Beaufort-Jasper water consumers	117,000
Port Wentworth water consumers	200,000
80-kilometer-radius population	852,000

[a]Age distribution of population: Beaufort-Jasper--21 percent child, 10 percent teen, 69 percent adult; Port Wentworth--100 percent adult; and 80-kilometer radius--21 percent child, 11 percent teen, 68 percent adult.

Table B-22. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor with seepage basin in first year (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	1.05×10^{-1}	6.32×10^{-4}	2.60×10^{-3}	1.24×10^{-4}	2.91×10^{-4}	1.80×10^{-4}	3.11×10^{-3}
Drinking	0.0	7.53×10^{-2}	2.98×10^{-3}	4.50×10^{-3}	2.97×10^{-3}	2.97×10^{-3}	2.97×10^{-3}	5.00×10^{-3}
Shoreline	6.32×10^{-5}	5.37×10^{-5}	5.37×10^{-5}	5.37×10^{-5}	5.37×10^{-5}	5.37×10^{-5}	5.37×10^{-5}	5.37×10^{-5}
Swimming	0.0	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}
Boating	0.0	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}
Total	6.32×10^{-5}	1.81×10^{-1}	3.67×10^{-3}	7.15×10^{-3}	3.15×10^{-3}	3.32×10^{-3}	3.20×10^{-3}	8.17×10^{-3}
				TEENAGER				
Fish	0.0	9.05×10^{-2}	6.11×10^{-4}	2.10×10^{-3}	9.20×10^{-5}	2.59×10^{-4}	1.57×10^{-4}	2.38×10^{-3}
Drinking	0.0	6.16×10^{-2}	2.10×10^{-3}	3.34×10^{-3}	2.09×10^{-3}	2.09×10^{-3}	2.09×10^{-3}	3.59×10^{-3}
Shoreline	2.12×10^{-4}	1.80×10^{-4}	1.80×10^{-4}	1.80×10^{-4}	1.80×10^{-4}	1.88×10^{-4}	1.80×10^{-4}	1.80×10^{-4}
Swimming	0.0	2.23×10^{-7}	2.37×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}
Boating	0.0	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}
Total	2.12×10^{-4}	1.52×10^{-1}	2.88×10^{-3}	5.63×10^{-3}	2.37×10^{-3}	2.53×10^{-3}	2.43×10^{-3}	6.15×10^{-3}
				CHILD				
Fish	0.0	1.02×10^{-1}	5.57×10^{-4}	2.24×10^{-3}	7.92×10^{-5}	2.30×10^{-4}	1.34×10^{-4}	1.07×10^{-3}
Drinking	0.0	1.55×10^{-1}	4.03×10^{-3}	7.16×10^{-3}	4.01×10^{-3}	4.01×10^{-3}	4.01×10^{-3}	5.46×10^{-3}
Shoreline	4.42×10^{-5}	3.76×10^{-5}	3.76×10^{-5}	3.76×10^{-5}	3.76×10^{-5}	3.76×10^{-5}	3.76×10^{-5}	3.76×10^{-5}
Swimming	0.0	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}	2.23×10^{-7}
Boating	0.0	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}	6.69×10^{-7}
Total	4.42×10^{-5}	2.57×10^{-1}	4.63×10^{-3}	9.43×10^{-3}	4.13×10^{-3}	4.28×10^{-3}	4.18×10^{-3}	6.57×10^{-3}

Table B-22. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor with seepage basin in first year (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	1.11×10^{-1}	3.96×10^{-3}	6.22×10^{-3}	3.94×10^{-3}	3.94×10^{-3}	3.94×10^{-3}	4.88×10^{-3}
Total	0.0	1.11×10^{-1}	3.96×10^{-3}	6.22×10^{-3}	3.94×10^{-3}	3.94×10^{-3}	3.94×10^{-3}	4.88×10^{-3}

Table B-23. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor with seepage basin in tenth year (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	1.05×10^{-1}	3.83×10^{-3}	5.79×10^{-3}	3.32×10^{-3}	3.48×10^{-3}	3.37×10^{-3}	6.30×10^{-3}
Drinking	0.0	7.53×10^{-2}	7.92×10^{-2}	8.07×10^{-2}	7.92×10^{-2}	7.92×10^{-2}	7.92×10^{-2}	8.12×10^{-2}
Shoreline	6.36×10^{-5}	5.41×10^{-5}	5.41×10^{-5}	5.41×10^{-5}	5.41×10^{-5}	5.41×10^{-5}	5.41×10^{-5}	5.41×10^{-5}
Swimming	0.0	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}
Boating	0.0	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}
Total	6.36×10^{-5}	1.81×10^{-1}	8.30×10^{-2}	8.65×10^{-2}	8.25×10^{-2}	8.27×10^{-2}	8.26×10^{-2}	8.76×10^{-2}
				TEENAGER				
Fish	0.0	9.05×10^{-2}	2.96×10^{-3}	4.47×10^{-3}	2.45×10^{-3}	2.62×10^{-3}	2.52×10^{-3}	4.74×10^{-3}
Drinking	0.0	6.16×10^{-2}	5.58×10^{-2}	5.71×10^{-2}	5.58×10^{-2}	5.58×10^{-2}	5.58×10^{-2}	5.73×10^{-2}
Shoreline	2.13×10^{-4}	1.81×10^{-4}	1.81×10^{-4}	1.81×10^{-4}	1.81×10^{-4}	1.81×10^{-4}	1.81×10^{-4}	1.81×10^{-4}
Swimming	0.0	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}
Boating	0.0	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}
Total	2.13×10^{-4}	1.52×10^{-1}	5.90×10^{-2}	6.17×10^{-2}	5.85×10^{-2}	5.86×10^{-2}	5.85×10^{-2}	6.23×10^{-2}
				CHILD				
Fish	0.0	1.02×10^{-1}	2.59×10^{-3}	4.27×10^{-3}	2.11×10^{-3}	2.26×10^{-3}	2.17×10^{-3}	3.11×10^{-3}
Drinking	0.0	1.55×10^{-1}	1.07×10^{-1}	1.10×10^{-1}	1.07×10^{-1}	1.07×10^{-1}	1.07×10^{-1}	1.08×10^{-1}
Shoreline	4.45×10^{-5}	3.78×10^{-5}	3.78×10^{-5}	3.78×10^{-5}	3.78×10^{-5}	3.78×10^{-5}	3.78×10^{-5}	3.78×10^{-5}
Swimming	0.0	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}	2.25×10^{-7}
Boating	0.0	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}	6.76×10^{-7}
Total	4.45×10^{-5}	2.57×10^{-1}	1.10×10^{-1}	1.14×10^{-1}	1.09×10^{-1}	1.09×10^{-1}	1.09×10^{-1}	1.12×10^{-1}

Table B-23. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor with seepage basin in tenth year (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	1.11×10^{-1}	1.05×10^{-1}	1.07×10^{-1}	1.05×10^{-1}	1.05×10^{-1}	1.05×10^{-1}	1.06×10^{-1}
Total	0.0	1.11×10^{-1}	1.05×10^{-1}	1.07×10^{-1}	1.05×10^{-1}	1.05×10^{-1}	1.05×10^{-1}	1.06×10^{-1}

Table B-24. Population dose resulting from liquid releases from operation of L-Reactor with seepage basin in first year (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	5.35	1.84×10^{-1}	2.93×10^{-1}	1.84×10^{-1}	1.84×10^{-1}	1.84×10^{-1}	2.95×10^{-1}
Port Wentworth	0.0	7.60	3.01×10^{-1}	4.55×10^{-1}	3.01×10^{-1}	3.01×10^{-1}	3.01×10^{-1}	5.06×10^{-1}
Total	0.0	1.30×10^{1}	4.85×10^{-1}	7.48×10^{-1}	4.85×10^{-1}	4.85×10^{-1}	4.85×10^{-1}	8.01×10^{-1}
Sport fish	0.0	3.25×10^{-1}	1.93×10^{-3}	7.76×10^{-3}	3.51×10^{-4}	8.66×10^{-4}	5.28×10^{-4}	8.22×10^{-3}
Commercial fish	0.0	1.89×10^{-2}	1.12×10^{-4}	4.52×10^{-4}	2.04×10^{-5}	5.04×10^{-5}	3.07×10^{-5}	4.78×10^{-4}
Shellfish	0.0	3.77×10^{-4}	2.51×10^{-6}	1.26×10^{-5}	6.32×10^{-7}	6.45×10^{-7}	6.35×10^{-7}	3.79×10^{-5}
Shoreline	6.32×10^{-4}	0.0	0.0	5.37×10^{-4}	5.37×10^{-4}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	2.23×10^{-6}	2.23×10^{-6}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	7.81×10^{-6}	7.81×10^{-6}	0.0	0.0	0.0
Total	6.32×10^{-4}	3.44×10^{-1}	2.04×10^{-3}	8.77×10^{-3}	9.19×10^{-4}	9.17×10^{-4}	5.59×10^{-4}	8.74×10^{-3}
Grand total	6.32×10^{-4}	1.33×10^{1}	4.87×10^{-1}	7.57×10^{-1}	4.86×10^{-1}	4.86×10^{-1}	4.86×10^{-1}	8.10×10^{-1}

Table B-25. Population dose resulting from liquid releases from operation of L-Reactor with seepage basin in tenth year (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	5.35	4.89	5.01	4.89	4.89	4.89	5.01
Port Wentworth	0.0	7.60	8.01	8.15	8.01	8.01	8.01	8.22
Total	0.0	1.30×10^{1}	1.29×10^{1}	1.32×10^{1}	1.29×10^{1}	1.29×10^{1}	1.29×10^{1}	1.32×10^{1}
Sport fish	0.0	3.25×10^{-1}	1.09×10^{-2}	1.68×10^{-2}	9.35×10^{-3}	9.86×10^{-3}	9.53×10^{-3}	1.72×10^{-2}
Commercial fish	0.0	1.89×10^{-2}	6.36×10^{-4}	9.75×10^{-4}	5.44×10^{-4}	5.74×10^{-4}	5.54×10^{-4}	1.00×10^{-3}
Shellfish	0.0	3.77×10^{-4}	1.87×10^{-5}	2.88×10^{-5}	1.69×10^{-5}	1.69×10^{-5}	1.69×10^{-5}	5.49×10^{-5}
Shoreline	6.36×10^{-4}	0.0	0.0	5.41×10^{-4}	5.41×10^{-4}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	2.25×10^{-6}	2.25×10^{-6}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	7.89×10^{-6}	7.89×10^{-6}	0.0	0.0	0.0
Total	6.36×10^{-4}	3.44×10^{-1}	1.16×10^{-2}	1.84×10^{-2}	1.05×10^{-2}	1.05×10^{-2}	1.01×10^{-2}	1.83×10^{-2}
Grand total	6.36×10^{-4}	1.33×10^{1}	1.29×10^{1}	1.32×10^{1}	1.29×10^{1}	1.29×10^{1}	1.29×10^{1}	1.32×10^{1}

Table B-26. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor without seepage basin in first year (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	3.12×10^{-1}	6.51×10^{-2}	4.66×10^{-2}	1.14×10^{-3}	2.08×10^{-2}	7.27×10^{-3}	1.56×10^{-2}
Drinking	0.0	1.37×10^{-1}	1.28×10^{-2}	1.54×10^{-2}	1.33×10^{-2}	1.25×10^{-2}	1.24×10^{-2}	1.63×10^{-2}
Shoreline	9.77×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}
Swimming	0.0	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}
Boating	0.0	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}
Total	9.77×10^{-5}	4.49×10^{-1}	7.80×10^{-2}	6.21×10^{-2}	1.45×10^{-2}	3.34×10^{-2}	1.98×10^{-2}	3.20×10^{-2}
				TEEN				
Fish	0.0	2.90×10^{-1}	6.53×10^{-2}	2.77×10^{-2}	9.41×10^{-4}	2.08×10^{-2}	8.30×10^{-3}	1.21×10^{-2}
Drinking	0.0	1.12×10^{-1}	9.14×10^{-3}	1.11×10^{-2}	9.52×10^{-3}	8.87×10^{-3}	8.78×10^{-3}	1.16×10^{-2}
Shoreline	3.27×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}
Swimming	0.0	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}
Boating	0.0	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}
Total	3.27×10^{-4}	4.02×10^{-1}	7.47×10^{-2}	3.91×10^{-2}	1.07×10^{-2}	2.99×10^{-2}	1.74×10^{-2}	2.40×10^{-2}
				CHILD				
Fish	0.0	3.53×10^{-1}	6.20×10^{-2}	1.66×10^{-2}	9.31×10^{-4}	1.88×10^{-2}	6.93×10^{-3}	5.45×10^{-3}
Drinking	0.0	2.82×10^{-1}	1.76×10^{-2}	2.25×10^{-2}	1.86×10^{-2}	1.70×10^{-2}	1.68×10^{-2}	1.95×10^{-2}
Shoreline	6.84×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}
Swimming	0.00	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}
Boating	0.00	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}
Total	6.84×10^{-5}	6.34×10^{-1}	7.96×10^{-2}	3.92×10^{-2}	1.96×10^{-2}	3.58×10^{-2}	2.38×10^{-2}	2.50×10^{-2}

Table B-26. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor without seepage basin in first year (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	2.02×10^{-1}	1.75×10^{-2}	2.06×10^{-2}	1.94×10^{-2}	1.67×10^{-2}	1.65×10^{-2}	1.82×10^{-2}
Total	0.0	2.02×10^{-1}	1.75×10^{-2}	2.06×10^{-2}	1.94×10^{-2}	1.67×10^{-2}	1.65×10^{-2}	1.82×10^{-2}

Table B-27. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor without seepage basin in tenth year (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	3.12×10^{-1}	6.98×10^{-2}	5.13×10^{-2}	5.81×10^{-3}	2.55×10^{-2}	1.19×10^{-2}	2.03×10^{-2}
Drinking	0.0	1.37×10^{-1}	1.24×10^{-1}	1.27×10^{-1}	1.25×10^{-1}	1.24×10^{-1}	1.24×10^{-1}	1.28×10^{-1}
Shoreline	9.77×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}	8.33×10^{-5}
Swimming	0.0	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}
Boating	0.0	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}
Total	9.77×10^{-5}	4.49×10^{-1}	1.94×10^{-1}	1.78×10^{-1}	1.30×10^{-1}	1.49×10^{-1}	1.36×10^{-1}	1.48×10^{-1}
				TEEN				
Fish	0.0	2.90×10^{-1}	6.87×10^{-2}	3.12×10^{-2}	4.39×10^{-3}	2.42×10^{-2}	1.17×10^{-2}	1.55×10^{-2}
Drinking	0.0	1.12×10^{-1}	8.77×10^{-2}	8.96×10^{-2}	8.80×10^{-2}	8.74×10^{-2}	8.73×10^{-2}	9.01×10^{-2}
Shoreline	3.27×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-2}	2.79×10^{-4}	2.79×10^{-4}	2.79×10^{-4}
Swimming	0.0	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}
Boating	0.0	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}
Total	3.27×10^{-4}	4.02×10^{-1}	1.57×10^{-1}	1.21×10^{-1}	9.27×10^{-2}	1.12×10^{-1}	9.93×10^{-2}	1.06×10^{-1}
				CHILD				
Fish	0.0	3.53×10^{-1}	6.50×10^{-2}	1.96×10^{-2}	3.90×10^{-3}	2.17×10^{-2}	9.94×10^{-3}	8.42×10^{-3}
Drinking	0.0	2.82×10^{-1}	1.68×10^{-1}	1.73×10^{-1}	1.69×10^{-1}	1.67×10^{-1}	1.67×10^{-1}	1.70×10^{-1}
Shoreline	6.84×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}	5.83×10^{-5}
Swimming	0.0	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}	3.18×10^{-7}
Boating	0.0	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}	9.53×10^{-7}
Total	6.84×10^{-5}	6.34×10^{-1}	2.33×10^{-1}	1.93×10^{-1}	1.73×10^{-1}	1.89×10^{-1}	1.77×10^{-1}	1.78×10^{-1}

Table B-27. Annual dose to maximally exposed individual resulting from liquid releases from L-Reactor without seepage basin in tenth year (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	2.02×10^{-1}	1.65×10^{-1}	1.68×10^{-1}	1.67×10^{-1}	1.64×10^{-1}	1.64×10^{-1}	1.66×10^{-1}
Total	0.0	2.02×10^{-1}	1.65×10^{-1}	1.68×10^{-1}	1.67×10^{-1}	1.64×10^{-1}	1.64×10^{-1}	1.66×10^{-1}

Table B-28. Population dose resulting from liquid releases from operation of L-Reactor without seepage basin in first year (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	9.79	7.96×10^{-1}	9.79×10^{-1}	8.19×10^{-1}	7.75×10^{-1}	7.70×10^{-1}	9.79×10^{-1}
Port Wentworth	0.0	1.39×10^{1}	1.29	1.56	1.33	1.27	1.25	1.65
Total	0.0	2.37×10^{1}	2.09	2.54	2.15	2.05	2.02	2.63
Sport fish	0.0	9.15×10^{-1}	1.98×10^{-1}	1.17×10^{-1}	2.42×10^{-3}	6.43×10^{-2}	2.31×10^{-2}	3.39×10^{-2}
Commercial fish	0.0	5.19×10^{-2}	1.15×10^{-2}	6.77×10^{-3}	1.28×10^{-4}	3.74×10^{-3}	1.34×10^{-3}	1.85×10^{-3}
Shellfish	0.0	7.70×10^{-4}	1.21×10^{-5}	2.53×10^{-5}	6.98×10^{-6}	3.73×10^{-6}	2.97×10^{-6}	9.48×10^{-5}
Shoreline	9.77×10^{-4}	0.0	0.0	8.33×10^{-4}	8.33×10^{-4}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	3.18×10^{-6}	3.18×10^{-6}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	1.11×10^{-5}	1.11×10^{-5}	0.0	0.0	0.0
Total	9.77×10^{-4}	9.68×10^{-1}	2.09×10^{-1}	1.25×10^{-1}	3.40×10^{-3}	6.80×10^{-2}	2.44×10^{-2}	3.58×10^{-2}
Grand total	9.77×10^{-4}	2.47×10^{1}	2.30	2.67	2.15	2.12	2.04	2.67

Table B-29. Population dose resulting from liquid releases from operation of L-Reactor without seepage basin in tenth year (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	9.79	7.70	7.88	7.70	7.68	7.68	7.88
Port Wentworth	0.0	1.39×10^{1}	1.25×10^{1}	1.28×10^{1}	1.26×10^{1}	1.25×10^{1}	1.25×10^{1}	1.29×10^{1}
Total	0.0	2.37×10^{1}	2.02×10^{1}	2.07×10^{1}	2.03×10^{1}	2.02×10^{1}	2.02×10^{1}	2.08×10^{1}
Sport fish	0.0	9.15×10^{-1}	2.11×10^{-1}	1.30×10^{-1}	1.56×10^{-2}	7.74×10^{-2}	3.62×10^{-2}	4.71×10^{-2}
Commercial fish	0.0	5.19×10^{-2}	1.22×10^{-2}	7.53×10^{-3}	8.93×10^{-4}	4.50×10^{-3}	2.11×10^{-3}	2.62×10^{-3}
Shellfish	0.0	7.70×10^{-4}	3.58×10^{-5}	4.90×10^{-5}	3.07×10^{-5}	2.74×10^{-5}	2.67×10^{-5}	1.18×10^{-4}
Shoreline	9.77×10^{-4}	0.0	0.0	8.33×10^{-4}	8.33×10^{-4}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	3.18×10^{-6}	3.18×10^{-6}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	1.11×10^{-5}	1.11×10^{-5}	0.0	0.0	0.0
Total	9.77×10^{-4}	9.67×10^{-1}	2.23×10^{-1}	1.38×10^{-1}	1.74×10^{-2}	8.19×10^{-2}	3.83×10^{-2}	4.98×10^{-2}
Grand total	9.77×10^{-4}	2.47×10^{1}	2.04×10^{1}	2.08×10^{1}	2.03×10^{1}	2.03×10^{1}	2.02×10^{1}	2.08×10^{1}

Table B-30. Annual dose to maximally exposed individual resulting from liquid releases from support facilities for L-Reactor in first year[a] (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	7.62×10^{-2}	2.29×10^{-2}	1.63×10^{-2}	1.94×10^{-4}	7.98×10^{-3}	2.76×10^{-3}	2.15×10^{-3}
Drinking	0.0	4.58×10^{-2}	4.80×10^{-3}	5.77×10^{-3}	4.62×10^{-3}	5.43×10^{-3}	4.64×10^{-3}	6.01×10^{-3}
Shoreline	4.47×10^{-5}	3.65×10^{-5}	3.65×10^{-5}	3.65×10^{-5}	3.65×10^{-5}	3.65×10^{-5}	3.65×10^{-5}	3.65×10^{-5}
Swimming	0.0	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}
Boating	0.0	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}
Total	4.47×10^{-5}	1.22×10^{-1}	2.78×10^{-2}	2.21×10^{-2}	4.85×10^{-3}	1.34×10^{-2}	7.43×10^{-3}	8.20×10^{-3}
				TEEN				
Fish	0.0	6.82×10^{-2}	2.29×10^{-2}	9.10×10^{-3}	1.43×10^{-4}	7.96×10^{-3}	3.15×10^{-3}	1.65×10^{-3}
Drinking	0.0	3.81×10^{-2}	3.43×10^{-3}	4.20×10^{-3}	3.26×10^{-3}	4.06×10^{-3}	3.28×10^{-3}	4.29×10^{-3}
Shoreline	1.50×10^{-4}	1.22×10^{-4}	1.22×10^{-4}	1.22×10^{-4}	1.22×10^{-4}	1.22×10^{-4}	1.22×10^{-4}	1.22×10^{-4}
Swimming	0.0	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}
Boating	0.0	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}
Total	1.50×10^{-4}	1.06×10^{-1}	2.64×10^{-2}	1.34×10^{-2}	3.52×10^{-3}	1.21×10^{-2}	6.55×10^{-3}	6.06×10^{-3}
				CHILD				
Fish	0.0	8.03×10^{-2}	2.16×10^{-2}	4.48×10^{-3}	1.23×10^{-4}	7.20×10^{-3}	2.64×10^{-3}	7.82×10^{-4}
Drinking	0.0	9.70×10^{-2}	6.59×10^{-3}	8.61×10^{-3}	6.24×10^{-3}	7.90×10^{-3}	6.27×10^{-3}	7.25×10^{-3}
Shoreline	3.13×10^{-5}	2.56×10^{-5}	2.56×10^{-5}	2.56×10^{-5}	2.56×10^{-5}	2.56×10^{-5}	2.56×10^{-5}	2.56×10^{-5}
Swimming	0.0	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}	3.50×10^{-8}
Boating	0.0	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}
Total	3.13×10^{-5}	1.77×10^{-1}	2.82×10^{-2}	1.31×10^{-2}	6.39×10^{-3}	1.51×10^{-2}	8.94×10^{-3}	8.06×10^{-3}

Table B-30. Annual dose to maximally exposed individual resulting from liquid releases from support facilities for L-Reactor in first year[a] (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	7.11×10^{-2}	6.55×10^{-3}	8.05×10^{-3}	6.12×10^{-3}	8.01×10^{-3}	6.17×10^{-3}	6.78×10^{-3}
Total	0.0	7.11×10^{-2}	6.55×10^{-3}	8.05×10^{-3}	6.12×10^{-3}	8.01×10^{-3}	6.17×10^{-3}	6.78×10^{-3}

[a]In the support facilities, only the doses resulting from L-Reactor operation are included.

Table B-31. Population dose resulting from liquid releases from support facilities for L-Reactor in first year[a] (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	3.30	2.98×10^{-1}	3.68×10^{-1}	2.86×10^{-1}	3.45×10^{-1}	2.88×10^{-1}	3.61×10^{-1}
Port Wentworth	0.0	4.64	4.86×10^{-1}	5.84×10^{-1}	4.67×10^{-1}	5.49×10^{-1}	4.69×10^{-1}	6.08×10^{-1}
Total	0.0	7.94	7.84×10^{-1}	9.52×10^{-1}	7.53×10^{-1}	8.94×10^{-1}	7.57×10^{-1}	9.69×10^{-1}
Sport fish	0.0	2.40×10^{-1}	7.14×10^{-2}	4.11×10^{-2}	5.45×10^{-4}	2.46×10^{-2}	8.77×10^{-3}	5.72×10^{-3}
Commercial fish	0.0	1.39×10^{-2}	4.15×10^{-3}	2.39×10^{-3}	3.17×10^{-5}	1.43×10^{-3}	5.10×10^{-4}	3.33×10^{-4}
Shellfish	0.0	2.30×10^{-4}	2.91×10^{-6}	6.52×10^{-6}	9.83×10^{-7}	4.05×10^{-6}	1.10×10^{-6}	6.89×10^{-6}
Shoreline	4.47×10^{-4}	0.0	0.0	3.65×10^{-4}	3.65×10^{-4}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	3.50×10^{-7}	3.50×10^{-7}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	1.23×10^{-6}	1.23×10^{-6}	0.0	0.0	0.0
Total	4.47×10^{-4}	2.54×10^{-1}	7.56×10^{-2}	4.39×10^{-2}	9.44×10^{-4}	2.60×10^{-2}	9.28×10^{-3}	6.06×10^{-3}
Grand total	4.47×10^{-4}	8.19	8.60×10^{-1}	9.96×10^{-1}	7.54×10^{-1}	9.20×10^{-1}	7.66×10^{-1}	9.75×10^{-1}

[a]For the support facilities, only the doses resulting from L-Reactor operation are included.

Table B-32. Annual dose to maximally exposed individual resulting from liquid releases from support facilities in tenth year[a] (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	7.63×10^{-2}	2.41×10^{-2}	1.75×10^{-2}	1.30×10^{-3}	9.26×10^{-3}	3.87×10^{-3}	8.11×10^{-3}
Drinking	0.0	4.60×10^{-2}	3.12×10^{-2}	3.22×10^{-2}	3.10×10^{-2}	3.21×10^{-2}	3.10×10^{-2}	4.34×10^{-2}
Shoreline	1.11×10^{-4}	9.28×10^{-5}	9.28×10^{-5}	9.28×10^{-5}	9.28×10^{-5}	9.28×10^{-5}	9.28×10^{-5}	9.28×10^{-5}
Swimming	0.0	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}
Boating	0.0	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}
Total	1.11×10^{-4}	1.22×10^{-1}	5.54×10^{-2}	4.98×10^{-2}	3.24×10^{-2}	4.15×10^{-2}	3.50×10^{-2}	5.16×10^{-2}
				TEEN				
Fish	0.0	6.83×10^{-2}	2.38×10^{-2}	9.98×10^{-3}	9.61×10^{-4}	8.96×10^{-3}	3.97×10^{-3}	6.19×10^{-3}
Drinking	0.0	3.83×10^{-2}	2.20×10^{-2}	2.28×10^{-2}	2.19×10^{-2}	2.30×10^{-2}	2.19×10^{-2}	3.11×10^{-2}
Shoreline	3.73×10^{-4}	3.10×10^{-4}	3.10×10^{-4}	3.10×10^{-4}	3.10×10^{-4}	3.10×10^{-4}	3.10×10^{-4}	3.10×10^{-4}
Swimming	0.0	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}
Boating	0.0	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}
Total	3.73×10^{-4}	1.07×10^{-1}	4.61×10^{-2}	3.31×10^{-2}	2.32×10^{-2}	3.23×10^{-2}	2.62×10^{-2}	3.76×10^{-2}
				CHILD				
Fish	0.0	8.04×10^{-2}	2.24×10^{-2}	5.26×10^{-3}	8.27×10^{-4}	8.07×10^{-3}	3.34×10^{-3}	3.09×10^{-3}
Drinking	0.0	9.75×10^{-2}	4.23×10^{-2}	4.43×10^{-2}	4.18×10^{-2}	4.41×10^{-2}	4.19×10^{-2}	5.08×10^{-2}
Shoreline	7.79×10^{-5}	6.50×10^{-5}	6.50×10^{-5}	6.50×10^{-5}	6.50×10^{-5}	6.50×10^{-5}	6.50×10^{-5}	6.50×10^{-5}
Swimming	0.0	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}	2.12×10^{-7}
Boating	0.0	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}	6.35×10^{-7}
Total	7.79×10^{-5}	1.78×10^{-1}	6.48×10^{-2}	4.96×10^{-2}	4.27×10^{-2}	5.22×10^{-2}	4.53×10^{-2}	5.40×10^{-2}

Table B-32. Annual dose to maximally exposed individual resulting from liquid releases from support facilities in tenth year[a] (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	--	7.17×10^{-2}	4.16×10^{-2}	4.32×10^{-2}	4.11×10^{-2}	4.37×10^{-2}	4.12×10^{-2}	4.69×10^{-2}
Total	0.0	7.17×10^{-2}	4.16×10^{-2}	4.32×10^{-2}	4.11×10^{-2}	4.37×10^{-2}	4.12×10^{-2}	4.69×10^{-2}

[a]For the support facilities, only the doses resulting from L-Reactor operation are included.

Table B-33. Population dose resulting from liquid releases from support facilities in tenth year[a] (In person-rems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	3.30	1.93	2.00	1.93	2.00	1.93	2.59
Port Wentworth	0.0	4.66	3.16	3.25	3.14	3.25	3.14	4.40
Total	0.0	7.96	5.09	5.25	5.07	5.25	5.07	6.99
Sport fish	0.0	2.40×10^{-1}	7.48×10^{-2}	4.44×10^{-2}	3.67×10^{-3}	2.83×10^{-2}	1.19×10^{-2}	2.14×10^{-2}
Commercial fish	0.0	1.39×10^{-2}	4.35×10^{-3}	2.58×10^{-3}	2.13×10^{-4}	1.64×10^{-3}	6.91×10^{-4}	1.25×10^{-3}
Shellfish	0.0	2.74×10^{-4}	1.84×10^{-5}	2.44×10^{-5}	6.60×10^{-6}	8.75×10^{-5}	6.72×10^{-6}	2.23×10^{-3}
Shoreline	1.11×10^{-3}	0.0	0.0	9.28×10^{-4}	9.28×10^{-4}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	2.12×10^{-6}	2.12×10^{-6}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	7.41×10^{-6}	7.41×10^{-6}	0.0	0.0	0.0
Total	1.11×10^{-3}	2.54×10^{-1}	7.92×10^{-2}	4.79×10^{-2}	4.83×10^{-3}	3.00×10^{-2}	1.26×10^{-2}	2.49×10^{-2}
Grand total	1.11×10^{-3}	8.21	5.17	5.30	5.07	5.28	5.08	7.01

[a]For the support facilities, only the doses resulting from L-Reactor operation are included.

TC preferred cooling-water alternative (doses derived from the reference-case analysis described in this appendix and presented in Appendix L). The methods used to calculate dose commitments from this source were the same as those used for other liquid releases, except a bioaccumulation factor of 3000 was used for cesium in freshwater fish rather than the value of 2000 recommended in NRC Regulatory Guide 1.109 (NRC, 1977). This higher bioaccumulation factor reflects the results of studies of fish from the Savannah River and Steel Creek performed by the Savannah River Laboratory and the Savannah River Ecology Laboratory (Du Pont, 1982; Smith et al., 1982).

Tables B-34 through B-37 list the results of dose calculations (for both average and low river flow) to maximally exposed individuals and to regional populations due to the first year (maximum) radioactive cesium and cobalt transport that results from the resumption of L-Reactor operation.

B.4 *CUMULATIVE EFFECTS*

The evaluation of the radiological impacts associated with the restart of L-Reactor also has considered the cumulative effects of all nuclear facilities in the affected region. These cumulative effects are summarized in Section 5.2.6 of the main text and the details of the calculated results are presented below.

Nuclear facilities, in addition to L-Reactor and its support facilities, whose impacts have been considered in the cumulative effects, include the following:

- Three production reactors (P, K, and C) onsite at Savannah River Plant and associated support facilities
- The Vogtle Nuclear Generating Station (VNGS) under construction across the Savannah River from the southwest boundary of Savannah River Plant
- The Defense Waste Processing Facility (DWPF) under construction at S-Area on the Savannah River Plant
- The Fuels Material Facility (FMF) under construction at F-Area on the Savannah River Plant

The maximum individual dose and population doses associated with each of these facilities have been calculated. Information necessary for these dose calculations was derived from supporting environmental documentation available for each facility (DOE, 1982a,b; Du Pont, 1983; and Georgia Power Company, 1973).

The results of the dose calculations are presented in Tables B-38 through B-48. The maximum individual and population doses due to the three production reactors and their support facilities presently operating at Savannah River Plant are given in Tables B-38 through B-41. The same information predicted for the VNGS is given in Tables B-42 through B-45. Projected doses for the DWPF and the FMF are included in Tables B-46 through B-48. These latter three tables also present the cumulative doses associated with L-Reactor and its support

Table B-34. First-year dose from radiocesium and cobalt transport (Average river flow rate)

Pathway	Total body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
				MAXIMUM INDIVIDUAL DOSE (mrem)				
Adult	3.48	3.28×10^{-3}	3.88	5.30	2.83×10^{-3}	1.80	6.01×10^{-1}	1.08×10^{-1}
Teen	1.86	1.10×10^{-2}	4.00	5.31	9.42×10^{-3}	1.81	7.11×10^{-1}	8.66×10^{-2}
Child	7.48×10^{-1}	2.29×10^{-3}	5.28	5.06	1.99×10^{-3}	1.65	5.95×10^{-1}	3.45×10^{-2}
Infant	6.99×10^{-3}	0.0	8.15×10^{-2}	9.55×10^{-2}	0.0	2.56×10^{-2}	1.04×10^{-2}	5.26×10^{-4}
				POPULATION DOSE (person-rem)				
Drinking water								
Port Wentworth	5.01×10^{-1}	0.0	5.48×10^{-1}	7.53×10^{-1}	0.0	2.55×10^{-1}	8.49×10^{-2}	9.59×10^{-2}
Beaufort-Jasper	2.94×10^{-1}	0.0	4.45×10^{-1}	5.51×10^{-1}	0.0	1.77×10^{-1}	6.11×10^{-2}	3.22×10^{-1}
Sport fish	8.52	0.0	1.30×10^{1}	1.64×10^{1}	0.0	5.53	1.90	2.70×10^{-1}
Commercial fish	4.96×10^{-1}	0.0	7.58×10^{-1}	9.54×10^{-1}	0.0	3.22×10^{-1}	1.11×10^{-1}	1.57×10^{-2}
Shellfish	1.47×10^{-4}	0.0	1.90×10^{-4}	2.49×10^{-4}	0.0	8.03×10^{-5}	2.77×10^{-5}	1.65×10^{-4}
Shoreline	2.81×10^{-2}	3.28×10^{-2}	0.0	0.0	2.81×10^{-2}	0.0	0.0	0.0
Swimming	5.97×10^{-5}	0.0	0.0	0.0	5.97×10^{-5}	0.0	0.0	0.0
Boating	2.09×10^{-4}	0.0	0.0	0.0	2.09×10^{-4}	0.0	0.0	0.0
Total	9.84	3.28×10^{-2}	1.48×10^{1}	1.87×10^{1}	2.84×10^{-2}	6.28	2.16	7.04×10^{-1}

Table B-35. First-year dose from radiocesium and cobalt transport (low river flow; 6100 cfs)

Pathway	Total body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
				MAXIMUM INDIVIDUAL DOSE (mrem)				
Adult	5.92	5.59×10^{-3}	6.61	9.04	4.82×10^{-3}	3.07	1.02	1.84×10^{-1}
Teen	3.17	1.87×10^{-2}	6.81	9.06	1.61×10^{-2}	3.09	1.21	1.48×10^{-1}
Child	1.28	3.91×10^{-3}	9.01	8.62	3.39×10^{-3}	2.81	1.01	5.88×10^{-2}
Infant	1.19×10^{-2}	0.0	1.39×10^{-1}	1.63×10^{-1}	0.0	4.37×10^{-2}	1.77×10^{-2}	8.97×10^{-4}
				POPULATION DOSE (person-rem)				
Drinking water								
Port Wentworth	8.56×10^{-1}	0.0	9.38×10^{-1}	1.29	0.0	4.34×10^{-1}	1.45×10^{-1}	1.64×10^{-1}
Beaufort-Jasper	5.00×10^{-1}	0.0	7.59×10^{-1}	9.39×10^{-1}	0.0	3.01×10^{-1}	1.04×10^{-1}	5.51×10^{-1}
Sport fish	1.45×10^{1}	0.0	2.22×10^{1}	2.80×10^{1}	0.0	9.42	3.25	4.61×10^{-1}
Commercial fish	8.45×10^{-1}	0.0	1.29	1.63	0.0	5.48×10^{-1}	1.89×10^{-1}	2.68×10^{-2}
Shellfish	2.52×10^{-4}	0.0	3.24×10^{-4}	4.25×10^{-4}	0.0	1.37×10^{-4}	4.73×10^{-5}	2.82×10^{-4}
Shoreline	4.78×10^{-2}	5.59×10^{-2}	0.0	0.0	4.78×10^{-2}	0.0	0.0	0.0
Swimming	1.02×10^{-4}	0.0	0.0	0.0	1.02×10^{-4}	0.0	0.0	0.0
Boating	3.56×10^{-4}	0.0	0.0	0.0	3.56×10^{-4}	0.0	0.0	0.0
Total	1.67×10^{1}	5.59×10^{-2}	2.52×10^{1}	3.19×10^{1}	4.83×10^{-2}	1.07×10^{1}	3.69	1.20

Table B-36. Tenth-year dose from radiocesium and cobalt transport (average river flow)

Pathway	Total body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
				MAXIMUM INDIVIDUAL DOSE (mrem)				
Adult	3.08×10^{-1}	2.71×10^{-4}	3.44×10^{-1}	4.70×10^{-1}	2.34×10^{-4}	1.60×10^{-1}	5.32×10^{-2}	9.41×10^{-3}
Teen	1.65×10^{-1}	9.07×10^{-4}	3.54×10^{-1}	4.71×10^{-1}	7.79×10^{-4}	1.61×10^{-1}	6.29×10^{-2}	7.52×10^{-3}
Child	6.63×10^{-2}	1.89×10^{-4}	4.68×10^{-1}	4.48×10^{-1}	1.64×10^{-4}	1.46×10^{-1}	5.27×10^{-2}	3.00×10^{-3}
Infant	6.07×10^{-4}	0.0	7.23×10^{-3}	8.46×10^{-3}	0.0	2.27×10^{-3}	9.19×10^{-4}	3.37×10^{-5}
				POPULATION DOSE (person-rem)				
Drinking water								
Port Wentworth	4.38×10^{-2}	0.0	4.86×10^{-2}	6.66×10^{-2}	0.0	2.25×10^{-2}	7.47×10^{-3}	3.86×10^{-3}
Beaufort-Jasper	2.30×10^{-2}	0.0	3.94×10^{-2}	4.75×10^{-2}	0.0	1.57×10^{-2}	5.42×10^{-3}	1.10×10^{-2}
Sport fish	7.55×10^{-1}	0.0	1.15	1.45	0.0	4.90×10^{-1}	1.69×10^{-1}	2.37×10^{-2}
Commercial fish	4.39×10^{-2}	0.0	6.72×10^{-2}	8.46×10^{-2}	0.0	2.85×10^{-2}	9.82×10^{-3}	1.38×10^{-3}
Shellfish	1.17×10^{-5}	0.0	1.69×10^{-5}	2.15×10^{-5}	0.0	7.14×10^{-6}	2.46×10^{-6}	5.52×10^{-6}
Shoreline	2.32×10^{-3}	2.71×10^{-3}	0.0	0.0	2.32×10^{-3}	0.0	0.0	0.0
Swimming	4.59×10^{-6}	0.0	0.0	0.0	4.59×10^{-6}	0.0	0.0	0.0
Boating	1.61×10^{-5}	0.0	0.0	0.0	1.61×10^{-5}	0.0	0.0	0.0
Total	8.68×10^{-1}	2.71×10^{-3}	1.31	1.65	2.34×10^{-3}	5.57×10^{-1}	1.92×10^{-1}	3.99×10^{-2}

Table B-37. Tenth-year dose from radiocesium and cobalt transport (low river flow)

Pathway	Total body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
			MAXIMUM INDIVIDUAL DOSE (mrem)					
Adult	5.25×10^{-1}	4.62×10^{-4}	5.86×10^{-1}	8.01×10^{-1}	3.99×10^{-4}	2.73×10^{-1}	9.07×10^{-2}	1.60×10^{-2}
Teen	2.81×10^{-1}	1.55×10^{-3}	6.04×10^{-1}	8.03×10^{-1}	1.33×10^{-3}	2.74×10^{-1}	1.07×10^{-1}	1.28×10^{-2}
Child	1.13×10^{-1}	3.22×10^{-4}	7.98×10^{-1}	7.64×10^{-1}	2.80×10^{-4}	2.49×10^{-1}	8.98×10^{-2}	5.11×10^{-3}
Infant	1.03×10^{-3}	0.0	1.23×10^{-2}	1.44×10^{-2}	0.0	3.87×10^{-3}	1.57×10^{-3}	5.75×10^{-5}
			POPULATION DOSE (person-rem)					
Drinking water								
Port Wentworth	7.47×10^{-2}	0.0	8.29×10^{-2}	1.14×10^{-1}	0.0	3.84×10^{-2}	1.27×10^{-2}	6.59×10^{-3}
Beaufort-Jasper	3.91×10^{-2}	0.0	6.71×10^{-2}	8.10×10^{-2}	0.0	2.66×10^{-2}	9.24×10^{-3}	1.88×10^{-2}
Sport fish	1.29	0.0	1.96	2.47	0.0	8.35×10^{-1}	2.88×10^{-1}	4.04×10^{-2}
Commercial fish	7.48×10^{-2}	0.0	1.15×10^{-1}	1.44×10^{-1}	0.0	4.86×10^{-2}	1.67×10^{-2}	2.35×10^{-3}
Shellfish	1.99×10^{-5}	0.0	2.88×10^{-5}	3.67×10^{-5}	0.0	1.22×10^{-5}	4.19×10^{-6}	9.41×10^{-6}
Shoreline	3.96×10^{-3}	4.62×10^{-3}	--	--	3.96×10^{-3}	--	--	--
Swimming	7.83×10^{-6}	0.0	--	--	7.83×10^{-6}	--	--	--
Boating	2.74×10^{-5}	0.0	--	--	2.74×10^{-5}	--	--	--
Total	1.48	4.62×10^{-3}	2.23	2.81	4.00×10^{-3}	9.49×10^{-1}	3.27×10^{-1}	6.81×10^{-2}

Table B-38. Annual dose to maximally exposed individual resulting from atmospheric releases from current SRP operation with three reactors (In millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.11×10^{-1}	5.70×10^{-1}
Ground plane	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	1.02×10^{-3}
Vegetation ingestion	3.05×10^{-1}	3.10×10^{-1}	4.93×10^{-2}	3.03×10^{-1}	3.04×10^{-1}	3.07	3.01×10^{-1}	3.01×10^{-1}
Meat ingestion	4.64×10^{-2}	7.83×10^{-2}	1.19×10^{-2}	4.63×10^{-2}	4.73×10^{-2}	1.39×10^{-1}	4.62×10^{-2}	4.62×10^{-2}
Milk ingestion	1.06×10^{-1}	1.06×10^{-1}	1.29×10^{-2}	1.06×10^{-1}	1.06×10^{-1}	5.72×10^{-1}	1.06×10^{-1}	1.06×10^{-1}
Inhalation	2.50×10^{-1}	2.48×10^{-1}	5.00×10^{-2}	2.57×10^{-1}	2.55×10^{-1}	2.52×10^{-1}	2.53×10^{-1}	2.48×10^{-1}
Total	8.14×10^{-1}	8.48×10^{-1}	2.30×10^{-1}	8.19×10^{-1}	8.19×10^{-1}	4.14	8.18×10^{-1}	1.27
				TEENAGER				
Plume immersion	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.11×10^{-1}	5.70×10^{-1}
Ground plane	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	1.02×10^{-3}
Vegetation ingestion	3.57×10^{-1}	3.63×10^{-1}	7.59×10^{-2}	3.56×10^{-1}	3.57×10^{-1}	2.46×10^{-0}	3.53×10^{-1}	3.53×10^{-1}
Meat ingestion	2.83×10^{-2}	4.78×10^{-2}	1.00×10^{-2}	2.82×10^{-2}	2.90×10^{-2}	6.43×10^{-2}	2.81×10^{-2}	2.81×10^{-2}
Milk ingestion	1.40×10^{-1}	1.39×10^{-1}	2.38×10^{-2}	1.40×10^{-1}	1.40×10^{-1}	5.41×10^{-1}	1.39×10^{-1}	1.39×10^{-1}
Inhalation	2.51×10^{-1}	2.50×10^{-1}	5.27×10^{-2}	2.60×10^{-1}	2.57×10^{-1}	2.52×10^{-1}	2.58×10^{-1}	2.50×10^{-1}
Total	8.82×10^{-1}	9.06×10^{-1}	2.69×10^{-1}	8.89×10^{-1}	8.89×10^{-1}	3.42	8.90×10^{-1}	1.34
				CHILD				
Plume immersion	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.11×10^{-1}	5.70×10^{-1}
Ground plane	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	1.02×10^{-3}
Vegetation ingestion	5.62×10^{-1}	5.66×10^{-1}	1.74×10^{-1}	5.62×10^{-1}	5.65×10^{-1}	2.57	5.58×10^{-1}	5.58×10^{-1}
Meat ingestion	3.54×10^{-2}	4.71×10^{-2}	1.89×10^{-2}	3.53×10^{-2}	3.64×10^{-2}	6.23×10^{-2}	3.53×10^{-2}	3.53×10^{-2}
Milk ingestion	2.24×10^{-1}	2.24×10^{-1}	5.82×10^{-2}	2.25×10^{-1}	2.25×10^{-1}	6.21×10^{-1}	2.24×10^{-1}	2.24×10^{-1}
Inhalation	2.22×10^{-1}	2.21×10^{-1}	4.17×10^{-2}	2.28×10^{-1}	2.26×10^{-1}	2.22×10^{-1}	2.28×10^{-1}	2.21×10^{-1}
Total	1.15	1.16	3.99×10^{-1}	1.16	1.16	3.58	1.16	1.16

Table B-38. Annual dose to maximally exposed individual resulting from atmospheric releases from current SRP operation with three reactors (In millirems per year) (continued)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.11×10^{-1}	5.70×10^{-1}
Ground plane	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	6.85×10^{-4}	1.02×10^{-3}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	3.47×10^{-1}	3.46×10^{-1}	1.13×10^{-1}	3.48×10^{-1}	3.48×10^{-1}	1.31	3.46×10^{-1}	3.46×10^{-1}
Inhalation	1.27×10^{-1}	1.27×10^{-1}	1.66×10^{-2}	1.30×10^{-1}	1.29×10^{-1}	1.28×10^{-1}	1.31×10^{-1}	1.27×10^{-1}
Total	5.81×10^{-1}	5.79×10^{-1}	2.36×10^{-1}	5.84×10^{-1}	5.83×10^{-1}	1.55	5.89×10^{-1}	1.04

Table B-39. Population dose resulting from atmospheric releases from current SRP operation with three reactors (In person-rem per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	5.11	5.11	5.11	5.11	5.11	5.11	6.03	7.36×10^{1}
Ground plane	3.70×10^{-1}	3.70×10^{-1}	3.70×10^{-1}	3.70×10^{-1}	3.70×10^{-1}	3.70×10^{-1}	3.70×10^{-1}	5.83×10^{-1}
Vegetation ingestion	2.48×10^{1}	2.51×10^{1}	5.34	2.46×10^{1}	2.48×10^{1}	1.88×10^{2}	2.45×10^{1}	2.45×10^{1}
Meat ingestion	4.44	6.78	1.39	4.43	4.51	1.14×10^{1}	4.43	4.43
Milk ingestion	6.30	6.29	1.17	6.30	6.30	2.28×10^{1}	6.29	6.28
Inhalation	3.94×10^{1}	3.91×10^{1}	7.38	4.05×10^{1}	4.01×10^{1}	3.96×10^{1}	4.00×10^{1}	3.91×10^{1}
Total	8.04×10^{1}	8.28×10^{1}	2.08×10^{1}	8.14×10^{1}	8.12×10^{1}	2.68×10^{2}	8.16×10^{1}	1.49×10^{2}

Table B-40. Annual dose to maximally exposed individual resulting from liquid releases from current SRP operation with three reactors (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	6.14×10^{-1}	2.73×10^{-1}	1.91×10^{-1}	9.68×10^{-3}	9.92×10^{-2}	3.94×10^{-2}	2.70×10^{-2}
Drinking	0.0	3.11×10^{-1}	2.33×10^{-1}	2.39×10^{-1}	2.31×10^{-1}	2.33×10^{-1}	2.31×10^{-1}	2.40×10^{-1}
Shoreline	5.23×10^{-4}	4.42×10^{-4}	4.42×10^{-4}	4.42×10^{-4}	4.42×10^{-4}	4.42×10^{-4}	4.42×10^{-4}	4.42×10^{-4}
Swimming	0.0	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}
Boating	0.0	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}
Total	5.23×10^{-4}	9.25×10^{-1}	5.06×10^{-1}	4.30×10^{-1}	2.41×10^{-1}	3.33×10^{-1}	2.71×10^{-1}	2.67×10^{-1}
				TEEN				
Fish	0.0	5.60×10^{-1}	2.71×10^{-1}	1.06×10^{-1}	7.15×10^{-3}	9.70×10^{-2}	4.20×10^{-2}	2.02×10^{-2}
Drinking	0.0	2.56×10^{-1}	1.65×10^{-1}	1.69×10^{-1}	1.63×10^{-1}	1.65×10^{-1}	1.63×10^{-1}	1.70×10^{-1}
Shoreline	1.75×10^{-3}	1.48×10^{-3}	1.48×10^{-3}	1.48×10^{-3}	1.48×10^{-3}	1.48×10^{-3}	1.48×10^{-3}	1.48×10^{-3}
Swimming	0.0	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}
Boating	0.0	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}
Total	1.75×10^{-3}	8.17×10^{-1}	4.37×10^{-1}	2.77×10^{-1}	1.71×10^{-1}	2.64×10^{-1}	2.07×10^{-1}	1.91×10^{-1}
				CHILD				
Fish	0.0	6.68×10^{-1}	2.55×10^{-1}	5.14×10^{-2}	6.16×10^{-3}	8.75×10^{-2}	3.53×10^{-2}	1.18×10^{-2}
Drinking	0.0	6.47×10^{-1}	3.16×10^{-1}	3.26×10^{-1}	3.12×10^{-1}	3.17×10^{-1}	3.12×10^{-1}	3.18×10^{-1}
Shoreline	3.66×10^{-4}	3.09×10^{-4}	3.09×10^{-4}	3.09×10^{-4}	3.09×10^{-4}	3.09×10^{-4}	3.09×10^{-4}	3.09×10^{-4}
Swimming	0.0	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}	1.31×10^{-6}
Boating	0.0	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}	3.94×10^{-6}
Total	3.66×10^{-4}	1.32	5.71×10^{-1}	3.78×10^{-1}	3.18×10^{-1}	4.05×10^{-1}	3.48×10^{-1}	3.30×10^{-1}

Table B-40. Annual dose to maximally exposed individual resulting from liquid releases from current SRP operation with three reactors (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	4.68×10^{-1}	3.11×10^{-1}	3.17×10^{-1}	3.06×10^{-1}	3.12×10^{-1}	3.07×10^{-1}	3.10×10^{-1}
Total	0.0	4.68×10^{-1}	3.11×10^{-1}	3.17×10^{-1}	3.06×10^{-1}	3.12×10^{-1}	3.07×10^{-1}	3.10×10^{-1}

Table B-41. Population dose resulting from liquid releases from current SRP operation with three reactors (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	2.23×10^{1}	1.44×10^{1}	1.49×10^{1}	1.43×10^{1}	1.45×10^{1}	1.43×10^{1}	1.48×10^{1}
Port Wentworth	0.0	3.15×10^{1}	2.36×10^{1}	2.42×10^{1}	2.34×10^{1}	2.36×10^{1}	2.34×10^{1}	2.43×10^{1}
Total	0.0	5.38×10^{1}	3.80×10^{1}	3.91×10^{1}	3.77×10^{1}	3.81×10^{1}	3.77×10^{1}	3.91×10^{1}
Sport fish	0.0	1.95	8.48×10^{-1}	4.80×10^{-1}	2.73×10^{-2}	3.04×10^{-1}	1.22×10^{-1}	7.27×10^{-2}
Commercial fish	0.0	1.13×10^{-1}	4.93×10^{-2}	2.79×10^{-2}	1.59×10^{-3}	1.77×10^{-2}	7.13×10^{-3}	4.23×10^{-3}
Shellfish	0.0	1.56×10^{-3}	7.20×10^{-5}	1.08×10^{-4}	4.92×10^{-5}	6.02×10^{-5}	5.06×10^{-5}	2.21×10^{-4}
Shoreline	5.23×10^{-3}	0.0	0.0	4.42×10^{-3}	4.42×10^{-3}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	1.31×10^{-5}	1.31×10^{-5}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	4.60×10^{-5}	4.60×10^{-5}	0.0	0.0	0.0
Total	5.23×10^{-3}	2.07	8.97×10^{-1}	5.12×10^{-1}	3.34×10^{-2}	3.22×10^{-1}	1.29×10^{-1}	7.72×10^{-2}
Grand total	5.23×10^{-3}	5.59×10^{1}	3.89×10^{1}	3.96×10^{1}	3.77×10^{1}	3.84×10^{1}	3.78×10^{1}	3.92×10^{1}

Table B-42. Annual dose to maximally exposed individual resulting from atmospheric releases from the Vogtle Nuclear Power Plant with two reactors (In millirems per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				ADULT				
Plume immersion	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	5.14×10^{-3}	2.86×10^{-2}
Ground plane	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	9.97×10^{-5}
Vegetation ingestion	6.94×10^{-4}	3.40×10^{-4}	8.52×10^{-4}	1.22×10^{-3}	2.10×10^{-3}	3.96×10^{-1}	0.0	0.0
Meat ingestion	3.50×10^{-5}	1.61×10^{-5}	4.27×10^{-5}	6.11×10^{-5}	1.05×10^{-4}	2.00×10^{-2}	0.0	0.0
Milk ingestion	3.78×10^{-4}	1.80×10^{-4}	4.63×10^{-4}	6.63×10^{-4}	1.14×10^{-3}	2.16×10^{-1}	0.0	0.0
Inhalation	1.34×10^{-5}	7.24×10^{-6}	1.78×10^{-5}	2.63×10^{-5}	4.52×10^{-5}	7.59×10^{-3}	0.0	0.0
Total	6.00×10^{-3}	5.43×10^{-3}	6.26×10^{-3}	6.86×10^{-3}	8.27×10^{-3}	6.44×10^{-1}	5.22×10^{-3}	2.87×10^{-2}
				TEENAGER				
Plume immersion	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	5.14×10^{-3}	2.86×10^{-2}
Ground plane	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	9.97×10^{-5}
Vegetation ingestion	6.12×10^{-4}	2.41×10^{-4}	8.18×10^{-4}	1.15×10^{-3}	1.98×10^{-3}	3.32×10^{-1}	0.0	0.0
Meat ingestion	2.67×10^{-5}	9.83×10^{-6}	3.55×10^{-5}	4.97×10^{-5}	8.55×10^{-5}	1.45×10^{-2}	0.0	0.0
Milk ingestion	6.29×10^{-4}	2.41×10^{-4}	8.39×10^{-4}	1.18×10^{-3}	2.03×10^{-3}	3.42×10^{-1}	0.0	0.0
Inhalation	1.74×10^{-5}	7.96×10^{-6}	2.50×10^{-5}	3.61×10^{-5}	6.22×10^{-5}	9.44×10^{-3}	0.0	0.0
Total	6.17×10^{-3}	5.38×10^{-3}	6.60×10^{-3}	7.30×10^{-3}	9.04×10^{-3}	7.02×10^{-1}	5.22×10^{-3}	2.87×10^{-2}
				CHILD				
Plume immersion	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	5.14×10^{-3}	2.86×10^{-2}
Ground plane	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	9.97×10^{-5}
Vegetation ingestion	8.72×10^{-4}	1.48×10^{-4}	1.53×10^{-3}	1.55×10^{-3}	2.54×10^{-3}	5.06×10^{-1}	0.0	0.0
Meat ingestion	3.76×10^{-5}	5.89×10^{-6}	6.58×10^{-5}	6.62×10^{-5}	1.09×10^{-4}	2.19×10^{-2}	0.0	0.0
Milk ingestion	1.16×10^{-3}	1.91×10^{-4}	2.04×10^{-3}	2.05×10^{-3}	3.37×10^{-3}	6.75×10^{-1}	0.0	0.0
Inhalation	1.85×10^{-5}	3.88×10^{-6}	3.39×10^{-5}	3.55×10^{-5}	5.84×10^{-5}	1.07×10^{-2}	0.0	0.0
Total	6.97×10^{-3}	5.23×10^{-3}	8.55×10^{-3}	8.58×10^{-3}	1.10×10^{-2}	1.22	5.22×10^{-3}	2.87×10^{-2}

Table B-42. Annual dose to maximally exposed individual resulting from atmospheric releases from the Vogtle Nuclear Power Plant with two reactors (In millirems per year) (continued)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				INFANT				
Plume immersion	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	4.80×10^{-3}	5.14×10^{-3}	2.86×10^{-2}
Ground plane	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	8.21×10^{-5}	9.97×10^{-5}
Vegetation ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meat ingestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk ingestion	2.20×10^{-3}	1.87×10^{-4}	4.25×10^{-3}	5.02×10^{-3}	5.86×10^{-3}	1.64	0.0	0.0
Inhalation	1.33×10^{-5}	1.50×10^{-6}	2.68×10^{-5}	3.29×10^{-5}	3.84×10^{-5}	9.81×10^{-3}	0.0	0.0
Total	7.09×10^{-3}	5.07×10^{-3}	9.16×10^{-3}	9.93×10^{-3}	1.08×10^{-2}	1.66	5.22×10^{-3}	2.87×10^{-2}

Table B-43. Population dose resulting from atmospheric releases from the Vogtle Nuclear Power Plant with two reactors (In person-rem per year)

Pathway	Total body	GI-tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume immersion	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	2.21×10^{-2}	2.78×10^{-1}
Ground plane	1.75×10^{-4}	1.75×10^{-4}	1.75×10^{-4}	1.75×10^{-4}	1.75×10^{-4}	1.75×10^{-4}	1.75×10^{-4}	2.13×10^{-4}
Vegetation ingestion	4.69×10^{-3}	1.50×10^{-3}	6.84×10^{-3}	8.29×10^{-3}	1.40×10^{-2}	2.69	0.0	0.0
Meat ingestion	1.02×10^{-4}	3.88×10^{-5}	1.38×10^{-4}	1.79×10^{-4}	3.04×10^{-4}	5.82×10^{-2}	0.0	0.0
Milk ingestion	7.61×10^{-4}	2.28×10^{-4}	1.14×10^{-3}	1.35×10^{-3}	2.27×10^{-3}	4.36×10^{-1}	0.0	0.0
Inhalation	1.61×10^{-4}	6.76×10^{-5}	2.36×10^{-4}	3.13×10^{-4}	5.33×10^{-4}	9.18×10^{-2}	0.0	0.0
Total	2.41×10^{-2}	2.03×10^{-2}	2.68×10^{-2}	2.86×10^{-2}	3.55×10^{-2}	3.29	2.23×10^{-2}	2.78×10^{-1}

Table B-44. Annual dose to maximally exposed individual resulting from liquid releases from the Vogtle Nuclear Power Plant with two reactors (In millirems per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Fish	0.0	1.52	2.31	1.59	9.14×10^{-2}	7.82×10^{-1}	2.57×10^{-1}	5.02×10^{-2}
Drinking	0.0	1.14×10^{-2}	2.87×10^{-2}	2.32×10^{-2}	1.48×10^{-1}	1.83×10^{-2}	1.34×10^{-2}	1.27×10^{-2}
Shoreline	1.13×10^{-3}	9.70×10^{-4}	9.70×10^{-4}	9.70×10^{-4}	9.70×10^{-4}	9.70×10^{-4}	9.70×10^{-4}	9.70×10^{-4}
Swimming	0.0	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}
Boating	0.0	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}
Total	1.13×10^{-3}	1.54	2.34	1.62	2.40×10^{-1}	8.01×10^{-1}	2.71×10^{-1}	6.39×10^{-2}
				TEEN				
Fish	0.0	1.56	2.29	8.62×10^{-1}	8.20×10^{-2}	7.76×10^{-1}	2.97×10^{-1}	3.62×10^{-2}
Drinking	0.0	1.11×10^{-2}	2.44×10^{-2}	1.43×10^{-2}	1.25×10^{-1}	1.46×10^{-2}	1.02×10^{-2}	8.96×10^{-3}
Shoreline	3.79×10^{-3}	3.25×10^{-3}	3.25×10^{-3}	3.25×10^{-3}	3.25×10^{-3}	3.25×10^{-3}	3.25×10^{-3}	3.25×10^{-3}
Swimming	0.0	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}
Boating	0.0	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}
Total	3.79×10^{-3}	1.57	2.32	8.79×10^{-1}	2.10×10^{-1}	7.94×10^{-1}	3.11×10^{-1}	4.84×10^{-2}
				CHILD				
Fish	0.0	2.03	2.13	3.52×10^{-1}	8.84×10^{-2}	6.94×10^{-1}	2.47×10^{-1}	1.47×10^{-2}
Drinking	0.0	3.22×10^{-2}	4.92×10^{-2}	2.15×10^{-2}	2.96×10^{-1}	2.84×10^{-2}	1.93×10^{-2}	1.63×10^{-2}
Shoreline	7.93×10^{-4}	6.79×10^{-4}	6.79×10^{-4}	6.79×10^{-4}	6.79×10^{-4}	6.79×10^{-4}	6.79×10^{-4}	6.79×10^{-4}
Swimming	0.0	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}	3.83×10^{-6}
Boating	0.0	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}	1.15×10^{-5}
Total	7.93×10^{-4}	2.07	2.18	3.74×10^{-1}	3.85×10^{-1}	7.23×10^{-1}	2.67×10^{-1}	3.17×10^{-2}

Table B-44. Annual dose to maximally exposed individual resulting from liquid releases from the Vogtle Nuclear Power Plant with two reactors (In millirems per year) (continued)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
Drinking	0.0	3.36×10^{-2}	5.78×10^{-2}	1.93×10^{-2}	4.56×10^{-1}	2.88×10^{-2}	1.97×10^{-2}	1.58×10^{-2}
Total	0.0	3.36×10^{-2}	5.78×10^{-2}	1.93×10^{-2}	4.56×10^{-1}	2.88×10^{-2}	1.97×10^{-2}	1.58×10^{-2}

Table B-45. Population dose resulting from liquid releases from the Vogtle Nuclear Power Plant with two reactors (In person-rem per year)

Pathway	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
Drinking water								
Beaufort-Jasper	0.0	9.29×10^{-1}	1.91	1.29	8.48	1.16	8.49×10^{-1}	7.59×10^{-1}
Port Wentworth	0.0	1.14	2.88	2.34	1.22×10^{1}	1.82	1.36	1.25
Total	0.0	2.07	4.79	3.63	2.07×10^{1}	2.98	2.21	2.01
Sport fish	0.0	5.13	7.11	3.92	1.41×10^{-1}	2.38	8.16×10^{-1}	1.20×10^{-1}
Commercial fish	0.0	2.98×10^{-1}	4.13×10^{-1}	2.28×10^{-1}	6.36×10^{-3}	1.38×10^{-1}	4.74×10^{-2}	6.90×10^{-3}
Shellfish	0.0	9.74×10^{-5}	1.27×10^{-4}	7.34×10^{-5}	6.42×10^{-4}	1.30×10^{-4}	1.70×10^{-5}	3.95×10^{-4}
Shoreline	1.13×10^{-2}	0.0	0.0	9.70×10^{-3}	9.70×10^{-3}	0.0	0.0	0.0
Swimming	0.0	0.0	0.0	3.83×10^{-5}	3.83×10^{-5}	0.0	0.0	0.0
Boating	0.0	0.0	0.0	1.34×10^{-4}	1.34×10^{-4}	0.0	0.0	0.0
Total	1.13×10^{-2}	5.43	7.52	4.16	1.58×10^{-1}	2.52	8.63×10^{-1}	1.27×10^{-1}
Grand total	1.13×10^{-2}	7.50	1.23×10^{1}	7.79	2.09×10^{1}	5.50	3.07	2.14

Table B-46. Maximum individual doses--tenth year atmospheric releases cumulative impact (millirem)

Source of Exposure	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
L-Reactor[a]	3.5×10^{-1}	1.0×10^{-1}	2.3×10^{-1}	2.3×10^{-1}	8.3×10^{-1}	2.3×10^{-1}	2.3×10^{-1}	2.4×10^{-1}
DWPF	1.6×10^{-4}	1.9×10^{-2}	6.6×10^{-4}	4.7×10^{-3}	9.4×10^{-3}	4.2×10^{-4}	3.0×10^{-4}	1.1×10^{-3}
FMF	3.2×10^{-6}	1.0×10^{-3}	8.3×10^{-7}	6.3×10^{-5}	8.3×10^{-7}	2.4×10^{-4}	2.7×10^{-4}	7.2×10^{-5}
SRP[b]	1.3	2.3×10^{-1}	8.2×10^{-1}	8.1×10^{-1}	4.1	8.2×10^{-1}	8.2×10^{-1}	8.5×10^{-1}
Vogtle[c]	2.9×10^{-2}	6.3×10^{-3}	6.9×10^{-3}	6.0×10^{-3}	6.4×10^{-1}	8.3×10^{-3}	5.2×10^{-3}	5.4×10^{-3}
Total	1.7	3.6×10^{-1}	1.1	1.1	5.6	1.1	1.1	1.1
				TEEN				
L-Reactor[a]	3.7×10^{-1}	1.1×10^{-1}	2.5×10^{-1}	2.5×10^{-1}	7.1×10^{-1}	2.5×10^{-1}	2.5×10^{-1}	2.5×10^{-1}
DWPF	1.7×10^{-4}	2.4×10^{-2}	8.7×10^{-4}	5.8×10^{-3}	7.2×10^{-3}	5.0×10^{-4}	4.2×10^{-4}	1.1×10^{-3}
FMF	3.2×10^{-6}	1.7×10^{-3}	8.3×10^{-7}	1.0×10^{-4}	8.3×10^{-7}	4.0×10^{-4}	4.7×10^{-4}	8.8×10^{-5}
SRP[b]	1.3	2.7×10^{-1}	8.9×10^{-1}	8.8×10^{-1}	3.4	8.9×10^{-1}	8.9×10^{-1}	9.1×10^{-1}
Vogtle[c]	2.9×10^{-2}	6.6×10^{-3}	7.3×10^{-3}	6.2×10^{-3}	7.0×10^{-1}	9.0×10^{-3}	5.2×10^{-3}	5.4×10^{-3}
Total	1.7	4.1×10^{-1}	1.1	1.1	4.8	1.1	1.1	1.2
				CHILD				
L-Reactor[a]	4.3×10^{-1}	1.6×10^{-1}	3.1×10^{-1}	3.1×10^{-1}	7.6×10^{-1}	3.1×10^{-1}	3.1×10^{-1}	3.2×10^{-1}
DWPF	1.9×10^{-4}	3.9×10^{-2}	1.2×10^{-3}	9.6×10^{-3}	6.8×10^{-3}	5.9×10^{-4}	4.5×10^{-4}	9.2×10^{-4}
FMF	3.2×10^{-6}	4.0×10^{-3}	8.3×10^{-7}	2.4×10^{-4}	8.4×10^{-7}	6.6×10^{-4}	4.2×10^{-4}	6.9×10^{-5}
SRP[b]	1.2	4.0×10^{-1}	1.2	1.2	3.6	1.2	1.2	1.2
Vogtle[c]	2.9×10^{-2}	8.6×10^{-3}	8.6×10^{-3}	7.0×10^{-3}	1.2	1.1×10^{-2}	5.2×10^{-3}	5.2×10^{-3}
Total	1.7	6.1×10^{-1}	1.5	1.5	5.6	1.5	1.5	1.5

Table B-46. Maximum individual doses--tenth year atmospheric releases cumulative impact (millirem) (continued)

Source of Exposure	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				INFANT				
L-Reactor[a]	3.0×10^{-1}	1.0×10^{-1}	1.8×10^{-1}	1.7×10^{-1}	3.6×10^{-1}	1.8×10^{-1}	1.8×10^{-1}	1.7×10^{-1}
DWPF	1.5×10^{-4}	2.0×10^{-3}	6.5×10^{-4}	4.3×10^{-4}	2.7×10^{-3}	3.0×10^{-4}	2.9×10^{-4}	1.5×10^{-4}
FMF	3.2×10^{-6}	1.3×10^{-4}	8.3×10^{-7}	1.1×10^{-5}	8.3×10^{-7}	2.8×10^{-5}	3.2×10^{-4}	1.9×10^{-6}
SRP[b]	1.0	2.4×10^{-1}	5.8×10^{-1}	5.8×10^{-1}	1.6	5.8×10^{-1}	5.9×10^{-1}	5.8×10^{-1}
Vogtle[c]	2.9×10^{-2}	9.2×10^{-3}	9.9×10^{-3}	7.1×10^{-3}	1.7	1.1×10^{-2}	5.2×10^{-3}	5.1×10^{-3}
Total	1.3	3.5×10^{-1}	7.7×10^{-1}	7.6×10^{-1}	3.7	7.7×10^{-1}	7.8×10^{-1}	7.6×10^{-1}

[a]Includes support facilities.

[b]Current SRP operation with three reactors.

[c]Vogtle Power Plant operation with two reactors.

Table B-47. Maximum individual doses--tenth year liquid releases cumulative impact (millirem)

Source of Exposure	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ADULT				
Co & Cs Remobi-lization	2.7×10^{-4}	3.4×10^{-1}	4.7×10^{-1}	3.1×10^{-1}	2.3×10^{-4}	1.6×10^{-1}	5.3×10^{-2}	9.4×10^{-3}
L-Reactor[a]	1.7×10^{-4}	3.0×10^{-1}	1.4×10^{-1}	1.4×10^{-1}	1.2×10^{-1}	1.2×10^{-1}	1.2×10^{-1}	1.4×10^{-1}
DWPF	2.6×10^{-5}	5.9×10^{-5}	7.5×10^{-3}	7.7×10^{-3}	7.7×10^{-3}	7.7×10^{-3}	7.7×10^{-3}	8.6×10^{-3}
FMF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SRP[b]	5.2×10^{-4}	9.3×10^{-1}	5.1×10^{-1}	4.3×10^{-1}	2.4×10^{-1}	3.3×10^{-1}	2.7×10^{-1}	2.7×10^{-1}
Vogtle[c]	1.1×10^{-3}	1.5	2.3	1.6	2.4×10^{-1}	8.0×10^{-1}	2.7×10^{-1}	6.4×10^{-2}
Total	2.1×10^{-3}	3.1	3.4	2.5	6.1×10^{-1}	1.4	7.2×10^{-1}	4.9×10^{-1}
				TEEN				
Co & Cs Remobi-lization	9.1×10^{-4}	3.5×10^{-1}	4.7×10^{-1}	1.7×10^{-1}	7.8×10^{-4}	1.6×10^{-1}	6.3×10^{-2}	7.5×10^{-3}
L-Reactor[a]	5.9×10^{-4}	2.6×10^{-1}	1.1×10^{-1}	9.5×10^{-2}	8.2×10^{-2}	9.1×10^{-2}	8.5×10^{-2}	1.0×10^{-1}
DWPF	8.5×10^{-5}	1.1×10^{-4}	5.5×10^{-3}	5.5×10^{-3}	5.5×10^{-3}	5.4×10^{-3}	5.5×10^{-3}	6.6×10^{-3}
FMF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SRP[b]	1.8×10^{-3}	8.2×10^{-1}	4.4×10^{-1}	2.8×10^{-1}	1.7×10^{-1}	2.6×10^{-1}	2.1×10^{-1}	1.9×10^{-1}
Vogtle[c]	3.8×10^{-3}	1.6	2.3	8.8×10^{-1}	2.1×10^{-1}	7.9×10^{-1}	3.1×10^{-1}	4.8×10^{-2}
Total	7.2×10^{-3}	3.0	3.3	1.4	4.7×10^{-1}	1.3	6.7×10^{-1}	3.5×10^{-1}

Table B-47. Maximum individual doses--tenth year liquid releases cumulative impact (millirem) (continued)

Source of Exposure	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				CHILD				
Co & Cs Remobilization	1.9×10^{-4}	4.7×10^{-1}	4.5×10^{-1}	6.6×10^{-2}	1.6×10^{-4}	1.5×10^{-1}	5.3×10^{-2}	3.0×10^{-3}
L-Reactor[a]	1.2×10^{-4}	4.4×10^{-1}	1.8×10^{-1}	1.6×10^{-1}	1.5×10^{-1}	1.6×10^{-1}	1.5×10^{-1}	1.7×10^{-1}
DWPF	1.8×10^{-5}	7.1×10^{-5}	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	5.3×10^{-3}	1.0×10^{-2}	1.1×10^{-2}
FMF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SRP[b]	3.7×10^{-4}	1.3	5.7×10^{-1}	3.8×10^{-1}	3.2×10^{-1}	4.1×10^{-1}	3.5×10^{-1}	3.3×10^{-1}
Vogtle[c]	7.9×10^{-4}	2.1	2.2	3.7×10^{-1}	3.9×10^{-1}	7.2×10^{-1}	2.7×10^{-1}	3.2×10^{-2}
Total	1.5×10^{-3}	4.3	3.4	9.9×10^{-1}	8.7×10^{-1}	1.4	8.3×10^{-1}	5.5×10^{-1}
				INFANT				
Co & Cs Remobilization	0.0	7.2×10^{-3}	8.5×10^{-3}	6.1×10^{-4}	0.0	2.3×10^{-3}	9.2×10^{-4}	3.4×10^{-5}
L-Reactor[a]	0.0	1.8×10^{-1}	1.5×10^{-1}	1.5×10^{-1}	1.5×10^{-1}	1.5×10^{-1}	1.5×10^{-1}	1.5×10^{-1}
DWPF	0.0	3.5×10^{-5}	9.9×10^{-3}	9.9×10^{-3}	9.9×10^{-3}	3.4×10^{-3}	9.9×10^{-3}	1.0×10^{-2}
FMF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SRP[b]	0.0	4.7×10^{-1}	3.1×10^{-1}	3.2×10^{-1}	3.1×10^{-1}	3.1×10^{-1}	3.1×10^{-1}	3.1×10^{-1}
Vogtle[c]	0.0	3.4×10^{-2}	5.8×10^{-2}	1.9×10^{-2}	4.6×10^{-1}	2.9×10^{-2}	2.0×10^{-2}	1.6×10^{-2}
Total	0.0	6.9×10^{-1}	5.4×10^{-1}	5.0×10^{-1}	9.3×10^{-1}	4.9×10^{-1}	4.9×10^{-1}	4.9×10^{-1}

[a]Includes support facilities.
[b]Current SRP operation with three reactors.
[c]Vogtle Power Plant operation with two reactors.

Table B-48. Population doses--tenth year cumulative impact (person-rem)

Source of Exposure	Skin	Bone	Liver	Total body	Thyroid	Kidney	Lung	GI-LLI
				ATMOSPHERIC				
L-Reactor[a]	4.2×10^{1}	8.8	1.7×10^{1}	1.6×10^{1}	1.1×10^{2}	1.7×10^{1}	1.7×10^{1}	1.7×10^{1}
DWPF[b]	1.2×10^{-2}	1.0	5.0×10^{-2}	2.3×10^{-1}	3.1×10^{-1}	3.5×10^{-2}	3.1×10^{-2}	5.1×10^{-2}
FMF	8.1×10^{-4}	4.0×10^{-2}	2.1×10^{-4}	2.6×10^{-3}	2.1×10^{-4}	8.3×10^{-3}	1.9×10^{-2}	1.8×10^{-3}
SRP[c]	1.5×10^{2}	2.1×10^{1}	8.1×10^{1}	8.0×10^{1}	2.7×10^{2}	8.1×10^{1}	8.2×10^{1}	8.3×10^{1}
Vogtle[d]	2.8×10^{-1}	2.7×10^{-2}	2.9×10^{-2}	2.4×10^{-2}	3.3	3.6×10^{-2}	2.2×10^{-2}	2.0×10^{-2}
Total	1.9×10^{2}	3.1×10^{1}	9.8×10^{1}	9.6×10^{1}	3.8×10^{2}	9.8×10^{1}	9.9×10^{1}	1.0×10^{2}
				LIQUID				
Co & Cs Remobilization	2.7×10^{-3}	1.3	1.7	8.7×10^{-1}	2.3×10^{-3}	5.6×10^{-1}	1.9×10^{-1}	4.0×10^{-2}
L-Reactor[a]	1.7×10^{-3}	2.2×10^{1}	1.8×10^{1}	1.9×10^{1}	1.8×10^{1}	1.8×10^{1}	1.8×10^{1}	2.0×10^{1}
DWPF[b]	2.6×10^{-4}	5.0×10^{-3}	1.2	1.2	1.2	1.1	1.2	1.4
FMF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SRP[c]	5.2×10^{-1}	5.6×10^{1}	3.9×10^{1}	4.0×10^{1}	3.8×10^{1}	3.8×10^{1}	3.8×10^{1}	3.9×10^{1}
Vogtle[d]	1.1×10^{-2}	7.5	1.2×10^{1}	7.8	2.1×10^{1}	5.5	3.1	2.1
Total	2.1×10^{-2}	8.7×10^{1}	7.2×10^{1}	6.9×10^{1}	7.8×10^{1}	6.3×10^{1}	6.0×10^{1}	6.3×10^{1}
Grand Total	1.9×10^{2}	1.2×10^{2}	1.7×10^{2}	1.7×10^{2}	4.6×10^{2}	1.6×10^{2}	1.6×10^{2}	1.6×10^{2}

[a]Includes support facilities.
[b]Combined stage 1 & 2 operation.
[c]Current SRP operation with three reactors.
[d]With two reactors.

facilities, current SRP operations with three reactors and their support facilities, and the other nuclear facilities being built in the affected region (VNGS, DWPF, and FMF).

B.5 ENVIRONMENTAL DOSE COMMITMENT CONCEPT

Man can receive doses externally from radioactive materials outside the body or internally from the intake of radioactive material by inhalation or ingestion. Radionuclides that enter the body are distributed to various organs and are removed by normal biological processes and radioactive decay. The rate at which each radionuclide is removed from the body depends on its chemical, physical, and radiological properties. Historically, dose calculations have included an accounting of doses resulting from the fraction of radionuclides retained in the body for 50 years following the year of intake. This 50-year "integrating period" is included in the dose commitment factors used in these dose calculations.

Similarly, radioactive material released in any year remains in the environment for varying lengths of time, depending on many environmental factors and on the decay rate of each radionuclide. The environmental dose commitment (EDC) concept is employed to account for this residual activity.

The EDC concept has been developed by the U.S. Environmental Protection Agency (EPA, 1974). EPA has defined the environmental dose commitment as "... the sum of all doses to individuals over the entire time period the material persists in the environment in a state available for interaction with humans." The EPA report describes how this concept is implemented and presents some sample calculations. These calculations integrate doses for 100 years following radionuclide release rather than "the entire time period." This 100-year integrating period is distinct from the 50-year integrating period discussed above because it deals with the accumulation of doses from residual radioactivity in the environment rather than in the body.

The 100-year integrating period was used in this analysis; in other words, all population dose calculations will include an accounting of population doses caused by environmental radioactivity levels for 100 years following each year's release. The 100-year period provides results that are meaningful by accounting for impacts over a period of time about equal to the maximum lifetime of an individual; thus, it provides a measure of risk to an individual. Longer integrating periods or an infinite time integral would require extremely speculative predictions about man's environment for thousands of years into the future.

For all EDC calculations, no attempt was made to predict changes in environmental characteristics. Population size and distribution were based on the latest estimates. Historic meteorology was assumed to continue into the future. Food production and consumption patterns were assumed to be static.

B.6 RADIATION-INDUCED HEALTH EFFECTS

Radiation can affect human health by causing cancer, genetic disorders, and other health problems. The Committee on the Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences has published a detailed review of available data on radiation-induced health effects (BEIR, 1980). This report (BEIR III) uses a variety of methods and data to quantify the health impacts of low levels of radiation. Its estimates of health risk associated with radiation exposure have been used to quantify the possible radiation-induced health effects that might be caused by L-Reactor operation; these potential health effects are discussed in Sections 4.1.2.6, 5.1.2.5, 5.1.2.7, and 5.2.7.

The BEIR III report identifies three categories of radiation-induced human health effects: (1) cancer, (2) genetic disorders, and (3) somatic effects other than cancer. The committee believes cancer induction is the most important effect of low-dose radiation. In this context, "low dose" refers to doses as high as a few rads per person per year. Natural background radiation ranges from 0.1 to 0.2 rad per person per year. Genetic effects of low-level radiation have been well documented and are addressed in detail in the BEIR III report. Somatic effects other than cancer include such effects as cataract induction and the impairment of fertility. The BEIR III report concludes that low-dose exposure of human populations does not increase the risk of somatic effects other than cancer and developmental changes in unborn children. The report also indicates that developmental changes in unborn children are probably not caused by radiation at or below natural background levels. For these reasons, only cancer and genetic disorders are considered in this analysis.

Cancer data from the Japanese survivors of atomic bombs are used in most of the analyses in the BEIR III report. Individual dose rates of these individuals were very high compared to the dose rates associated with L-Reactor operation. A major question addressed by the BEIR III report is how to extrapolate the cancer risks observed at the relatively high dose rates down to the lower dose rates caused by most nuclear facilities. The BEIR III report adopted a parametric family of functions to accomplish this extrapolation. The linear model represents an upper limit or maximum risk; the linear-quadratic model, an intermediate or probable risk; and the quadratic model, a low limit or minimum risk. These functions have been suggested by the report for low linear energy transfer (LET) radiation. This type of radiation includes gamma and x-radiation and electrons (beta particles). High-LET radiation includes alpha particles, encountered in the decay of radionuclides in the natural uranium decay chain. The BEIR III report states that, for high-LET radiation ". . . the linear hypothesis is less likely to lead to overestimates of risk and may, in fact, lead to underestimates." The linear model would, therefore, represent the best estimate for probable risk from this type of radiation.

One characteristic of radiation-induced cancer is that it takes a long time to develop, a period referred to as the "latent period." Leukemia has a characteristically short latent period (less than 25 years), while other cancers can have latent periods as long as the life span of an individual. Because only about 30 years of cancer data have been collected on the survivors of the atomic bombs, the data do not account for all the cancers that might develop because of the bomb's radiation. Two projection models have been developed to account for these future cancer deaths: (1) the absolute-risk projection model assumes that the cancer rate (risk per year) observed since the atomic bomb blasts will continue throughout the lifespans of those exposed; (2) the relative-risk model assumes the excess radiation-induced risk is proportional to the natural incidence of cancer with age. The relative-risk model results in cancer-risk estimates greater than those predicted by the absolute model. However, the BEIR III report states that the absolute model is generally more applicable to most forms of cancer. The absolute model has been used in calculating the minimum risk, the relative model has been used for the maximum risk, and the arithmetic average of the two for the probable-risk estimates.

Health effects estimators for low-LET and high-LET radiation were derived for use in estimating health effects based on an evaluation of the data presented in the BEIR III report. The resulting health effects estimators used in this document are summarized in Table B-49. They total 120 fatalities per million person-rem for low-LET radiation and 285 fatalities per million person-rem for high-LET radiation. The health effects estimates for genetic effects used in this document is 257 genetic effects per million person-rem of whole-body gamma radiation.

Table B-49. Health effects estimators used in the evaluation of radiation health effects

	Cancer fatalities per 10^6 person-rem	
Organ/cancer	Low-LET radiation[a,b]	High-LET radiation[a,b]
Leukemia and bone cancer	20.0	45.0
Lung	34.0	66.0
Liver	7.9	16.0
Kidney	4.0	7.8
Gastrointestinal tract	6.4	13.0
Thyroid[c]	0.0	0.0
Other	48.0	137.0
Total	120.3	284.8

[a]LET = linear energy transfer.

TC [b]The arithmetic average of the absolute and relative model values have been used for both low- and high-LET radiation. In addition, the linear-quadratic model has been assumed for low-LET radiation and the linear model has been assumed for high-LET radiation (refer to Section B.6).

[c]Although thyroid cancer can be induced, it is rarely fatal (BEIR, 1980).

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APPENDIX C

ECOLOGY

The Savannah River Plant (SRP) occupies a 780-square-kilometer site on the upper coastal plain of South Carolina (Figure C-1). At the time of government acquisition, approximately one-third of the site was forested and the rest was cropland. During the past 32 years, natural succession, forestry management practices, and the construction and operation of nuclear reactors and their support facilities have contributed to the current ecological complexity and diversity.

In 1972, the Savannah River Plant was designated a National Environmental Research Park. It contains perhaps one of the most intensively studied environments in this country. Wiener and Smith (1981) list more than 700 scientific publications resulting principally from research efforts by three institutions on the SRP site: the Savannah River Laboratory, the Savannah River Ecology Laboratory, and the U.S. Forest Service. Other research efforts include: (1) surveys of the aquatic ecology of the Savannah River since 1951 by the Academy of Natural Sciences of Philadelphia, (2) temperature and flow monitoring of the river by the United States Geological Survey (USGS) since 1959, (3) remote sensing of the plant using aerial imagery, and (4) various ecological studies by state government and by industry. In addition, research has been performed by visiting scientists from other universities and laboratories in the United States.

This appendix is based on these sources, and also on recent ecological studies conducted by the Savannah River Ecology Laboratory (SREL) and Environmental and Chemical Services, Inc. (ECS). These studies include research by Smith et al. (1981, 1982a,b, 1983), Du Pont (1982, 1983), and ECS (1982, 1983a,b,c). This appendix emphasizes Steel Creek and the Savannah River swamp (Figure C-1), and the "important" biota that reside there, as these areas will be impacted by L-Reactor for both the reference case (direct discharge) and the preferred cooling-water alternative (see Appendix L for more detail). The important biota are defined as species that are (1) commercially or recreationally valuable, (2) endangered or threatened, (3) important to the well-being of the species included in categories 1 and 2, or (4) critical to the structure and function of the ecosystem. TC

C.1 SOILS

Soils are an important component of the environment because they influence the occurrence and distribution of the vegetation, wildlife, and potential land use by man. The distribution of soils of the Steel Creek watershed is shown in Figure C-2. The portion of the watershed depicted here covers approximately 20,000 acres, and includes 24 different soil types (Table C-1). The most widely distributed soils of the Steel Creek watershed include Blanton sand (14 percent), Wagram loamy sand (13 percent), Troup sand (12 percent), Orangeburg loamy sand (8 percent), Rembert sandy loam (8 percent), Fuquay loamy sand (7 percent), and Wehadkee loam (7 percent). Streambed soils of Steel Creek consist primarily

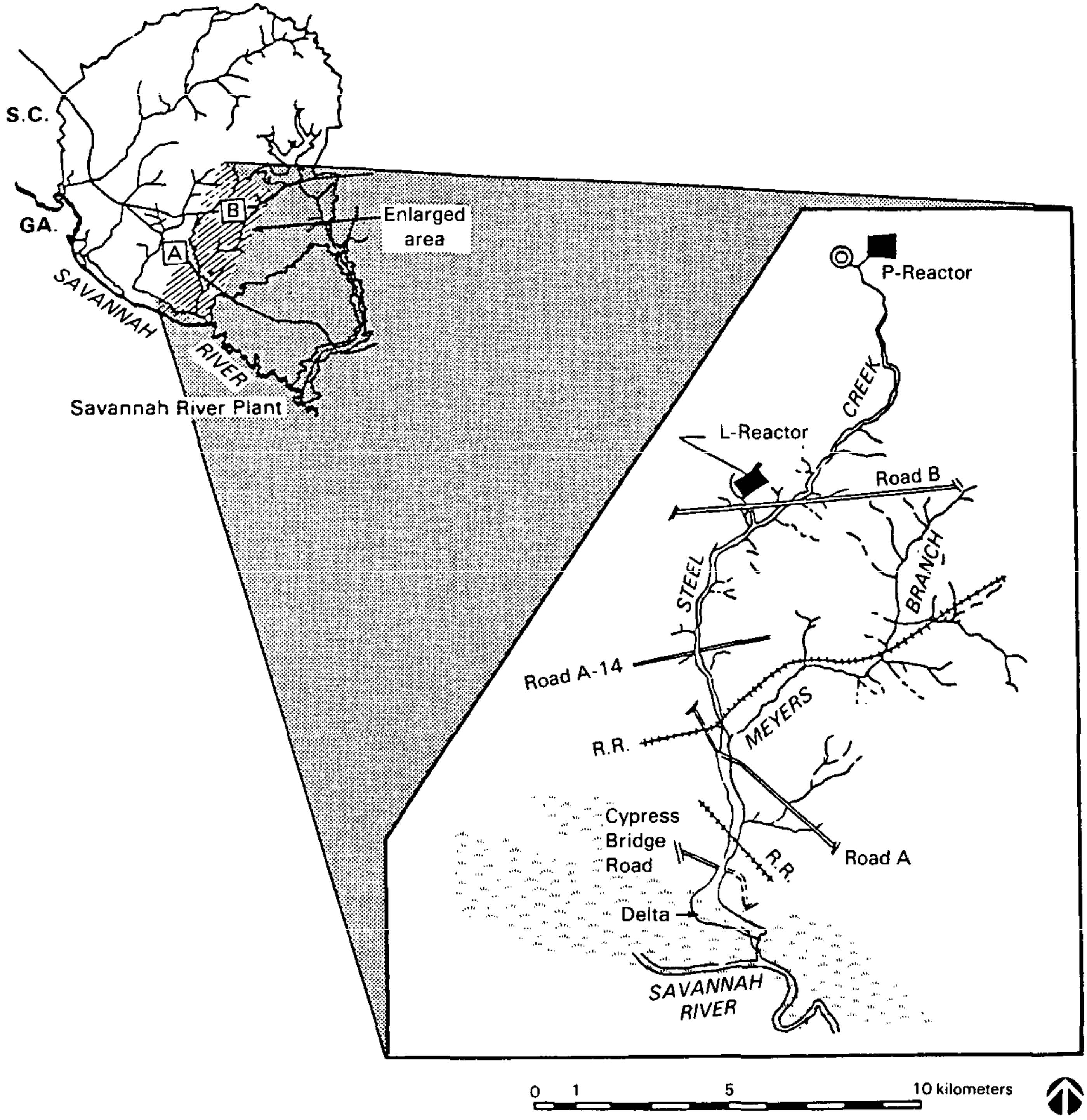
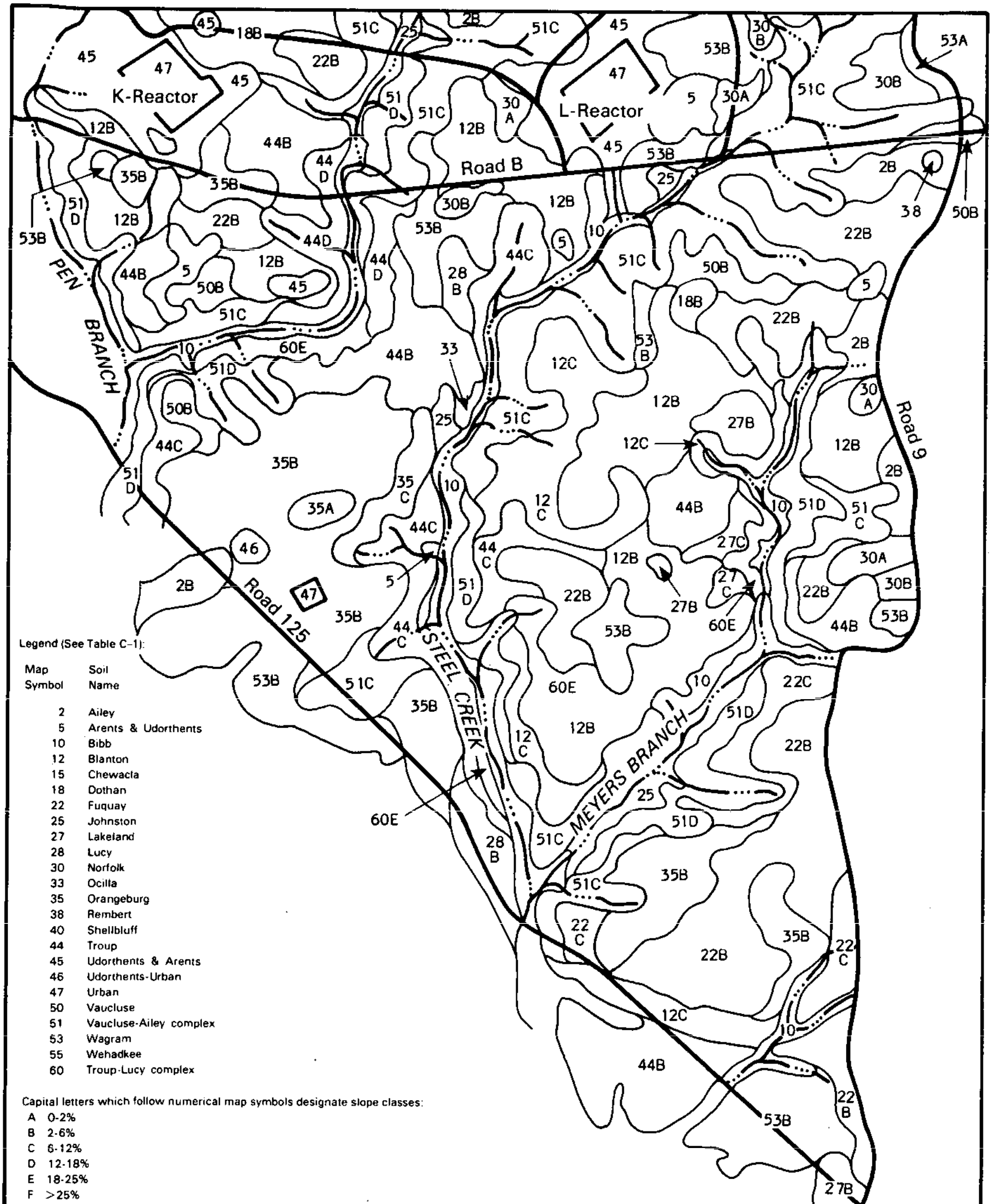


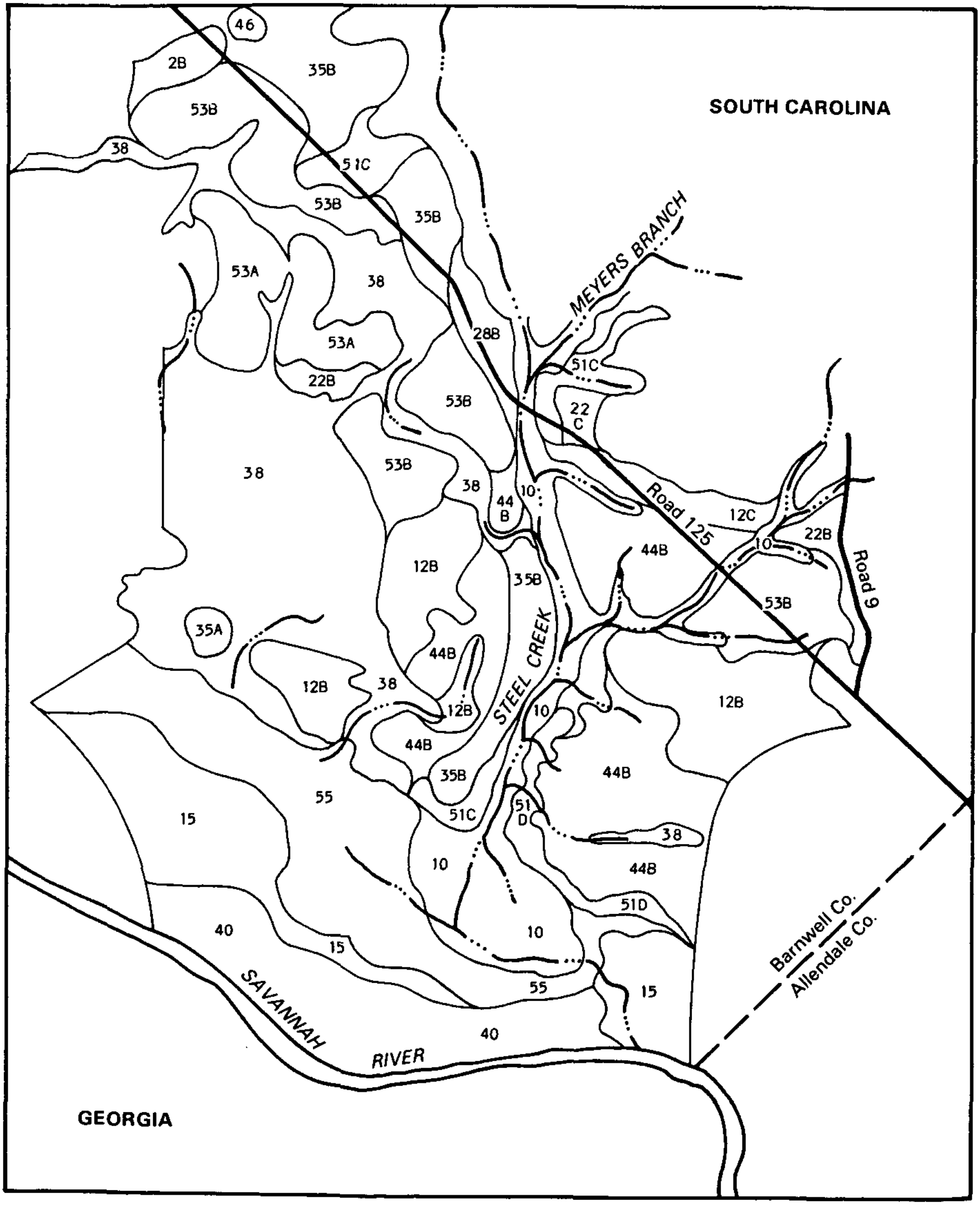
Figure C-1. Site location of L-Reactor and its immediate environment on the Savannah River Plant.



Source: USDA Soil Conservation Service 1983 - Unpublished advanced copy; soil names subject to change

0 500 1000 1500 2000 2500 meters

Figure C-2. General soils map of the Steel Creek watershed (Sheet 1 of 2).



Note: See Sheet 1 of 2 for legend.

Figure C-2. General soils map of the Steel Creek watershed (Sheet 2 of 2).

Table C-1. Occurrence, distribution, and selected characteristics of the soils of the Steel Creek watershed

Soil name	Map symbol	Texture (A horizon)	Drainage class	Hectares	Acres	Percent
Ailey	2	Loamy sand	Well drained	104	258	1.3
Arents and Udorthents	5	Sandy loam or sandy clay loam	Poorly drained	63	155	0.8
Bibb	10	Sandy loam	Poorly drained	560	1,383	6.9
Blanton	12	Sand	Well drained	1098	2,714	13.5
Chewacla	15	Sandy loam	Poorly drained	288	712	3.5
Dothan	18	Loamy sand	Well drained	4	11	0.1
Fuquay	22	Loamy sand	Well drained	604	1,492	7.4
Johnston	25	Mucky loam	Poorly drained	100	247	1.2
Lakeland	27	Sand	Well drained	79	195	1.0
Lucy	28	Loamy sand	Well drained	67	166	0.8
Norfolk	30	Loamy sand	Well drained	116	287	1.4
Ocilla	33	Sand	Poorly drained	4	11	0.1
Orangeburg	35	Loamy sand	Well drained	678	1,676	8.4
Rembert	38	Sandy loam	Poorly drained	681	1,682	8.4
Shellbluff	40	Silty loam	Well drained	253	626	3.1
Troup	44	Sand	Well drained	994	2,456	12.2
Udorthents and Arents	45	Loam	Poorly drained	74	184	0.9
Udorthents-Urban	46	Sandy clay loam	Well drained	221	545	2.7
Urban	47	Variable	Variable	7	17	0.1
Vaucluse	50	Loamy sand	Well drained	74	184	0.9
Vaucluse-Ailey complex	51	Loamy sand	Well drained	79	195	1.0
Wagram	53	Loamy sand	Well drained	1034	2,554	12.7
Wehadkee	55	Loam	Poorly drained	581	1,435	7.2
Troup-Lucy complex	60	Loamy sandy	Well drained	353	872	4.3
Total				8116	20,057	99.9

of Bibb sandy loam; these soils were scoured and eroded during previous reactor operations. The dominant texture of the surficial horizons is loamy sand and sandy loam. Slopes typically range less than 6 percent, and most soils are well drained.

C.2 VEGETATION

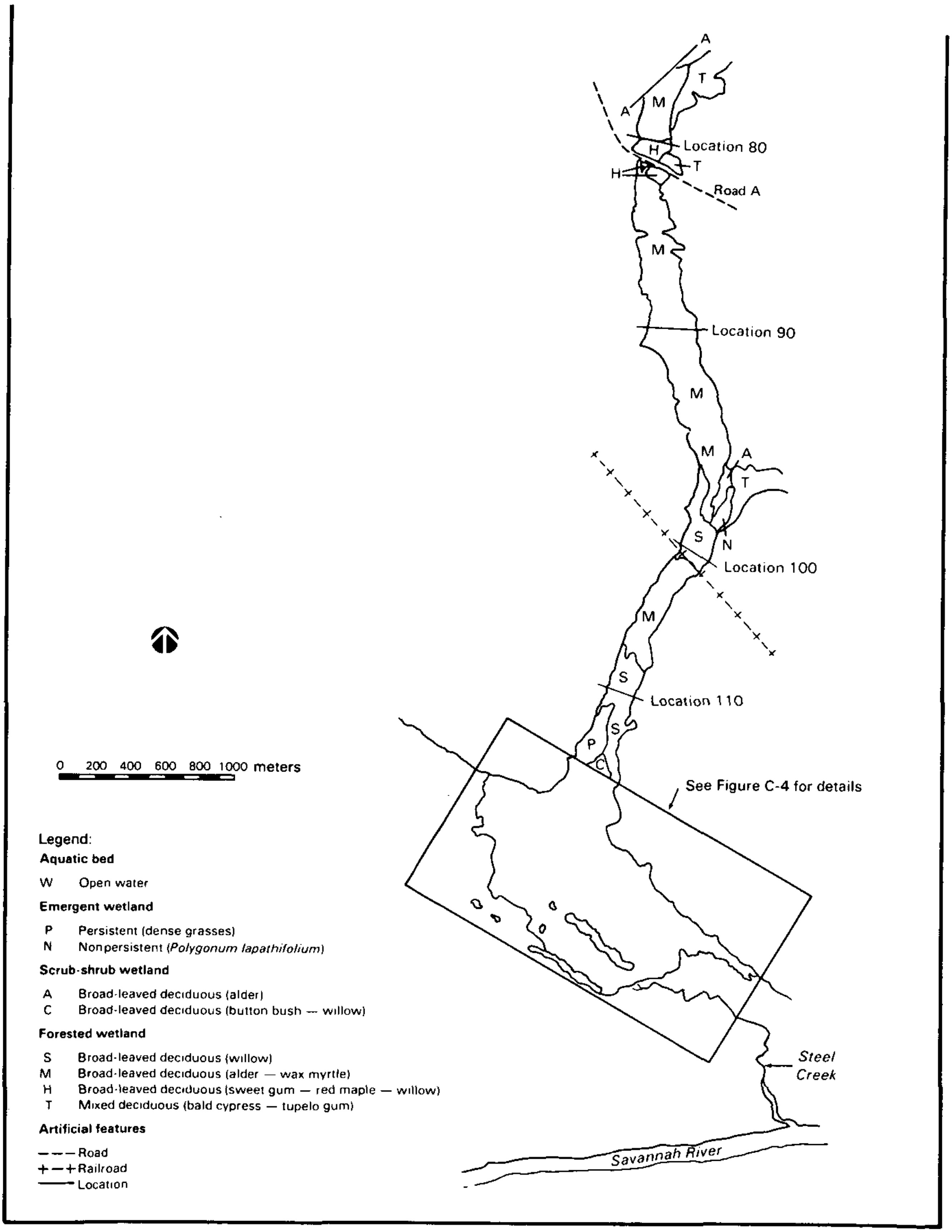
The phytogeography of Georgia and South Carolina includes two principal forest types. Associated with the Piedmont is the oak-hickory-pine forest whereas the southern mixed forest overlies the coastal plain (Kuchler, 1964). Dominant canopy species of the oak-hickory-pine forest include hickory, shortleaf and loblolly pine, white oak, and post oak. Beech, sweetgum, magnolia, slash and loblolly pine, white oak, and laurel oak characterize the canopy of the southern mixed forest. The southern floodplain forest, which adjoins major rivers such as the Savannah, typically consists of tupelo, numerous species of oak, and bald cypress.

The Savannah River Plant (SRP) is near the line that divides the oak-hickory-pine forest and the southern mixed forest. Consequently, species representative of each occur. In addition, SRP vegetation has been influenced strongly by farming, fire, edaphic features, and topography. There is no virgin forest in the region (Braun, 1950). Except for the nuclear production areas and their support facilities, many previously disturbed areas have been reclaimed by natural plant succession or have been planted with pine by the U.S. Forest Service.

The vegetation that will be most affected by the proposed action includes: (1) the plant communities of the Steel Creek corridor from the reactor outfall to the delta, and (2) the Steel Creek delta, which is contiguous with the Savannah River swamp (Figure C-3). The structure and species composition of these communities reflects not only the heterogeneity of the physical environment, but also the influence of previous reactor operations.

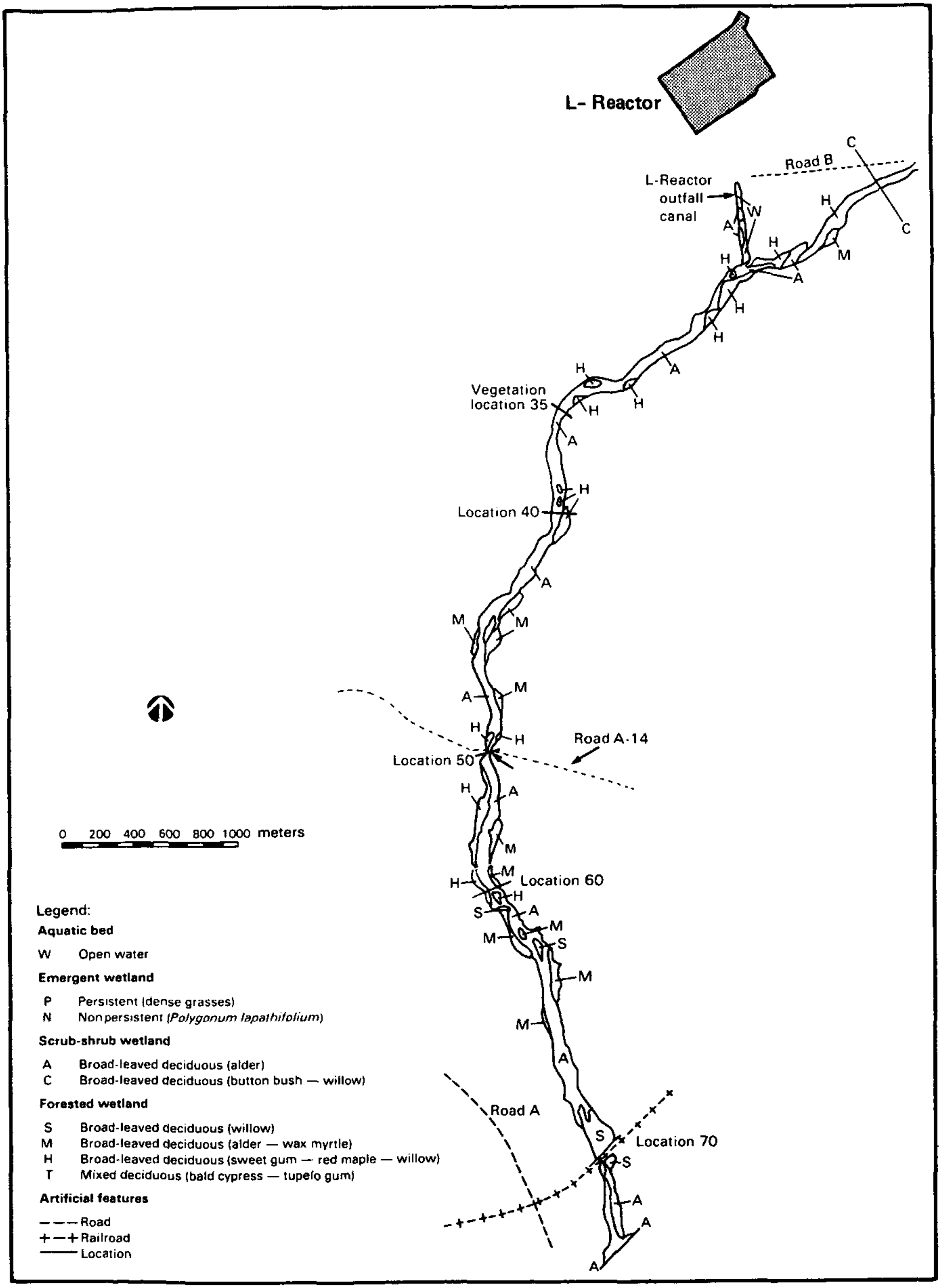
During earlier L-Reactor operations, the thermal effluent eliminated vegetation in the Steel Creek channel, floodplain, and swamp. A delta developed rapidly at the entrance of the creek to the swamp from the sediments transported down the creek. A tree-kill zone, covering about 300 acres, developed in the swamp.

These impacts were caused by the elevation of stream temperatures and marked increases in the stream flow. The discharge of thermal reactor effluents into Steel Creek before 1968 essentially eradicated the emergent and semiemergent flora, as well as portions of the swamp forest, leaving stumps and standing dead cypress and tupelo. Since 1968, when the reactor was shut down, the Steel Creek corridor and portions of the swamp have been overgrown by successional woody and herbaceous vegetation (Smith et al., 1981, 1982a).



Source: Smith et al. (1981).

Figure C-3. Steel Creek corridor vegetation map and sampling locations. (Sheet 1 of 2)



Source: Smith et al. (1981).

Figure C-3. Steel Creek corridor vegetation map and sampling locations. (Sheet 2 of 2)

C.2.1 Steel Creek corridor

The vegetation of the Steel Creek corridor, which is classified as palustrine wetland (Cowardin et al., 1979), varies markedly between P-Reactor and the delta. More than 85 species of plants representing 50 families were listed in this area in the summer of 1981 (Smith et al., 1981). Tables C-2 and C-3 list the structural attributes of the flora, including estimates of the species' basal area and biomass. Figure C-3 shows the distribution of the principal plant communities, including sampling locations. The following detailed list describes the characteristic vegetation in the various communities:

1. Aquatic bed

   W - Open Water. The outfall canal of L-Reactor contained open water bordered by persistent herbaceous species and occasional shrubs.

2. Emergent wetland

   P - Persistent. This community was dominated by dense grasses and forbs with scattered low shrubs.

   N - Nonpersistent. A single small area existed just north of location 100. It was dominated by *Polygonum* spp. with a border of persistent herbs including cattail, burreed (*Sparganium americanum*), Canada rush (*Juncus canadensis*), and sugarcane beardgrass (*Erianthus giganteus*).

3. Scrub-shrub wetland

   Broad-leaved deciduous

   C - *Cephalanthus occidentalis* - *Salix* spp. This community consisted of a dense shrub canopy dominated by buttonbush and willow near the mouth of Steel Creek.

   A - *Alnus serrulata*. Alder (*Alnus serrulata*) was the dominant species on Steel Creek, although wax myrtle (*Myrica cerifera*) and willow (*Salix* spp.) were locally abundant. Beneath these shrubs, blackberry (*Rubus* spp.) was abundant over a diverse herbaceous flora of *Hypericum* spp., false nettle, goldenrod (*Solidago canadensis*), wapato, jewelweed (*Impatiens capensis*), *Polygonum* spp., *Aneilema keisak*, cut-grass, knotgrass, and *Ludwigia virgata*. These herbs also covered open areas along stream channels within this vegetation type and were the dominant ground cover in some of the other woody mapping units described below.

   This community generally bordered the stream channels and, for most of the length of Steel Creek, extended nearly across the width of the floodplain. Narrow strips of young hardwood trees of other species bordering the upland were included in the boundary of this unit. The height of the shrubs was greater near the mouth of Steel Creek than near the L-Reactor outfall. The density varied from nearly impenetrable thickets between

Table C-2. Basal area of woody species sampled from the Steel Creek corridor[a] (In square meters per hectare)

Species	Sampling location[b]			
	10	35	50	100
Trees				
Acer rubrum	0.08			0.72
Amelanchier sp.				0.03
Baccharis halimifolia	0.52			0.20
Cornus florida				0.05
Liquidambar styraciflua	0.14	0.06		0.23
Liriodendron tulipifera				8.68
Myrica cerifera				0.59
Pinus taeda				0.25
Platanus occidentalis	0.31			
Salix spp.	1.93	0.70		
Total	2.98	0.76	0	10.75
Shrubs				
Acer rubrum	0.08		1.35	
Alnus serrulata	9.37	3.27	11.87	1.20
Campsis radicans				0.03
Liquidambar styraciflua				0.53
Myrica cerifera	2.79			
Platanus occidentalis	0.41			0.20
Quercus spp.	1.23			
Salix spp.		0.20	0.01	
Total	13.88	3.47	13.23	1.96
Grand Total	16.86	4.23	13.23	12.71

[a]Adapted from Smith et al. (1981).
[b]Sampling locations are shown in Figure C-3.

Table C-3. Occurrence and biomass of herbaceous flora sampled from the Steel Creek corridor[a] (In grams per square meter)

Species	Sampling location[b] 10	35	50	100	Average
Acer rubrum	0.52	0.52			0.26
Aneilema keisak				90.60	22.65
Boehmeria cylindrica	0.32	8.36	180.80		47.37
Campsis radicans	0.08				0.02
Cicuta maculata				19.20	4.80
Cuscuta spp.		7.56	2.12		2.42
Decumaria barbara	0.64				0.16
Galium obtusum		0.48			0.12
Galium tinctorum			0.24		0.06
Gelsemium sempervirens	2.68				0.67
Gnaphalium sp.	0.08				0.02
Hydrocotyle sp.			0.32		0.08
Hypericum mutilum		9.36	6.84		4.05
Hypericum walteri		0.08		12.92	3.25
Impatiens capensis		4.64	4.64	4.20	3.37
Juncus effusus		5.36	8.84		3.55
Leersia spp.	0.72			1.76	0.62
Lespedeza sp.		0.20	11.88		3.02
Lonicera japonica	0.48			1.16	0.41
Ludwigia virgata		8.88	3.36		3.06
Lycopus rubellus		10.72			2.68
Mikania scandens		2.36	3.48	4.20	2.51
Myrica cerifera				0.36	0.09
Onoclea sensibilis	2.64			18.68	5.33
Panicon spp.	0.24	1.26	5.36		1.72
Polygonum hydropiperoides		25.56			6.39
Polygonun sagittum		4.08	0.20		1.07
Rubus sp.		37.04	172.68	74.44	71.04
Salix spp.				1.20	0.30
Scirpus cyperinus			25.64		6.41
Scutellaria laterifolia			0.60		0.15
Solidago sp.		1.92	3.92		1.46
Miscellaneous	0.72	0.56	0.52		0.45
Total	9.12	128.94	431.44	228.72	199.56

[a]Adapted from Smith et al. (1981).
[b]Sampling locations are shown in Figure C-3.

locations 60 and 70 and locations 20 and 40 to sparser concentrations between locations 40 and 60.

4. Forested wetland

Broad-leaved deciduous

S - Salix spp. Willows exceeding 5 meters in height were dominant near the mouth of Steel Creek and in a few locations near bridges and power lines farther upstream. Occasional hardwood species (e.g., sweetgum, red maple) also occurred in the canopy. Beneath the willow was a shrub layer of alder, wax myrtle, and blackberry with sparse herbaceous cover, which included some of the plants of the alder-dominated shrubland.

M - Myrica cerifera - Alnus serrulata. Wax myrtle and alder (as high as 7 meters) were codominant, and grew in dense stands on most of the floodplain between transects 70 and 100. Willow was also abundant. This shrub canopy was broken by occasional hardwood trees (sycamore, sweet gum, red maple) on some of the more stable sandbars. Beneath the alder-wax myrtle canopy was dense blackberry and a sparse covering of the herbs listed in the alder-dominated scrub-shrub wetland description. These herbs were also dominant in old streambeds that lack abundant woody vegetation.

H - Liquidambar styraciflua - Acer rubrum - Salix spp. Species of trees that are typical of the upland areas adjacent to Steel Creek had also become established on some of the more stable sandbars, at stream obstructions such as bridges and dikes, and along the Steel Creek upland border, especially upstream from L-Reactor. The most frequent canopy species included tulip tree (Liriodendron tulipifera), sycamore, red maple, and sweetgum. Saplings of these trees, wax myrtle, alder, blackberry, and groundsel tree (Baccharis halimifolia) were abundant in the understory. Although nearly half of the substrate surface was covered by leaf litter, many herbs and vines occur. Chief among the herbs were sensitive fern, false nettle, Hypericum spp., sericea (Lespedeza cuneata), and goldenrod. The most frequent vines included peppervine (Ampelopsis arborea) and honeysuckle (Lonicera japonica).

Mixed deciduous

T - Taxodium distichum - Nyssa sylvatica var. biflora. This vegetation type was dominated by cypress (Taxodium distichum) intermixed with some water gum (Nyssa sylvatica var. biflora) on parts of the Steel Creek corridor. In the Savannah River swamp, cypress and water tupelo (N. aquatica) dominated the canopy.

North of location 30, Steel Creek is narrow, bordered by alder and confined between steep banks that rise nearly 5 meters above the floodplain. Sandbars covered by persistent emergent herbs and forested wetland dominated by sweetgum, red maple, and willow occurred where the stream meanders.

Between locations 30 and 70, the stream border was dominated by dense alder 3 to 5 meters tall with a patchy ground cover. More upland areas were dominated by alder intermixed with wax myrtle and willow. Open areas dominated by blackberry and herbaceous flora occurred in partially filled remnant stream channels. This vegetation was dense where total sunlight was available, but formed a sparse ground cover beneath shrubs. Hardwood saplings bordered the upland.

From locations 70 to 110, the elevation of the Steel Creek floodplains was approximately 0.6 meter lower than the upland hardwoods. A dense growth of the wax myrtle-alder-dominated scrub-shrub wetland extended from within 10 meters of the upland to approximately 3 meters from the active stream channel. Willow was locally dominant in some areas of this corridor segment. The channel was bordered by a zone of low persistent herbs dominated by wapato, cut-grass, and _Aneilema keisak_. Remnant-braided stream channels and open areas elevated slightly above the stream beds were dominated by species characteristic of the alder-dominated scrub-shrub wetland. These species also formed the ground cover beneath the shrub thickets.

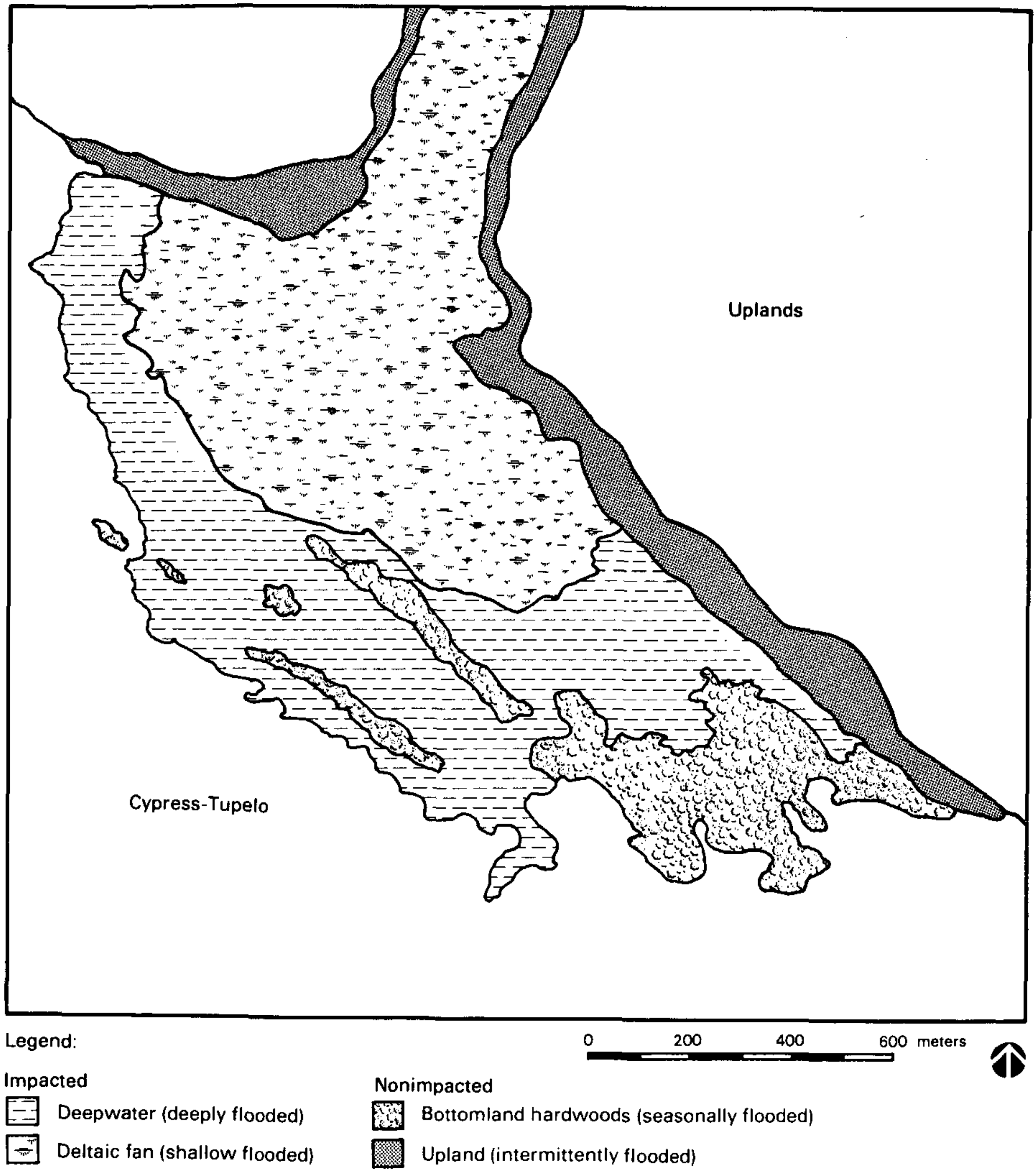
The vegetative composition of the lower segment of Steel Creek (from location 110 to the delta) was similar to that found in the delta. The persistent emergent wetland species described for the delta dominated the western portion of the creek. Willow and buttonbush increased in density toward the eastern bank.

C.2.2 Steel Creek delta

The Steel Creek delta, which is adjoined by the Savannah River swamp near the mouth of Steel Creek, contained several vegetative associations, four of which are differentiated by the degree of previous reactor impact and the hydrologic regime (Figure C-4). Impacted zones that have experienced structural reductions of the canopy include deepwater habitats and deltaic fan. Bottomland and upland hardwoods comprised the nonimpacted zones. Since the shutdown of L-Reactor in 1968, patterns of vegetative recovery have varied according to the hydrologic regime. The distribution of the principal plant communities was associated almost exclusively with these various zones.

The deltaic fan zone, which was formed by the deposition of sediments at the mouth of Steel Creek, consisted of a raised substrate composed primarily of organic and alluvial deposits over sand. It measured approximately 500 by 1200 meters, was stabilized by vegetation, and was traversed by many old streambeds less than 1 meter deep. The more successionally advanced vegetation stages that occurred here included (1) broad-leaved deciduous forest (_Salix_ spp.), (2) scrub-shrub wetland (_Cephalanthus occidentalis_ - _Salix_ spp.), and (3) persistent emergent wetland (_Leersia_ spp.).

The impacted deepwater zone extended as an arc on the periphery of the deltaic fan. Most of the trees in this zone were destroyed during reactor operation. The zone was characterized by scattered cypress, an abundance of stumps bearing shrubs, and submergent and nonpersistent aquatic herbs. The main channel of Steel Creek flowed through this zone after passing through the delta. The rooted vascular aquatic bed, nonpersistent emergent wetland, mixed forest/



Source: Smith et al. (1981).

Figure C-4. Vegetative zones of Steel Creek delta resulting from L-Reactor operation (1952-1968) and associated hydrologic regimes.

scrub-shrub wetland, and mixed scrub-shrub/rooted vascular wetland associations were well developed.

The nonimpacted deepwater zone contained mixed deciduous forest that was typical of the swamp before reactor operations began on the Savannah River Plant. The underlying substrate near the impacted zone was composed of fine particulate material less than 0.5 meter deep (Ruby et al., 1981).

The bottomland hardwood zone is generally flooded in the spring, but not during the growing season. Two types of broad-leaved deciduous forest were found exclusively in this zone: (1) areas dominated by laurel oak (Quercus laurifolia) are inundated only during the river flood stage; (2) those intermixed with overcup oak (Q. lyrata), water hickory (Carya aquatica), and water tupelo (Nyssa aquatica), might retain standing water until early in the growing season.

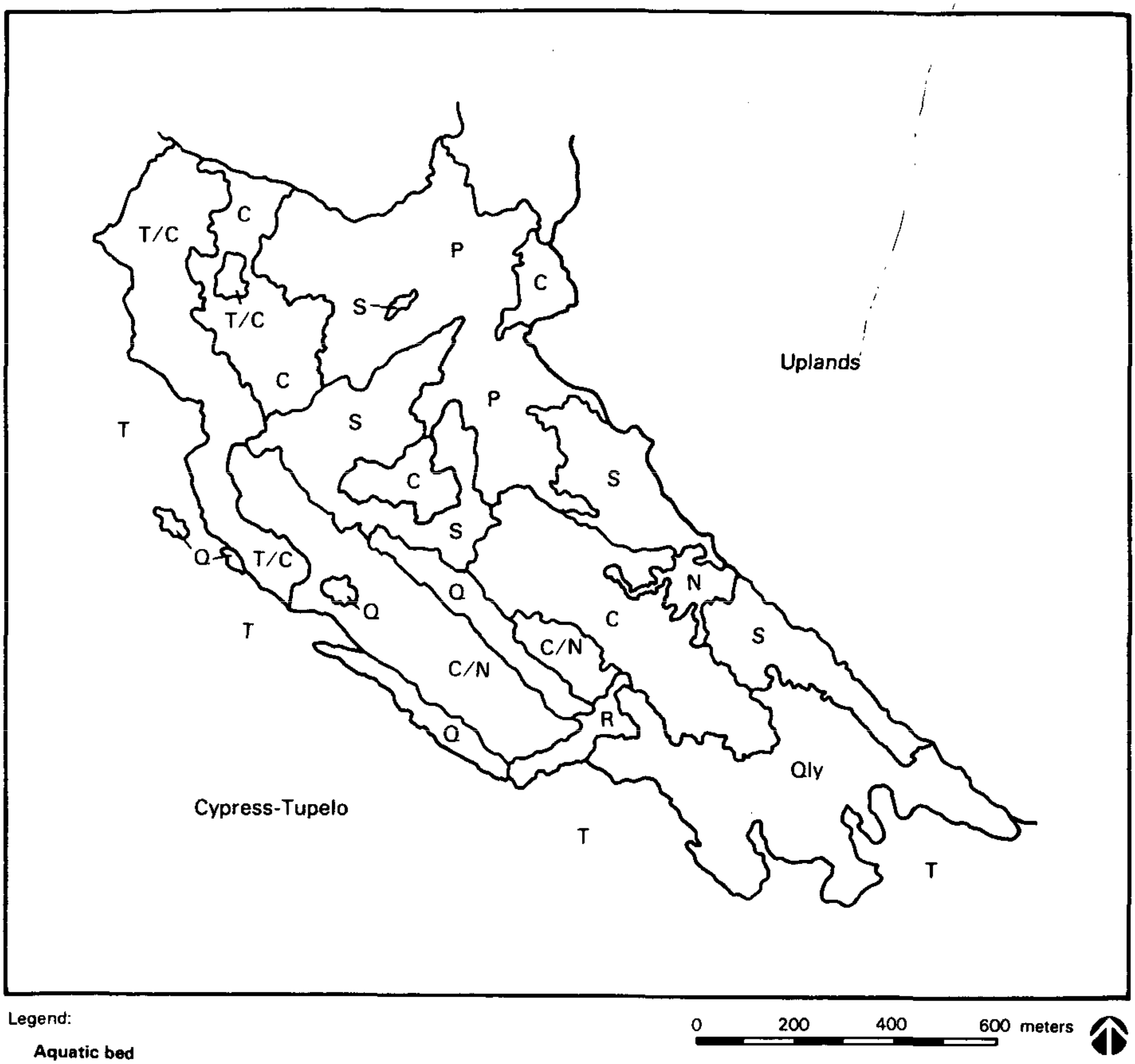
Figure C-5 shows the distribution of the principal plant communities of the Steel Creek delta, determined from 1978 aerial photography and field studies conducted during the summer of 1981; the classification and mapping terminology follow Cowardin et al. (1979), with minor modifications (Smith et al., 1981). All categories are termed palustrine, which includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens.

Approximately one-fourth of the delta area was covered by shrub communities that were dominated by buttonbush and willow (Table C-4). Five habitat types (P, S, Qly, C/N, and T/C) were similar in area of coverage, and three minor habitat types also occurred. Forested areas dominated by cypress and water tupelo bordered the delta; their coverage was not measured. More than 123 species of plants representing 66 families were listed during the 1981 field studies. Tables C-5 and C-6 list basal areas of trees and shrubs and biomass for herbaceous flora. The following list describes the plant associations of the Steel Creek delta:

1. Aquatic bed

Rooted vascular

R - Myriophyllum brasiliense. In the impacted deepwater zone where the main flow of Steel Creek courses northeasterly, the open water, which is approximately 2 meters deep, predominates beneath scattered live bald cypress trees that are remnants from the pre-SRP swamp. Scattered stumps of dead trees supported shrubs (e.g., buttonbush (Cephalanthus occidentalis), Virginia willow (Itea virginica)), young trees (e.g., water ash (Fraximus caroliniana), water elm (Planera aquatica)), and herbs (e.g., false nettle (Boehmeria cylindrica), marsh St.-Johnswort (Hypericum walteri)). Patches of duckweed (Lemna perpusilla) inhabit mats of submerged vascular plants such as hornwort (Ceratophyllum demersum) and parrotfeather (Myriophyllum brasiliense), which root on subsurface logs and on tree and stump bases. Where the water flow is slow, Polygonum spp. formed dense colonies.



Legend:

Aquatic bed

R Rooted vascular (parrot-feather)

Emergent wetland

P Persistent (cut grass)
N Nonpersistent (hydrolea)

Scrub-shrub wetland

C Broad-leaved deciduous (buttonbush — willow)
C/N Mixed scrub-shrub/nonpersistent emergent (buttonbush — polygonum)

Forested wetland

S Broad-leaved deciduous (willow)
Q Broad-leaved deciduous (laurel oak)
Qly Broad-leaved deciduous (overcup oak — water hickory — tupelo gum)
T Mixed deciduous (bald cypress — tupelo gum)
T/C Mixed forested/scrub-shrub (bald cypress — buttonbush)

Source: Smith et al. (1981).

Figure C-5. Vegetation map of Steel Creek delta based on 1978 aerial photographs and 1981 field studies.

Table C-4. Areal coverage and relative abundance of principal plant associations of Steel Creek delta[a]

Mapping unit	Symbol	Dominant flora	Area: Hectares	Area: Acres	Percent
Scrub-shrub wetland	C	*Cephalanthus* - *Salix* (buttonbush-willow)	29	72	23.1
Emergent wetland (persistent)	P	*Leersia* (cut-grass)	22	55	17.7
Broad-leaved deciduous	S	*Salix* spp.	21	51	16.6
Broad-leaved deciduous forest	Qly	*Quercus lyrata* - *Carya* - *Nyssa* (overcup oak - water hickory - water tupelo)	17	42	13.5
Mixed scrub-shrub	C/N	*Cephalanthus*/*Polygonum* (buttonbush/Polygonum)	16	39	12.4
Mixed forested/scrub-shrub	T/C	*Taxodium*/*Cephalanthus* (bald cypress/buttonbush)	13	31	10.1
Broad-leaved deciduous forest	Q	*Quercus laurifolia* (laurel oak)	5	13	4.3
Emergent wetland	N	*Hydrolea* (hydrolea)	2	4	1.4
Rooted vascular	R	*Myriophyllum* (parrot-feather)	1	3	1.0
Total			126	310	100.1

[a]Adapted from Smith et al. (1981).

Table C-5. Basal area of trees and shrubs of Steel Creek delta[a]
(In square meters per acre)

Species	Mapping unit[b]							
	P	C/N	C	S	T/C	T	Qly	Q
Trees								
Carya aquatica								3.20
Celtis leavigata							0.36	1.54
Cephalanthus occidentalis			0.04		0.25			0.06
Crataegus spp.							0.02	
Forestiera accuminata							0.06	
Fraxinus americana				0.10			1.42	
Fraxinus caroliniana		0.17			0.93	0.51		1.42
Ilex opaca								0.01
Liquidambar styraciflua		0.02					0.56	
Nyssa aquatica					0.69	11.37	4.09	
Planera aquatica		0.10			0.06	.27	0.51	0.03
Platanus occidentalis							1.36	
Quercus laurifolia		0.06			0.09			0.17
Quercus lyrata								2.41
Quercus nigra								4.66
Salix spp.	0.01		0.50	3.35				
Taxodium distichum		1.17			7.65	12.97	5.03	
Ulmus spp.						0.05		0.01
Total	0.01	1.52	0.54	3.45	9.67	25.17	13.41	13.51

Table C-5. Basal area of trees and shrubs of Steel Creek delta[a] (continued)
(In square meters per acre)

Species	Mapping unit[b] P	C/N	C	S	T/C	T	Qly	Q
Shrubs								
Amelopsis arborea			0.03					
Cephalanthus occidentalis			0.15		0.07			
Fraxinus caroliniana					0.09			
Ilex decidua								0.02
Salix spp.			0.23					
Total	0.0	0.0	0.41	0.0	0.16	0.0	0.0	0.02
Total basal area	0.01	1.52	0.95	3.45	9.83	25.17	13.41	13.53
Number of quadrants	3	3	8	3	5	3	3	3

[a]Adapted from Smith et al. (1981).

[b]Symbols of the palustrine system--aquatic bed: P = persistent (*Myriophyllum brasiliense*); scrub-shrub wetland: C/N = mixed scrub-shrub/nonpersistent emergent (*Cephalanthus occidentalis*/*Polygonum* spp.); C = broad-leaved deciduous (*Cephalanthus occidentalis* - *Salix nigra*) nonpersistent; forested wetland: S = broad-leaved deciduous (*Salix* spp.), T/C = mixed forested/scrub-shrub (*Taxodium distichum*/*Cephalanthus occidentalis*), T = mixed deciduous (*Taxodium distichum*-*Nyssa aquatica*), Qly = broad-leaved deciduous (*Quercus lyrata* - *Carya aquatica* - *Nyssa aquatica*), Q = broad-leaved deciduous (*Quercus laurifolia*).

Table C-6. Occurrence and biomass of herbaceous species in the Steel Creek delta, summer 1981[a]
(In grams per square meter)

Species	Mapping unit[b]										
	R	N	P	C/N	C	S	T/C	T	Qly	Q	Mean
Ampelopsis arborea					3.82	0.14			0.04	0.28	0.84
Aneilema keisak		16.96	30.56	11.16	42.20	65.36					19.14
Apios americana						7.40					0.33
Aster sp.		0.76				8.32					0.58
Berchemia scandens									2.52		0.25
Bidens frondosa						1.44	8.00				0.89
Boehmeria cylindrica			20.76		4.08	26.96	0.04	12.60	3.60		5.04
Campsis radicans									0.08		0.01
Cephalanthus occidentalis					0.04						0.01
Ceratophyllum demersum				11.28							1.13
Cicuta maculata		1.00			0.24		1.04				0.24
Cyperus haspan			3.18								0.32
Echinodorus cordifolius				6.72		0.92					0.73
Galium tinctorium			0.07	0.24	0.16	0.08					0.06
Gelsemium sempervirens									0.08		0.04
Hydrocotyle sp.					0.09						0.03
Hydrolea quadrivalvis		60.68	3.59	29.88	7.51	2.28	0.32				9.58
Hypericum mutilum			38.11		0.48	0.04					0.08
Hypericum walteri		2.56	22.28	19.36	18.96	7.12	6.20				8.56
Ilex opaca									0.08		0.01
Itea virginica									0.36		0.04
Leersia spp.		9.96	374.43	62.88	52.92	0.09	13.56				60.52
Ludwigia palustris		56.92	0.27	26.72	13.20	0.01					13.57
Lycopus rubellus						0.97					0.06
Lycopus virginicus					1.52		0.80				0.23
Mikania scandens				0.60	1.17	3.68		3.20			0.75
Myriophyllum brasilense		31.68		38.80		4.28					7.48
Onoclea sensibilis					0.02	27.12			2.44		2.14

Table C-6. Occurrence and biomass of herbaceous species in the Steel Creek delta, summer 1981[a] (continued)
(In grams per square meter)

Species	Mapping unit[b] R	N	P	C/N	C	S	T/C	T	Qly	Q	Mean
Panicum agrostoides					55.36	50.23					10.39
Polygonum hydropiperoides	356.08	271.72	52.02	105.56	29.24	9.68	34.60				86.21
Polygonum spp.				171.16	29.60						21.05
Rhynchospora corniculata				5.32	15.76	91.60					7.85
Rubus sp.										0.56	0.06
Sagittaria latifolia		144.84	50.97	37.92	42.30	16.80					28.65
Salix spp.						0.22					0.01
Scirpus cyperinus			176.76								
Saururus cernus						4.16			0.08		
Scutellaria laterifolia						1.08					0.06
Smilax bona-nox										3.68	0.37
Smilax walteri									0.32	16.48	1.68
Miscellaneous		0.88	4.99	0.12	1.24	5.33		8.28	0.08	0.16	1.96
Total	356.08	597.96	777.99	527.72	388.82	335.31	64.56	24.08	9.68	21.44	318.25

[a]Adapted from Smith et al. (1981, 1982a). (See Figure C-4)

[b]The following are symbols of the palustrine system. Aquatic bed: R-rooted vascular (*Myriophyllum brasiliense*); emergent wetland: N = nonpersistent (*Hydrolea quadrivalus*), P = persistent (*Leersia* spp.); scrub-shrub wetland: C/N = mixed scrub-shrub/nonpersistent emergent (*Cephalanthus occidentalis*/*Polygonum* spp.); C = broad-leaved deciduous (*Cephalanthus occidentalis* - *Salix* spp.); forested wetland: S = broad-leaved deciduous (*Salix nigra*), T/C = mixed forested/scrub-shrub (*Taxodium distichum*/*Cephalanthus occidentalis*), T = mixed deciduous (*Taxodium distichum* - *Nyssa aquatica*), Qly = broad-leaved deciduous (*Quercus lyrata* - *Carya aquatica* - *Nyssa aquatica*), Q = broad-leaved deciduous (*Quercus laurifolia*).

2. Emergent wetland

Persistent

P - Leersia spp. Persistent emergent monocots dominated a large area (17.7 percent of the delta) of the deltaic fan. Except during extreme drought, the water level during the growing season was 10 to 50 centimeters deep (excluding old stream channels that are as deep as 1 meter).

Although the dominant herbaceous species varied with water depth and location on the deltaic fan, scattered shrubs (buttonbush and willow) were usually present. Cut-grass (Leersia spp.) was dominant, with redtop panicgrass (Panicum agrostoides) forming an abundant ground cover except under dense woody vegetation and in the deeper stream channels.

These grasses were usually overtopped by knotgrass (Scirpus cyperinus), that was approximately 2.5 meters tall. There were also several nearly monotypic stands of cattail (Typha latifolia). The many old stream channels that crossed the deltaic fan were dominated by the herbaceous species characteristic of the nonpersistent emergent wetland.

Nonpersistent

N - Hydrolea quadrivalvis. In this classification, emergent vascular plants that die back to the ground and leave a winter aspect of open water are considered to be nonpersistent. This characteristic was verified by a comparison of multispectral scanner images taken in March with autumn photographs; the comparison showed open-water areas with small patches of dead vegetation in the early spring and herbaceous dominance in the fall. Patches of open water as deep as 1 meter with slight, if any, flow were common here. The substrate was a deep, fine particulate mud. With the exception of the old stream channels, this vegetation type occurred only in the impacted deepwater zone.

This community contained relatively monospecific, as well as mixed, colonies of hydrolea (Hydrolea quadrivalvis), Aneilema keisak, waterpepper (Polygonum hydropiperoides), water purslane (Ludwigia palustris), and wapato (Sagittaria latifolia). These characteristic, nonpersistent species were also common in old stream beds throughout the deltaic fan in the persistent emergent and scrub-shrub wetland types.

The many standing dead trees and stumps bear such characteristic stump community vegetation as buttonbush, water ash, water elm, false nettle, and marsh St.-Johnswort.

3. Scrub-shrub wetland

Broad-leaved deciduous

C - *Cephalanthus occidentalis* - *Salix spp.* Most of the deltaic fan was dominated by shrub and low trees. This community was heterogeneous and exhibited considerable variation in water regimes across the entire delta. It occurred in both of the impacted deltaic deepwater zones.

In the deltaic fan, where the water was less than 50 centimeters deep, buttonbush or willow dominated the uppermost layer. Buttonbush dominated the canopy in some areas and formed the understory at sites dominated by willow. Knotgrass joined the woody species in the upper stratum whereas cut-grass covered most of the ground. Redtop panicgrass, beggarticks (*Bidens frondosa*), false nettle, and marsh St.-Johnswort were common in many places. Climbing hemp (*Mikania scandens*) and peppervine (*Ampelopsis arborea*) were frequently found vines in the shrubland. The scrub-shrub wetland also had open areas of persistent emergent wetland and old stream channels dominated by herbs.

The scrub-shrub wetland intergraded with the persistent emergent wetland where the shrubs were sparse, and with the broad-leaved deciduous forest vegetation where willows were more than 5 meters tall and dominant.

The scrub-shrub wetland areas located in the impacted deepwater zone differed from those in the deltaic fan zone in water regime, substrate, and ground cover. The summer water depth was approximately 0.5 to 1 meter and overlayed a substrate of decomposing vegetation and fine inorganic sediment that was about 0.5 meter deep. Buttonbush was dominant above the ground-cover species described for the nonpersistent emergent wetland.

4. Mixed scrub-shrub/nonpersistent emergent wetland

C/N - *Cephalanthus occidentalis* - *Polygonum* spp. In the impacted deepwater zone, shrubs and young trees (buttonbush, Virginia willow, water elm, water ash) were restricted to the many stumps remaining from the original forest. Scattered live bald cypress (up to 20 meters tall) were present. The stump bases had the characteristic stump-community herbs (false nettle and marsh St.-Johnswort) and several vines including poison ivy (*Rhus radicans*), peppervine, and wisteria (*Wisteria frutescens*).

Water depths here ranged from 0.5 to 2.0 meters during the typical growing season. Some of the main flow of Steel Creek coursed swiftly through this area. Lateral to this flow, the water moved sluggishly, allowing the establishment of rooted vascular plants. More than 50 percent of the surface was dominated by *Polygonum* spp., erect, deeply rooted, emergent annuals that die back in the winter. Nonpersistent emergent wetland species (e.g., waterpepper and *Aneilema keisak*) were common; submerged aquatics, such as hornwort and parrotfeather, were abundant. In places, this herbaceous cover at the edges of the stump communities extended as a dense mat beneath the scrub-shrub canopy.

5. Forested wetland

Broad-leaved deciduous

S - Salix spp. Willow that is up to 5 meters tall with an understory of buttonbush dominated the more elevated portions of the deltaic fan. The ground was dry or flooded by less than 15 centimeters of water. The herbaceous vegetation was relatively sparse due to the dense canopy. Small patches of herbs included redtop panicgrass, waterpepper, false nettle, marsh St.-Johnswort, and sensitive fern (Onoclea sensibilis). The vines--climbing hemp and peppervine--were also common. Some small areas contained species that are typical of the persistent emergent wetland on the most shallow sites and of the nonpersistent emergent wetland in the old stream channels. Although drier and of a different species composition than the pre-SRP swamp, this was the most successionally advanced vegetation type on the deltaic fan.

Qly - Quercus lyrata - Carya aquatica - Nyssa aquatica. Adjacent to and slightly higher in substrate elevation than the cypress-tupelo swamp was an area of broad-leaved deciduous trees. Although dry during most of the growing season, this area was subject to seasonal flooding of longer duration than areas on the deltaic fan. Several of the more common species in this vegetation type leaf out late in the season and can withstand flooding that lasts as late as July (Whitlow and Harris, 1979). Water marks on the trees indicated that the water was approximately 1.5 meters above the substrate at flood stage. The substrate consisted of a thin (approximately 2 centimeters) humus layer over an apparent clay-loam soil.

No single species clearly dominated this community. Some of the more consistently common species of the canopy and understory were water hickory, sycamore (Platanus occidentalis), red maple (Acer rubrum), white ash (Fraxinus americana), sweetgum (Liquidambar styraciflua), and bald cypress. Although apparently not being replaced, overcup oak and water tupelo were abundant canopy components.

The shrub layer included a sparse growth of possum haw (Ilex decidua), swamp privet (Forestiera acuminata), and hawthorn (Crataegus sp.). Rattan vine (Berchemia scandens) and bristly greenbrier (Smilax hispida) were the most common vines.

The duration and magnitude of seasonal flooding prevents persistent herbaceous ground cover. This vegetative layer was sparse except for occasional dense patches in low areas. Herbs found in widely scattered spots included dayflower (Commelina virginica), false nettle, and ladies tresses (Spiranthes sp.).

Q - *Quercus laurifolia*. This community occurred only on islands in the swamp that were slightly higher in elevation than the surrounding swamp and, therefore, were inundated for shorter periods. The canopy (more than 20 meters high) contained laurel oak, overcup oak, swamp chestnut oak (*Q. michauxii*), red maple, and water hickory. In addition, the subcanopy contained sweetgum, American elm (*Ulmus americana*), hackberry (*Celtis laevigata*), and ironwood (*Carpinus caroliniana*). Shrubs, including palmetto (*Sabal minor*), possum haw, and hawthorn, were widely scattered. Dense vines such as rattan vine, coral greenbrier (*Smilax walteri*), catbrier (*Smilax rotundifolia*), muscadine (*Vitis rotundifolia*), summer grape (*Vitis aestivalis*), peppervine, and poison ivy occurred in some areas. The ground was covered by leaf litter with widely scattered herbaceous plants including marsh fleabane (*Pluchea rosea*) and several grasses and sedges.

Mixed deciduous

T - *Taxodium distichum* - *Nyssa aquatica*. The cypress-tupelo swamp typical of pre-SRP conditions extended beyond the impacted deepwater zone to the Savannah River. Water as deep as 2 meters flowed slowly over a shallow substrate (less than 0.5 meter deep) composed of organic and fine particulate material. During the growing season, flooding is controlled by the regulation of reservoir levels upstream on the Savannah River and by the flow from Four Mile Creek and Pen Branch.

The canopy, which has more than 80-percent closure, was dominated by 20- to 30-meter-tall water tupelo and bald cypress; both can occur either as fairly monospecific stands or as mixtures of the two. Tree bases provided the primary substrate for a sparse growth of shrubs and herbs, as described above for the stump communities of the scrub-shrub/nonpersistent emergent wetland. Occasional patches of submergent and emergent plants, as described in the description of the rooted vascular aquatic bed, were found in association with submerged tree bases or debris.

T/C - Mixed forested/scrub-shrub wetland

Taxodium distichum - *Cephalanthus occidentalis*. This mapping unit occupied part of the impacted deepwater zone to the west of the deltaic fan. A patchy canopy of bald cypress (more than 20 meters tall) covered about 50 percent of the zone. The understory was a mixture of buttonbush, water ash, and water elm. Cut-grass dominated the ground cover; marsh St.-Johnswort and beggarticks were abundant. Where the cypress canopy was sparse, open areas were dominated by species of the nonpersistent emergent wetland intermixed with many stumps bearing woody growth.

The water depth varied from 50 to 80 centimeters (except in channels) over a deep (more than 50 centimeters) substrate of organic and fine inorganic sediment.

Smith et al. (1982b) presents a revised vegetative map of the Steel Creek delta based on more recent (1981) aerial photography. The principal difference between this map and Figure C-5 is that buttonbush and willow shrub communities have expanded into areas previously occupied by emergent grasses and other herbaceous species. Additionally, community classification was modified slightly due to a different ordination analysis. These changes are subtle and are not duplicated herein.

C.3 WILDLIFE

The abundance and diversity of wildlife that inhabits the Savannah River Plant reflect the interspersion and heterogeneity of the habitats occurring there. Emphasis was given to "important" species as defined previously, especially those fauna that inhabit Steel Creek and the Savannah River swamp, which are potentially affected by the direct discharge (reference case) and the preferred cooling-water alternative (see Appendix L).

C.3.1 Amphibians and reptiles

Because of its temperate climate and numerous aquatic habitats, the SRP site contains a diversified and abundant herpetofauna. Species having zoogeographic ranges that include the Savannah River Plant include 17 salamanders, 26 frogs and toads, 10 turtles, 1 crocodilian, 9 lizards, and 31 snakes (Conant, 1975). Many additional species have ranges that are peripheral to the site, and could also occur here. Gibbons and Patterson (1978) provide an overview of the herpetofauna of the entire Savannah River Plant, including comments on relative abundance and peripheral species accounts.

Based on field studies in 1981 and 1982, more than 1560 individuals representing 65 species were collected or observed in the Steel Creek area (Smith et al., 1981, 1982b). Ranked in order of decreasing relative abundance, frogs and toads, turtles, and salamanders comprised more than 85 percent of the species enumerated. Five habitat types were examined during the surveys: (1) the stream channel below and above the delta, (2) the delta, (3) islands, (4) floodplain, and (5) the swamp forest. Of these habitats, twice as many species were collected on the floodplain than in the other habitats; this was due in part to a greater diversity of terrestrial and aquatic microhabitats present there, and also because the floodplain is the characteristic habitat type of Steel Creek.

The most frequently captured terrestrial salamander was the slimy salamander (*Plethodon glutinosus*). Additionally, three species of *Ambystoma* were found at Steel Creek, of which the marbled salamander (*A. opacum*) was the most frequently captured species. The mole salamander (*A. talpoideum*) and the spotted salamander (*A. maculatum*) were uncommon. The tiger salamander (*A. tigrinum*), which is a winter breeder, is expected to inhabit Steel Creek but none were collected. Three species, the two-toed amphiuma (*Amphiuma means*), the greater siren (*Siren lacertina*), and the lesser siren (*Siren intermedia*) were the only species to be collected that are entirely aquatic throughout their life cycle.

Of the 26 species of frogs and toads that could inhabit Steel Creek, 14 were confirmed during the 1981 and 1982 surveys. Additional species will undoubtedly be obtained from future surveys planned for the breeding season. Based on their frequency of capture, the southern toad (Bufo terrestris) was the most abundant of the terrestrial species and the southern leopard frog (Rana utricularia) ranked first in relative abundance for the aquatic species.

More than half of the species of snakes documented on the Savannah River Plant also inhabit Steel Creek (Gibbons and Patterson, 1978). Based on relative abundance values, the poisonous eastern cottonmouth (Agkistrodon piscivorus) was the most common species. Watersnakes (genus Nerodia) were also abundant in aquatic habitats. Other venomous reptiles observed near Steel Creek were the canebrake rattlesnake (Crotalus horridus) and the southern copperhead (Agkistrodon contortrix).

Nine species of lizard were collected at Steel Creek. The six-lined racerunner (Cnemidophorus sexlineatus), broad-headed skink (Eumeces laticeps), five-lined skink (Eumeces fasciatus), and anole (Anolis carolinensis) ranked as the most abundant species. The glass lizards (Ophisaurus attenuatus and O. ventralis) were encountered less frequently, due perhaps to habitat restrictions.

Of the nine species of turtles documented on the Savannah River Plant, all but the spiny softshell (Trionyx spiniferus) were collected in the Steel Creek area. Turtles were found in all aquatic areas, but most abundantly in the delta and floodplain. Turtles inhabiting the swamp forest were either the more terrestrial species (e.g., box turtles) or were nesting females of aquatic species. Pseudemys scripta, a turtle ubiquitous in southeastern aquatic areas, was the most common; more than 200 individuals were captured, marked, and released during the summer. Several river cooters (P. concinna) were captured in the delta and in the stream channel between the delta and the Savannah River. This riparian species has never been reported from lentic habitats on the Savannah River Plant and is not expected to be common in the delta or in upstream areas. The relative abundance of eastern mud turtles (Kinosternon subrubrum) and musk turtles (Sternotherus odoratus), when compared with other species, was similar to that observed in other aquatic areas on the site. The striped mud turtle (Kinosternon bauri) has been collected in the Steel Creek system. Populations of these species probably occur throughout the Steel Creek ecosystem.

Alligator

The American alligator, an inhabitant of wetland ecosystems in the Southeast, was threatened with extinction in the 1950s and 1960s. It is listed as endangered by the Federal Government (USDOI, 1983), and threatened by the State of South Carolina. The SRP is near the northern limit of the alligator's range; in this region, winter temperatures probably restrict its distribution.

Earlier studies of the fauna of the SRP site (Freeman, 1955; Jenkins and Provost, 1964) indicate that the alligator has always been a resident of the area. Its abundance probably increased following closure of the area to the public. This isolation afforded protection from hunting for several years before such protection was provided legally.

Murphy (1981) reported sightings of alligators in the Savannah River swamp and in the major SRP streams. Alligator breeding habitat with documented nests exists along the backwater lakes and in the swamp associated with Beaver Dam Creek, which enters the swamp several kilometers upstream from Steel Creek.

Although much of Steel Creek and the Savannah River swamp do not contain vast areas of optimum alligator habitat, patches of quality habitat are present. There are beaver ponds and Carolina bays near the river swamp or creek floodplain margins, open-water oxbow lakes, and open-canopied, marshy areas typical of productive alligator habitat described by Joanen (1969), Joanen and McNease (1970), and Smith et al. (1981, 1982a).

Studies of the American alligator in the Steel Creek ecosystem were begun in 1981 and have included censuses by foot, boat, and air, capture and release, and radiotelemetry (Smith et al., 1981, 1982a,b). These investigations have confirmed that alligators utilize the Steel Creek ecosystem from the L-Reactor outfall to the Steel Creek delta and swamps, including other areas near Steel Creek such as Carolina bays, backwater lagoons, and beaver ponds. The population of alligators in the Steel Creek ecosystem was estimated to range between 23 and 35 individuals (Smith et al., 1982b). Sex ratios and size data suggest a higher reproductive potential in Steel Creek than is known for Par Pond, where nearly 80 percent of the adults are males (Murphy, 1977).

Studies of the wintering behavior and movements of alligators in the Steel Creek ecosystem were initiated in 1981 (Smith et al., 1982a). Generally, it was found that alligators on the SRP site do not utilize over-wintering dens, but remain active whenever winter temperatures are suitable. Alligators were able to survive with a body temperature as low as 3.3°C, the coldest ever recorded for a free-ranging alligator. Based on studies using three individuals, alligators move between the lagoons near S.C. Highway 125, and utilize the swamp forest below the Steel Creek delta (Smith et al., 1982b). A single alligator nest was located at the edge of the Steel Creek delta, but hatching was unsuccessful. No additional nests have been subsequently found.

AB-4 These studies were based on the direct discharge alternative. After DOE selected the 1000-acre lake as the preferred cooling water alternative, new studies were conducted and a new biological assessment was transmitted to FWS (Sires, 1984a). Temperatures in 50% of the lake and in Steel Creek below the embankment would be less than 32.2°C, and the critical thermal maximum temperature for alligators is 38°C. DOE is awaiting a decision on its conclusion that operation of L-Reactor under the preferred alternative would not jeopardize the continued existence of the species.

C.3.2 Avifauna

The avifauna of the Steel Creek ecosystem are among the most mobile of the vertebrates. Some species, termed resident, inhabit SRP environs year round. Others, termed migrants, use the area enroute to their breeding and wintering grounds. Several species either winter or breed in the area. Habitat affinities of birds range from cavity-nesters such as wood ducks to red-winged blackbirds, which typically nest among emergent cattails. These species-specific attributes, the isolation of the SRP site from the public, and its proximity to the Atlantic Flyway, all contribute to an abundant and diversified avifauna.

The SRP avifauna have been studied by several investigators. Norris (1963) surveyed the Savannah River Plant but presented little information about Steel Creek. Fendley (1978) initiated a study of the wood duck in the Steel Creek drainage system in 1973 that continues to date. Angerman (1979, 1980) listed 59 species on the Savannah River Plant during Christmas bird counts, but did not include specific observations along Steel Creek.

Birds of the Steel Creek ecosystem were investigated in summer 1981 at eight locations using a combination of strip censuses, mist nets, and aerial surveys. A total of 1062 birds representing 59 species was tabulated during the survey (Smith et al., 1981). These data reflect only summer populations, and winter surveys would undoubtedly augment this listing. Avifauna that potentially winter on the Savannah River Plant are listed by Smith et al. (1981).

The avifauna listed along Steel Creek in the summer of 1981 also probably breed there. Active nests of the Bachman's sparrow, parula warbler, and red-headed woodpecker were observed, as were juveniles of 22 other species. The white-eyed vireo was the most abundant species based on all census techniques, followed closely by the Carolina wren. The frequency of observation or capture of the other species was relatively similar, and no single species dominated the census results.

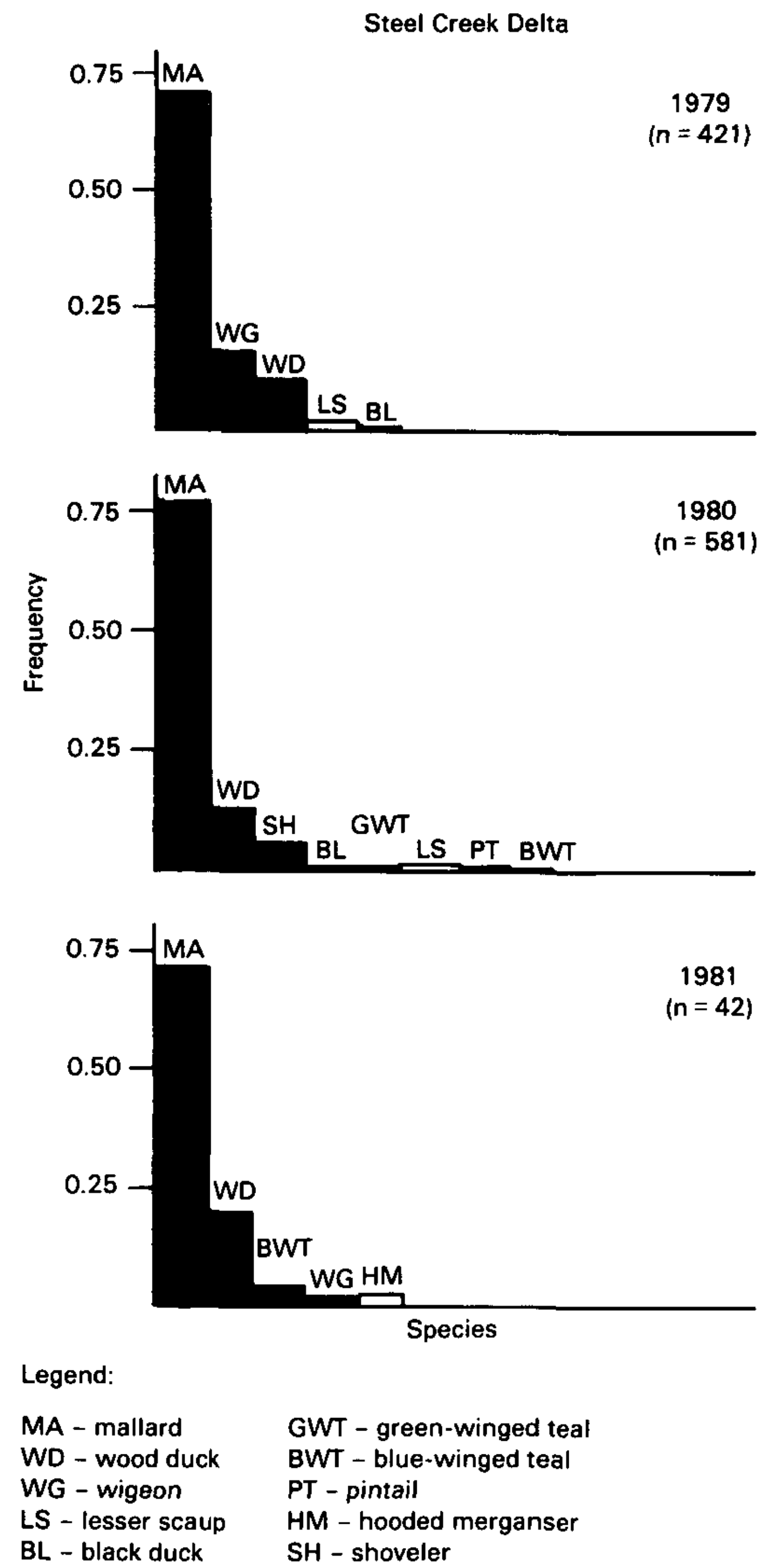
Waterfowl

Waterfowl are among the most important members of the Steel Creek avifauna. Because of the interspersion of habitats and isolation from the public, the Steel Creek delta and Savannah River swamp provide an important regional sanctuary and refuge for waterfowl.

Based on ground counts and aerial surveys, nine species of waterfowl have been observed in the Steel Creek delta area. The wood duck is the only species of waterfowl to breed commonly in the SRP region, and is present throughout the year. Wintering populations are larger than summer populations because of the influx of migratory wood ducks from the north. Wood ducks banded in the fall on the SRP site have been recovered in Minnesota, Wisconsin, and Ontario, as well as in South Carolina. In general, the remaining species are present only during the fall and/or winter months, although hooded mergansers may occasionally breed on the SRP site. In previous years, shovelers (*Athya clypeata*) and lesser scaup (*A. affinis*) have also been observed in the Steel Creek delta area (Angerman, 1979, 1980).

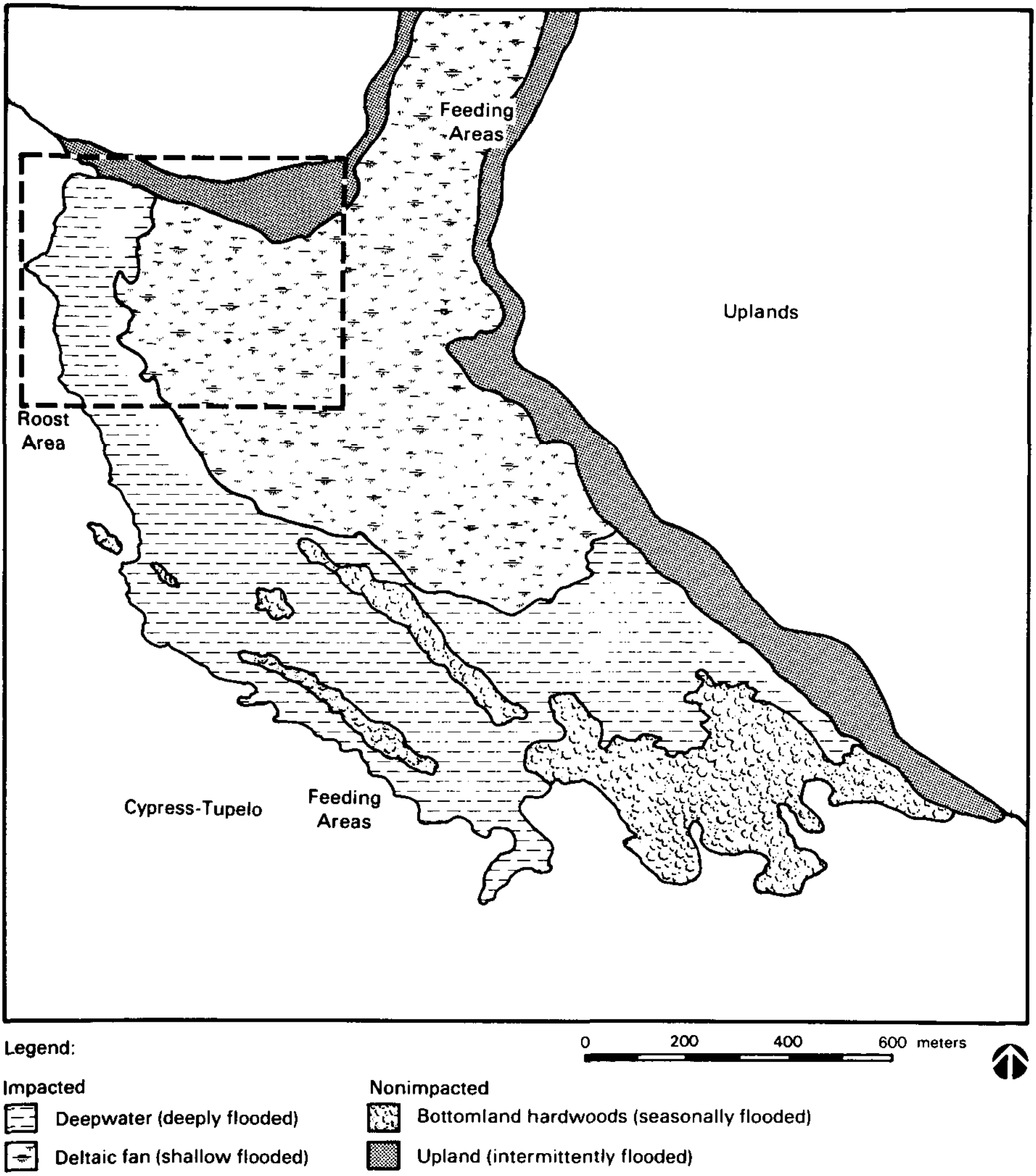
The mallard and wood duck dominated the Steel Creek delta area waterfowl community (Figure C-6). The frequency distribution of the number of each species observed was rather consistent, with mallards being dominant in all three years and wood ducks ranking second in two of three years. These two species also comprise the largest proportion of the hunter's bag in South Carolina. Use of the Steel Creek delta area by other species was generally low. Flocks of 50 green-winged teal, 25 American widgeon, 20 hooded mergansers, 1 pintail, and 1 bufflehead were observed during the fall and winter of 1981 and 1982.

Waterfowl used the Steel Creek delta extensively for both feeding and roosting (Figure C-7). Typically, they moved at dusk from the feeding grounds to a common roosting area where they spent the night. The roost area, which was



Source: Smith et al. (1982a).

Figure C-6. Frequency distribution of waterfowl in the Steel Creek delta.



Source: Smith et al. (1983).

Figure C-7. Feeding and roosting areas of waterfowl in the Steel Creek delta, fall 1981 and winter 1982. Zones influenced by L-Reactor operation (1954-1968) and associated hydrologic regimes are also shown.

characterized by dense buttonbush, provides good overhead protection from predators. In addition to numerous feeding areas in the delta (Figure C-7), waterfowl also fed extensively in the adjoining cypress-typelo forest.

Approximately 100 mallard were observed roosting in the Steel Creek delta in November and early December 1982 (Figure C-8). By mid-December, this number increased to 700. A minimum of 600 mallards roosted in the Steel Creek delta until March when numbers declined. The maximum number of mallards observed was slightly more than 1100 individuals on February 17, 1983.

The wood duck also roosted in the Steel Creek delta (Figure C-9) but in lesser numbers than mallards. Over 400 wood ducks were observed in January 1983 using the Steel Creek delta roosting area. Numbers declined in late January and leveled out through February and March.

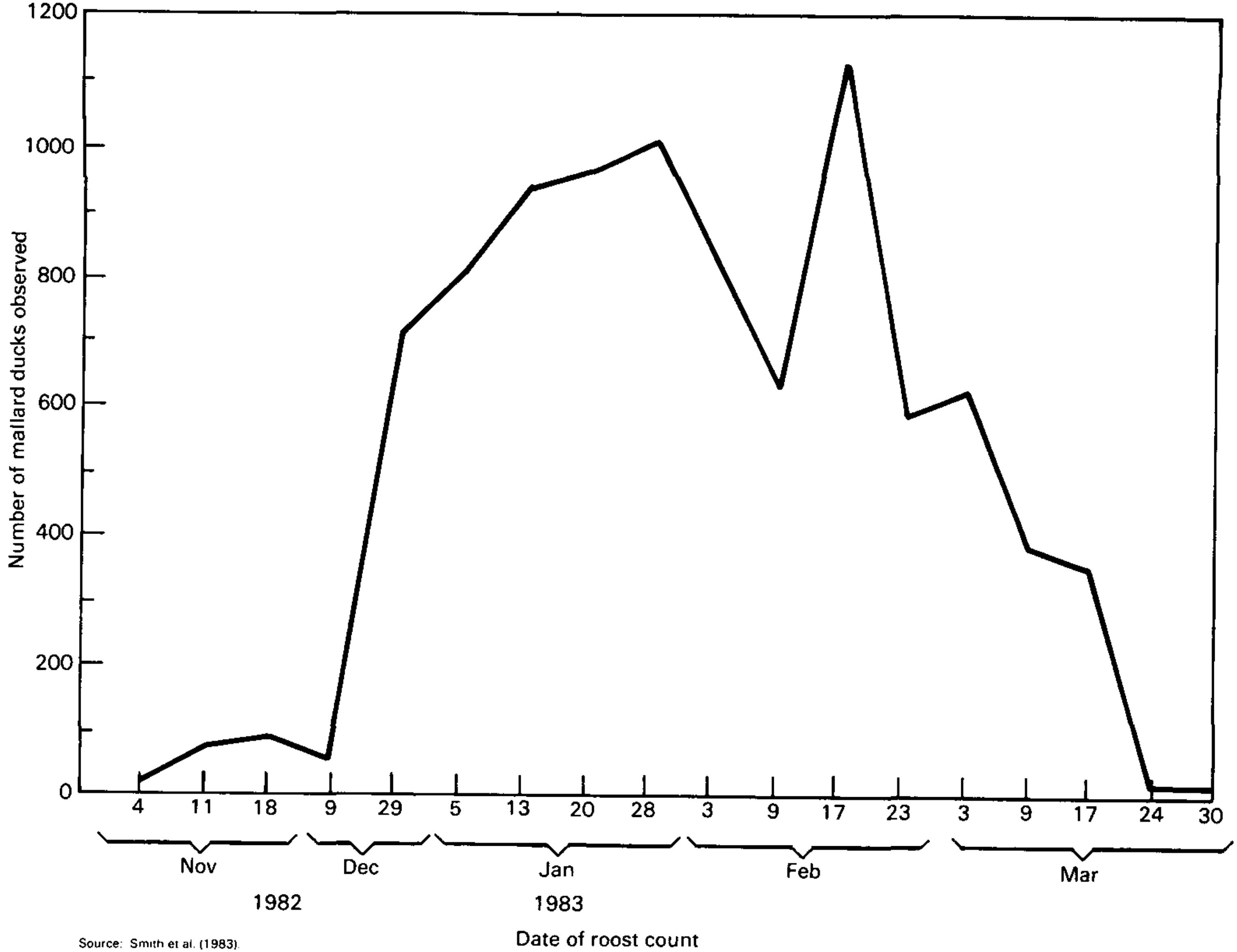
Wood ducks have responded rapidly to the long-term nesting box program in the Steel Creek area. Studies have shown a general decline in the quality of nesting habitat in the Steel Creek area, but excellent brood habitat is present (Smith et al., 1981, 1982b).

Aerial surveys (Figure C-10) over the Steel Creek delta area, Pen Branch delta, Four Mile delta area, and Beaver Dam Creek revealed substantial use by mallards. However, waterfowl were never observed in Pen Branch delta. Mallard use of the Four Mile delta area in 1982 was generally higher than that of Steel Creek (Figure C-11). Mallards in the Four Mile delta area were associated with open channels that branch off the main delta at a 90° angle (Figure C-10). Mallards were observed in these channels whether C-Reactor was up or down except during the December 30 and January 5 surveys when C-Reactor was operating and the swamp water level reached a peak. During this period, the Savannah River had breached its levee and normal water flow across Four Mile delta was disrupted.

Hot water normally flows in a southwesterly direction across the delta toward the river and does not flow directly into the open channels. However, during peak water levels, hot water was probably diverted directly into the open channels making them unsuitable for use by waterfowl. Thus, the open channels associated with Four Mile delta were heavily used by waterfowl except during periods when normal water flow is disrupted.

During 1983, however, the number of mallards utilizing the Steel Creek delta area was markedly higher than Four Mile or Beaver Dam Creek (Figure C-11). This was attributable to consistently higher water levels and the greater availability of food.

These open channels exist because of the area's topography. Hardwood islands prevent the flow of hot water directly into these channels during periods of normal water levels. Around Pen Branch, similar open channels have not developed because of the different orientation of the hardwood islands. Although two hardwood islands are present in Steel Creek delta it is unlikely that suitable waterfowl habitat will develop between them after L-Reactor restart because flow from Steel Creek moves directly between the islands.



Source: Smith et al. (1983).

Figure C-8. Number of mallard ducks observed roosting in the Steel Creek delta, 1982-1983.

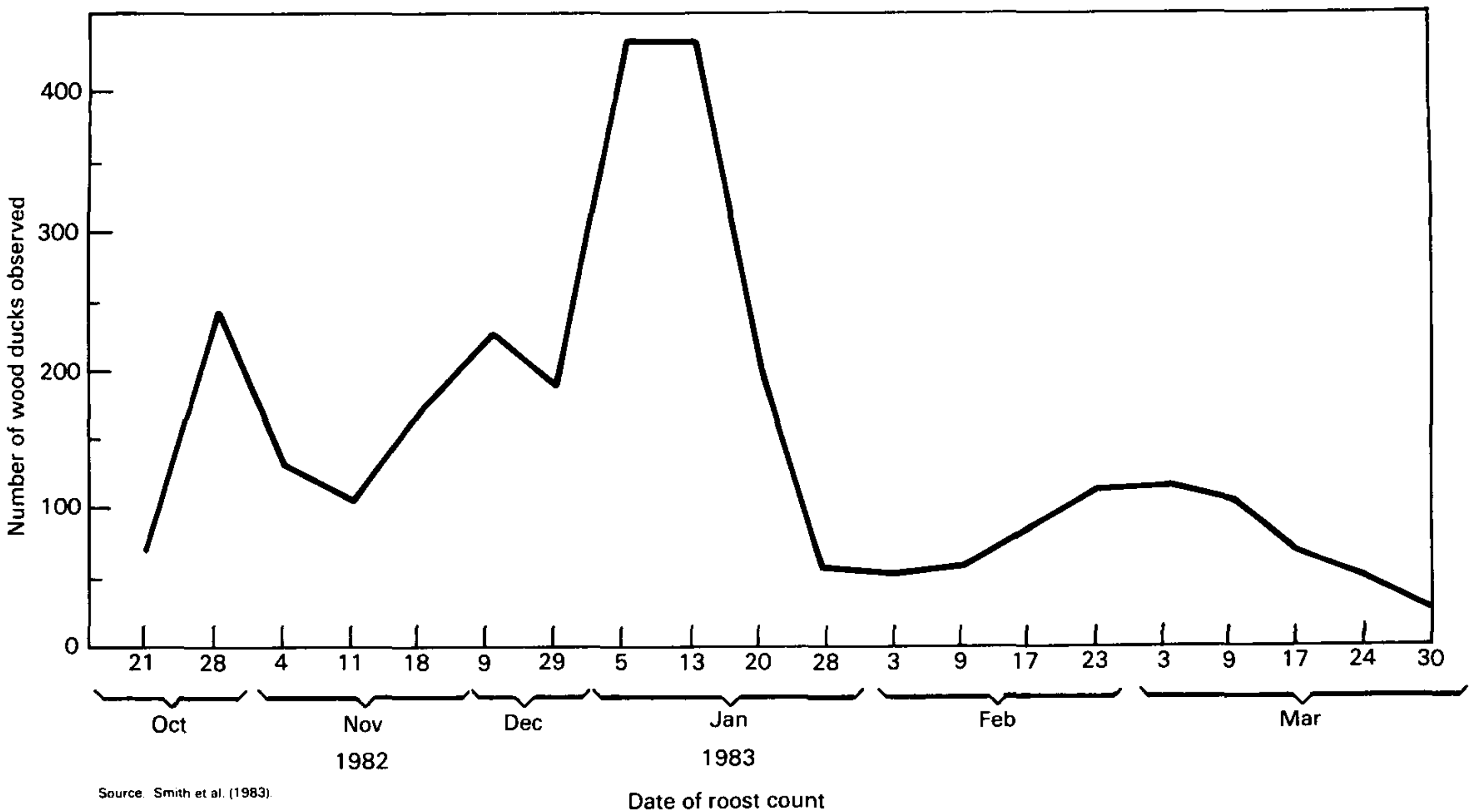
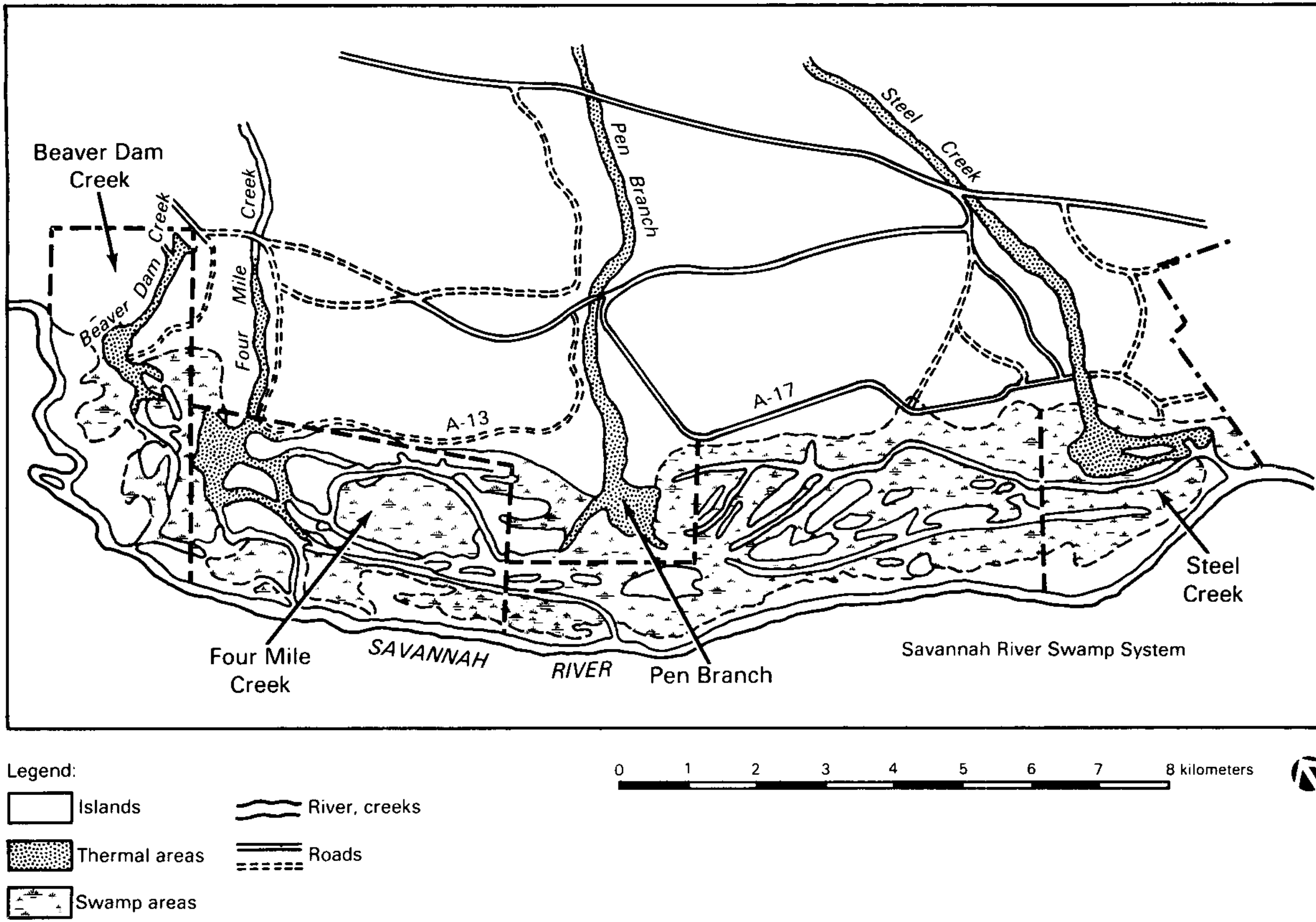
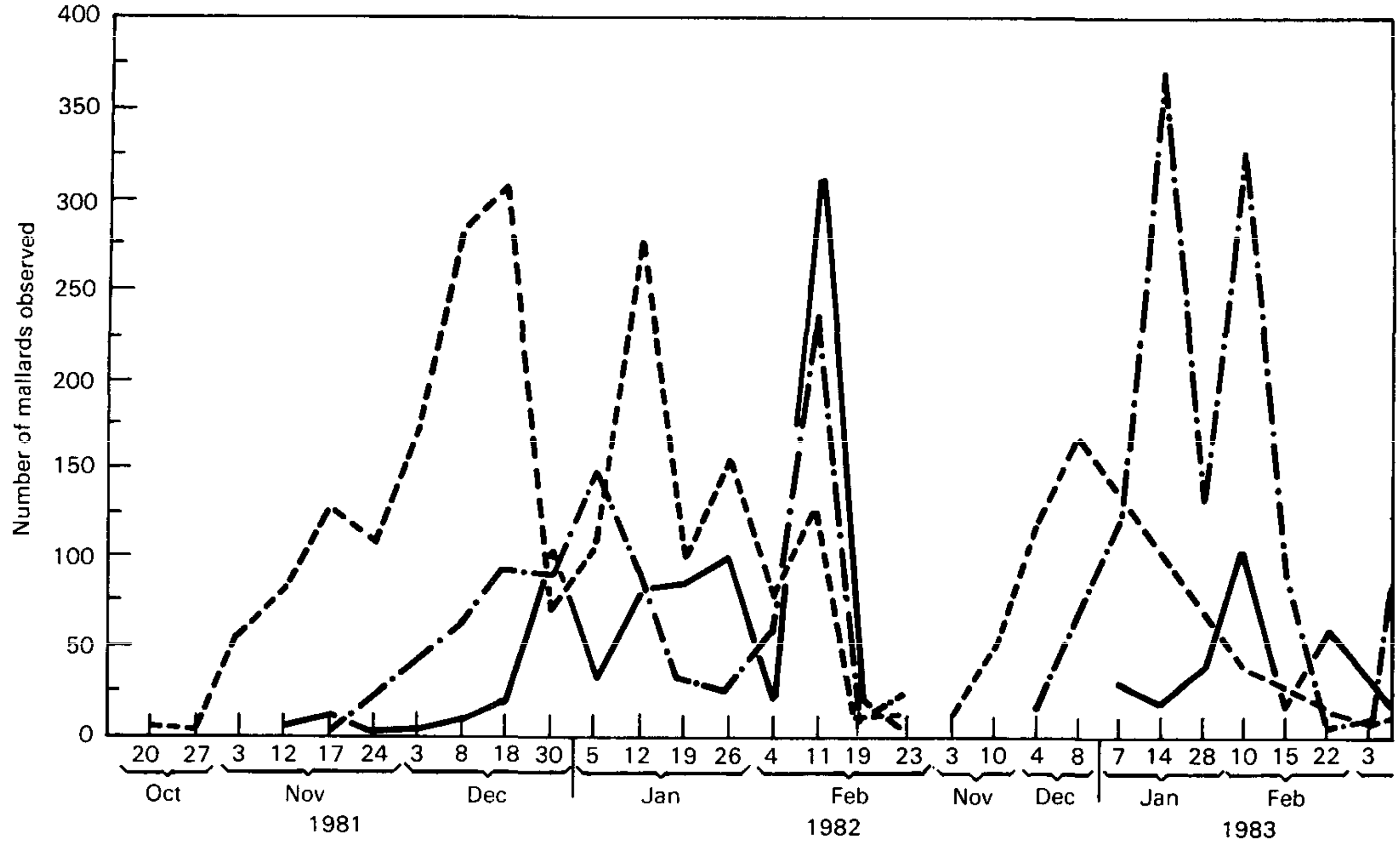


Figure C-9. Number of wood ducks observed roosting in the Steel Creek delta, 1982-1983.



Source: Smith et al (1983)

Figure C-10. Areas of the Savannah River swamp censused for waterfowl during fall 1981 and winter 1982.



Legend:

- - - Four Mile Delta
— Beaver Dam Creek
-·- Steel Creek Delta

Source: Smith et al (1981, 1983)

Figure C-11. Number of mallards observed in Four Mile Creek, Beaver Dam, and Steel Creek deltas during fall 1981 and winter 1982.

Wood stork

The wood stork, which is the only "true" stork to nest in the United States, has experienced a 75-percent decline in its population since the 1930s.
It is classified as endangered by the State of South Carolina and the U.S. Fish AD-3
and Wildlife Service (Federal Register, 1984).

Although the wood stork once nested throughout the coastal region of the southeastern United States from Texas to South Carolina, (Palmer, 1962) they
currently nest only in Florida and Georgia. The most northern rookery in the AD-1,
United States, the Birdsville rookery, is in Jenkins County, Georgia; it was AD-3,
discovered in July 1980. The cypress swamp surrounding the Birdsville colony is AY-2
privately owned. At present the Georgia Department of Natural Resources leases the land and patrols the stork colony.

Two wood storks were observed in the Savannah River swamp in 1981; one bird was sighted between Pen Branch and Four Mile Creek deltas, and one was observed between Steel Creek and Pen Branch deltas. Since these sightings were recorded, more intensive surveys using aerial censuses and habitat analysis have been conducted by the Savannah River Ecology Laboratory.

Wood storks were sighted on 14 different dates between May 31 and Septem-
ber 3, 1982 (Table C-7). Of the 53 individuals that were observed flying and AD-1,
foraging, all but 3 observations occurred in the Steel Creek delta. AD-3,
AY-2

A total of 478 wood stork observations were made on the SRP site in summer 1983. These surveys showed that large concentrations of wood storks foraged in the swamp near Steel Creek and Beaver Dam Creek deltas (Table C-7). Small numbers were also recorded for Four Mile Creek and Pen Branch deltas. Wood storks have been followed from the Birdsville rookery to the Savannah River Plant, a distance of 45 kilometers, where they foraged in the swamp.

The sightings of wood storks in Steel Creek delta corresponded closely with wood stork activity at the Birdsville rookery. In July 1980, 200 nesting wood storks were present at this rookery (Georgia Department of Natural Resources, 1980), and more than 20 wood storks were seen at one time over Steel Creek delta. In 1981, wood storks at the Birdsville rookery did not complete the nesting cycle, and by June 6, 1981, only three storks remained there (Georgia DNR, 1981). Only four wood stork sightings were made in 1981. However, approximately 115 to 130 adult wood storks were present at the Birdsville rookery from April through July 1982, and nests were observed to contain feathered young. In 1983, a total of 238 breeding adults was present at the Birdsville rookery; this corresponded to the maximum number of 478 recorded observations at the Savannah River Plant.

The Birdsville rookery produced more than two wood storks per nest in 1983
(Table C-8). A productivity of 1.7 storks per nest is considered adequate to AD-1,
maintain stork population levels (Ogden and Patty, 1981). Many of the nests at AD-3,
Birdsville in 1983 contained three young (one contained four), which indicates AY-4
that food resources were abundant at feeding areas.

Foraging sites in the SRP Savannah River swamp system ranked significantly higher ($P < 0.05$) than other sites when comparing the mean number of storks

Table C-7. Date, number, and locations of wood storks observed on the Savannah River Plant site, 1982 and 1983[a]

Date	Number observed	Location
1982		
May 31	2	Bulldog Bay
June 11	1	Steel Creek delta
June 15	1	Steel Creek delta
June 18	1	P-Reactor
June 23	1	Steel Creek delta
June 25	1	Steel Creek delta
June 29	5	Steel Creek delta
July 1	1	Steel Creek delta
July 20	1	Steel Creek delta
July 22	1	Steel Creek delta
August 6	2	Steel Creek delta
August 27	14	Steel Creek delta
September 2	11	Steel Creek delta
September 3	11	Steel Creek delta
1983		
June 23	5	Pen Branch swamp
June 25	2	Four Mile swamp
June 28	2	Steel Creek delta
June 30	23	Steel Creek delta
July 1	29	Steel Creek delta
July 1	28	Beaver Dam Creek swamp
July 2	32	Beaver Dam Creek swamp
July 2	36	Pen Branch swamp
July 11	43	Steel Creek delta
July 12	17	Beaver Dam Creek swamp
July 12	5	Steel Creek delta
July 12	3	Pen Branch delta
July 13	195	Beaver Dam Creek swamp
July 14	30	Beaver Dam Creek swamp
July 25	1	Beaver Dam Creek swamp
July 27	1	Beaver Dam Creek swamp
July 27	2	Four Mile Creek swamp
July 28	1	Four Mile Creek swamp
July 30	3	Pen Branch swamp
August 1	11	Beaver Dam Creek swamp
August 3	9	Four Mile Creek swamp

[a]Adapted from Smith et al. (1982a, 1983).

TC

Table C-8. Results of wood stork nest survey, Birdsville, Georgia

Year	Number of active nests	Mean number of young per nest[a]
1980	100[b]	2[b]
1981	failed	0
1982	60[b]	no data
1983	113[c]	2.19[c]

[a]Young at least 5 weeks old.
[b]Estimated from ground or aerial surveys.
[c]Actual count from 26 nest trees.

observed at all SRP sites (29.8) with those observed at other sites (8.4) before fledging (Table C-9). After fledging, juveniles and adults were recorded foraging at non-SRP sites. Juveniles did not use SRP foraging sites. Foraging sites at the Steel Creek delta attracted an average of 19.3 storks, which was not statistically higher ($P > 0.05$) than the average of 8.4 storks observed at other sites not located on the SRP. AD-1, AD-3, AY-2

After July 12, 1983, wood storks were not recorded in the Steel Creek delta, even though they were present at other SRP sites (Table C-7). On this date or soon thereafter, the water depth at site 012 in the Steel Creek delta increased to 48 centimeters (from 18 centimeters) due to cold-flow testing at L-Reactor. Depths at site 012 remained between 44 and 48 centimeters through September 1983. High water resulting from SRP reactor testing prevented storks from feeding because the fish that were originally concentrated in shallow pools had dispersed.

A majority of the wood stork's foraging sites (39 percent) were within 10 kilometers of the Birdsville colony. Surveys indicated that only a few sites were found greater than 50 kilometers from the colony. However, 24 percent of the sites were located between 40 and 50 kilometers from Birdsville. This includes the foraging sites at SRP swamps. These results indicate that the Savannah River Swamp, particularly the deltas of Beaver Dam Creek and Steel Creek, represent important feeding habitat for wood storks of the Birdsville rookery.

A recent biological assessment on the wood stork was submitted to FWS for their consideration (Sires, 1984b). The assessment concluded that the proposed L-Reactor operation and 1000-acre lake construction and operation would not jeopardize the continued existence of the wood stork.

Table C-9. Mean number of wood storks observed foraging at SRP sites and other sites before and after fledging of young from the Birdsville, Georgia, colony

Site	Number of sites	Mean[a]	S.D.
SRP SAVANNAH RIVER SWAMP SYSTEM SITES[b]			
Beaver Dam Creek	5	37.2	30.3
Pen Branch	1	24.0	--
Steel Creek	3	19.3	15.5
All SRP sites	9	29.8	24.5
OTHER SITES (NOT LOCATED ON SRP)			
Before fledging	18	8.4	7.1
After fledging	23	14.3	14.6
Total sites	50	14.5	16.4

[a]Mean based on maximum number of storks observed at each site.

[b]Storks foraged at SRP swamps only before fledging (July 25 to 28, 1983).

AD-1, AD-2, AY-3

C.3.3 Mammals

More than 40 species of mammals have zoogeographic ranges that include the Savannah River Plant (Burt and Grossenheider, 1976; Golley, 1966); 25 of these are known to occur near Steel Creek (Smith et al., 1981). The presence of two additional species, the muskrat (Ondatra zibeethica) and the black bear (Ursus americanus), was confirmed near Steel Creek, even though their documented ranges do not include Savannah River Plant. Transient occurrences along the river floodplains by the black bear are not considered uncommon.

Based on the use of drift fences, pitfall traps, and the board transects during the summer of 1981, the short-tailed shrew (Blarina brevicauda), the least shrew (Cryptotis parva), and the southeastern shrew (Sorex longirostris) were determined to be the most frequently captured small mammals. The Steel Creek delta provided habitat for the rice rat (Oryzonomys palustris), and the eastern wood rat (Neotoma floridana) and hispid cotton rat (Sigmodon hispidus) also occur there. The gray squirrel (Sciurus carolinensis), fox squirrel (Sciurus niger), and southern flying squirrel (Glaucomys volans) were common in the upland and lowland forests along Steel Creek. Large mammals, such as the feral pig (Sus scrofa) and the white-tailed deer (Odocoileus virginianus), were common on the Steel Creek floodplain and delta. Other inhabitants of the flood-plain and delta included the raccoon (Procyon lotor), opossum (Didelphis marsupialis), and gray fox (Urocyon cinereoargenteus). Signs of the beaver (Castor canadensis) were common along the length of Steel Creek and one dead individual was observed between Road A and Cypress Bridge.

C.4 AQUATIC BIOTA

Six major aquatic habitat types occur on the SRP site: small ponds, Carolina bays, reservoirs, streams, and the Savannah River and its associated floodplain swamp. The standing waters vary in size from less than 1 acre to about 2800 acres. Flows in the various streams range from less than 0.028 to 11 cubic meters per second.

The floodplain swamp, which includes the Steel Creek delta, bordering the river is the least known aquatic habitat on the Savannah River Plant. Its possible use as spawning and rearing grounds and as nutrient sink are largely unknown. It is quite diverse as distinct water courses alternate with braided channels and broad flats of barely perceptible water movement. It is also one of the most variable habitats, experiencing depth fluctuations of 4 meters or more and, also, the input of thermal effluent from three SRP sources.

C.4.1 Aquatic flora

In running-water environments like the Savannah River, attached algae (periphyton) are the predominant primary producers. Much of the phytoplankton (floating algae) community consists of true planktonic forms as well as detached periphytic forms that are discharged from upstream reservoirs and from backwaters and tributary streams.

The algal flora of the Savannah River are dominated by diatoms, although blue-green algae are at times an important component, particularly at upstream locations that are subject to organic enrichment from municipal effluents from the communities of Augusta and Horse Creek Valley. The greatest algal diversity consistently occurs during the summer, coincident with low river flow and decreased turbidity, which allows greater light penetration.

Approximately 400 species of algae have been identified from the Savannah River near the Savannah River Plant (Patrick et al., 1967). Since 1951, when algal studies began, diversity has decreased. Patrick et al. (1967) suggested that this reflects an increase of organic loading to the river from the area above the Savannah River Plant (ANSP, 1961; 1974).

Aquatic macrophytes in the river, most of which are rooted, are limited to shallow areas of reduced current and along the shallow margins of tributaries. Eight species of vascular plants have been identified from the river adjacent to the Savannah River Plant, the most abundant being water milfoil, hornwort, alligatorweed, waterweed, and duck potato (Georgia Power Company, 1974).

In the SRP streams that receive thermal effluents, the flora are greatly reduced, reflecting the influence of high flows and elevated (greater than 40°C) water temperatures. In these areas, thermophilic bacteria and blue-green algae thrive where no other aquatic life occurs.

Vegetation mapping of the Steel Creek delta and swamp conducted by the Savannah River Ecology Laboratory (Smith et al., 1981) revealed a deepwater zone where the main flow of Steel Creek courses toward the Savannah River and the hardwood canopy is reduced. In this area, the vegetation was dominated by submergent and emergent macrophytes. Patches of duckweed (*Lemma perpusilla*) collected on mats of submerged vascular plants such as hornwort (*Ceratophyllum demersum*) and parrotfeather (*Myriophyllum brasiliense*) that root on subsurface logs, trees, and stumpbases. Where the water flow was slow-moving, *Polygonum* spp. formed dense colonies.

C.4.2 Aquatic fauna

C.4.2.1 Macroinvertebrates

Shallow areas and quiet backwaters of the Savannah River near the SRP site supported diverse aquatic invertebrate assemblages; however, the bottom substrate of most open portions of the river consisted of shifting sand that does not provide optimum habitat for bottom-dwelling organisms. The total number of invertebrate species occurring in the river decreased sharply during the 1950s which has been attributed primarily to the effects of dredging (Patrick et al., 1967). The stabilization of river discharges and the elimination of habitat caused by the reduction in flooding of backwater areas, as well as organic loading above Savannah River Plant, might also have contributed to the decline. Some recovery occurred during the early 1960s, but complete recovery has not taken place. The groups most affected were those sensitive to the effects of siltation and substrate instability. Of the insect fauna, mayflies and dragonflies had the largest number of species in earlier surveys. Since the decline in species between 1955 and 1960, dipterans (true-flies) have been represented by the most species.

To evaluate the effects of thermal loading to SRP streams, Howell and Gentry (1974) compared the aquatic insect populations of Upper Three Runs Creek (natural stream), Pen Branch (thermal stream), and Steel Creek (post-thermal stream). The Pen Branch stream had overflowed its banks with heated water, causing a floodplain in which the trees had been killed. This led to exposure of the stream to direct sunlight. There was also considerable siltation. The macroinvertebrate associations in Pen Branch were characterized by low diversity and low evenness. The absence of caddisflies, stoneflies, and mayflies in this stream indicated that a significant portion of the natural aquatic insect community had been eliminated by thermal effects. The few remaining insect populations were large, which is indicative of thermal influence.

Between March 13 and August 29, 1982, the macroinvertebrate drift community was sampled as part of the Biological Measurement Program in the Savannah River (ECS, 1983b). Sample sites included the Savannah River, the pumphouse intake canals, as well as the mouths of Upper Three Runs Creek, Four Mile Creek and Steel Creek. A total of 131,815 macroinvertebrates was collected representing 47 insect families and 6 non-insect groups.

The most abundant insect family collected was the true-fly family, chironomidae (midges), which comprised 66.2 percent of the total macroinvertebrates collected. Macroinvertebrate drift communities with a predominance of true-flies are typical of riverine habitats.

Other abundant taxa included mayflies, caddisflies, scuds, water mites and nematode worms. When the invertebrate community was examined with respect to functional feeding groups, insect collectors (which feed on small organic particles in the water) were found to be the most abundant functional group, accounting for 64 to 85 percent of the organisms collected. Non-insect piercers (which feed by sucking plant juices), consisting entirely of water mites; these were very abundant in the canals, and comprised 13 to 18 percent of the invertebrate fauna. Snails were infrequently found in the drift samples, although they are abundant in the river.

In general, samples from the pumphouse intake canals and the creeks contained significantly fewer taxa than did the river samples. The mean density of macroinvertebrates was also less in the canals and Upper Three Runs Creek and Steel Creek than in the river.

There were fewer true-flies and caddisflies in the canals and more beetles and water mites, based on qualitative collections. True-flies were less abundant in creeks than the river. Upper Three Runs Creek had higher percentages of mayflies, caddisflies, beetles and stoneflies than river collections, but no scuds. Four Mile Creek, which is thermally affected, had a high percentage of mayflies, mostly Caenidae, but low percentage of caddisflies, beetles and water mites. Steel Creek, which has heated water from Pen Branch in its lower one kilometer, had more abundant scuds than the river transects.

An investigation of the aquatic invertebrate communities living on wood substrates and submerged macrophytes in the Steel Creek stream-swamp ecosystem was conducted by the Savannah River Ecology Laboratory in the upper and lower reaches of Steel Creek and in the floodplain swamp (Smith et al., 1982b). The habitats were selected based on preliminary investigations and current literature that showed them to be the most diverse, to have the highest productivity and to be the most closely associated with fish trophic dynamics in the swamp.

Sampling sites of snags were located along a continuum from the rapidly flowing sections of Steel Creek above the floodplain swamp, through the swamp to the lower portion of the creek, which flows rapidly from the swamp to the Savannah River. Results of collections revealed significant differences between sampling sites in terms of species density, richness and colonization patterns. Many of the same invertebrate taxa occurred at the sampling sites in upper and lower Steel Creek, although organism density and diversity were much higher in the upper reach than in the lower reach and were lowest in the swamp. An abundant macroinvertebrate population was also associated with macrophyte beds in the swamp. Abundance varied significantly between plant species and was generally dominated by amphipods. These invertebrate populations on macrophytes may form a significant source of fish food in the swamp.

C.4.2.2 Fish

Like other typical southeastern coastal plain rivers and streams, the Savannah River and its associated swamp and tributaries have a diverse fish fauna. Descriptions of the fishes of the Savannah River have been included in many ecological studies during the last 30 years. Matthews (1982) reviewed those studies published by the Academy of Natural Sciences of Philadelphia between 1951 and 1976. The results of fisheries studies in the portion of the river near the Savannah River Plant were reported by McFarlane et al. (1978a) and Dudley et al. (1977). Additionally, the Georgia Game and Fish Division (1982) reported on an electrofishing survey they conducted at 24 locations in the Savannah River between the New Savannah River Bluff Lock and Dam and Port Wentworth. Data on anadromous species, many of which are important in the Savannah River, were compiled by Rulifson et al. (1982).

<u>Steel Creek studies</u>

Studies of fish populations in the Steel Creek delta-swamp system and the Savannah River adjacent to the SRP showed a high species diversity (ECS, 1983a, 1983b, Smith et al., 1982b, 1983) (Tables C-10 and C-11).

The highest abundance and diversity of fish in Steel Creek occurred in deepwater areas where the tree canopy was eliminated during previous reactor operations and the vegetation was dominated by submergent and emergent macrophytes.

The use of the Steel Creek delta-swamp area by anadromous fish species (e.g., American shad and blueback herring) was minimal during 1982. Only 10 individuals of both species were collected. The appearance of American shad in Steel Creek was late in 1982 and the numbers were quite small. However, it appears that the shad spawning run in the Savannah River was smaller than in previous years; large year-to-year variations in abundance of anadromous fish species are quite common. In 1983, the American shad and blueback herring spawning run in Steel Creek occurred earlier than in 1982 (February through April for blueback herring and late March through May for American shad) (Smith et al., 1983). There was a greater utilization of the Steel Creek delta-swamp area by adult shad and blueback herring in 1983 as compared to 1982 (76 shad in 1983 versus 6 in 1982; 124 blueback herring in 1983 versus 4 in 1982). Two striped bass were collected in the delta-swamp area in 1983 while none were collected in 1982 (Smith et al., 1983).

During 1982, ichthyoplankton sampling revealed no evidence of spawning by shad, blueback herring, or striped bass in upper Steel Creek and the Steel Creek delta. However, ichthyoplankton of all three species was collected from the mouth of Steel Creek.

AY-7, EZ-1, EZ-5

In 1983, Steel Creek yielded 518 fish larvae and 103 eggs in 23 ichthyoplankton collections made between March and August. The larvae were predominantly minnows, yellow perch, and sunfish and bass. Many blueback herring eggs were also collected. When compared to other creeks that were sampled ten or more times, Steel Creek ranked eighth in larval density of all species combined. This creek was distinctive in having minnows and yellow perch represent about 27 and 30 percent, respectively, of the fish larvae collected here. In all other streams of a similar size, these two species comprised no more than

Table C-10. Scientific and common names of fish collected in the Steel Creek river-swamp, October 1981-July 1982[a]

Scientific name	Common name
Amblyopsidae	
Chologaster cornuta	Swampfish
Amiidae	
Amia calva	Bowfin
Anguillidae	
Anguilla rostrata	American eel
Aphredoderidae	
Aphredoderus sayanus	Pirate perch
Atherinidae	
Labidesthes sicculus	Brook silverside
Belonidae	
Strongylura marina	Atlantic needlefish
Catostomidae	
Erimyzon oblongus	Creek chubsucker
Erimyzon sucetta	Lake chubsucker
Minytrema melanops	Spotted sucker
Centrarchidae	
Centrarchus macropterus	Flier
Elassoma zonatum	Banded pygmy sunfish
Enneacanthus chaetodon	Blackbanded sunfish
Enneacanthus gloriosus	Bluespotted sunfish
Lepomis auritus	Redbreast sunfish
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Micropterus salmoides	Largemouth bass
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Clupeidae	
Alosa sapidissima	American shad
Alosa aestivalis	Blueback herring
Dorosoma cepedianum	Gizzard shad
Cyprinidae	
Cyprinus carpio	Carp
Hyboganthus nuchalis	Silvery minnow
Notemigonus crysoleucas	Golden shiner
Notropis chatybaeus	Ironcolor shiner
Notropis cummingsae	Dusky shiner
Notropis emiliae	Pugnose minnow
Notropis hudsonius	Spottail shiner
Notropis leedsi	Bannerfin shiner
Notropis lutipinnie	Yellowfin shiner
Notropis maculatus	Taillight shiner
Notropis niveus	Whitefine shiner
Notropis petersoni	Coastal shiner

Table C-10. Scientific and common names of fish collected in the Steel Creek river-swamp, October 1981-July 1982[a] (continued)

Scientific name	Common name
Cyprinodontidae	
Fundulus lineolatus	Lined topminnow
Esocidae	
Esox americanus	Redfin pickerel
Esox niger	Chain pickerel
Ictaluridae	
Ictaluris natalis	Yellow bullhead
Ictaluris nebulosus	Brown bullhead
Ictaluris platycephalus	Flat bullhead
Ictaluris punctatus	Channel catfish
Noturus gyrinus	Tadpole madtom
Noturus leptacanthus	Speckled madtom
Lepisosteidae	
Lepisosteus osseus	Longnose gar
Lepisosteus platyrhincus	Florida gar
Mugilidae	
Mugil cephalus	Striped mullet
Percichthyidae	
Morone saxatilis	Striped bass
Percidae	
Etheostoma fusiforme	Swamp darter
Etheostoma olmstedi	Tesselated darter
Perca flavescens	Yellow perch
Percina nigrofasciata	Blackbanded darter
Poeciliidae	
Gambusia affinis	Mosquitofish
Umbridae	
Umbra pygmaea	Eastern mudminnow

[a]Adapted from Smith et al. (1982b).

Table C-11. Fish species collected during adult fisheries study, Savannah River Plant: August 1982, October 1982, and January 1983[a]

Scientific name	Common name
Acipenser oxyrhnchus	Atlantic sturgeon
Lepisosteus osseus	Longnose gar
Amia calva	Bowfin
Anguilla rostrata	American eel
Alosa aestivalis	Blueback herring
Alosa mediocris	Hickory shad
Alosa sapidissima	American shad
Dorosoma cepedianum	Gizzard shad
Dorosoma pretenense	Threadfin shad
Esox americanus	Redfin pickerel
Esox niger	Chain pickerel
Cyrpinus carpio	Carp
Hybognathus nuchalis	Silvery minnow
Hybopsis rubifrons	Rosyface chub
Nocomis leptocephalus	Bluehead chub
Notimogonus crysoleucas	Golden shiner
Notropis chalybaeus	Ironcolor shiner
Notropis emiliae	Pugnose minnow
Notropis hudsonius	Spottail shiner
Notropis leedsi	Ohoopee shiner
Notropis maculatus	Taillight shiner
Notropis niveus	Whitefin shiner
Notropis petersoni	Coastal shiner
Erimyzon sucetta	Lake chubsucker
Minytrema melanops	Spotted sucker
Moxostoma anisurum	Silver redhorse
Ictalurus brunneus	Snail bullhead
Ictalurus catus	White catfish
Ictalurus nebulosus	Brown bullhead
Ictalurus platycephalus	Flat bullhead
Ictalurus punctatus	Channel catfish
Noturus leptacanthus	Speckled madtom
Aphredoderus sayanus	Pirate perch
Fundulus notti	Starheaded topminnow
Gambusia affinis	Mosquitofish
Labidesthes sicculus	Brook silverside
Morone saxatilis	Striped bass
Acantharchus pomotis	Mud sunfish
Centrarchus macropterus	Flier
Lepomis auritus	Redbreast sunfish
Lepomis gibbosus	Pumpkinseed
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis marginatus	Dollar sunfish
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Micropterus salmoides	Largemouth bass

Table C-11. Fish species collected during adult fisheries study, Savannah River Plant: August 1982, October 1982, and January 1983[a] (continued)

Scientific name	Common name
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Etheostoma olmstedi	Tessellated darter
Perca flavescens	Yellow perch
Percina nigrofasciata	Blackbanded darter
Agonostomus monticola	Mountain mullet
Mugil cephalus	Striped mullet
Trinectes maculatus	Hogchoker

[a]Adapted from ECS (1983a,b,c).

about 13 and 7 percent of the total larvae, respectively. In Steel Creek, densities of crappie larvae relative to other species were much lower than in the other large streams sampled.

AY-7, EZ-1, EZ-5

Much more fish spawning occurred in Four Mile Creek in 1983 than in 1982, apparently because high river levels reversed stream flow enough to allow fish to enter the creek. A high density of larvae, mostly blueback herring, was observed on April 4, 1983. However, similar medium-sized streams that were sampled had higher larval densities and longer spawning periods than Four Mile Creek. Apparently, the elevated water temperature in this stream was a factor that limited spawning.

The diversity and abundance of fish in the thermally affected SRP streams was high only during periods of reactor shutdown (McFarlane, 1976). In addition, the fauna upstream of the thermal effluents was depauperate in both numbers and diversity. With the exception of the mosquitofish (*Gambusia affinis*), few fish lived in the streams when thermal effluent was present. During reactor shutdown, the streams return to ambient temperature and are invaded immediately by many fish from adjacent nonthermal areas. The diversity and abundance of species in the headwater tributaries of Four Mile Creek and Pen Branch upstream from reactor thermal effluents were reduced greatly in contrast to comparable areas in Upper Three Runs Creek or Steel Creek (McFarlane, 1976). Collection efforts have revealed that the first- and second-order tributaries of these streams were essentially devoid of fish.

To evaluate the potential for the entrainment of young stages of fish in the cooling-water systems, an ichthyoplankton sampling program was conducted in the river from March to August 1977 (McFarlane et al., 1978a). Fish eggs occurred in the collections during each month of the study. The greatest densities occurred in May. American shad comprised 96 percent of all fish eggs collected during the study. More than 1700 fish larvae representing at least 22 species were identified from the plankton collections. The greatest larval densities occurred in April. Clupeidae, primarily blueback herring, accounted for more than half of the larvae collected. Other abundant species were spotted sucker, black crappie, cyprinids, and channel catfish. The greatest number of fish larvae were collected in Upper Three Runs Creek and in the 1G and 3G intake canals.

Savannah River fisheries program

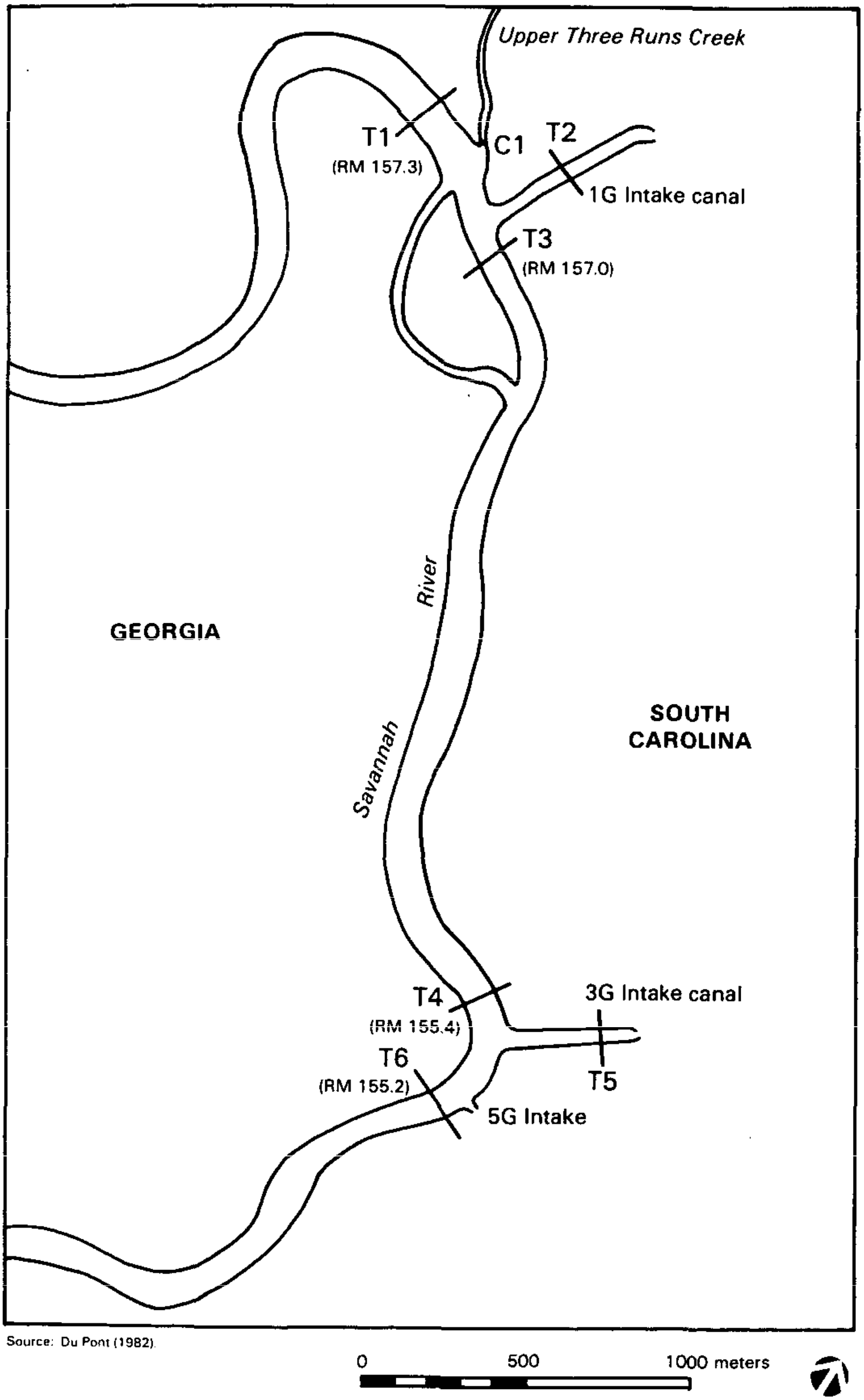
The Biological Measurement Program in the Savannah River initiated in March 1982 was designed to provide additional data on the biological communities in the river that might be affected by the present and proposed activities at the Savannah River Plant. The long-term study of the river encompasses many factors including fish populations, meroplankton communities, and fish impingement at the SRP pumphouse intake screens. This section summarizes the results of the meroplankton and impingement sampling conducted from March through August 1982 and from February through July 1983 and electrofishing collections made in August and October 1982 and January 1983 (ECS, 1982, 1983a,b,c,d). A preliminary report (ECS, 1983d) describes portions of the 1983 results.

Meroplankton collections were made at nine transects and three creek stations during March through August 1982. The approximate locations of the sampling points are shown in Figures C-12 and C-13.

Larval fish populations in the region of the Savannah River sampled in 1982 were clearly dominated by the herring and shad family (Clupeidae). The herring and shad larvae combined made up almost 50 percent of all fish larvae collected (Table C-12). On 13 sampling dates between March 11 and August 29, 1982, a total of 2138 samples was collected. When these samples were sorted and analyzed, 10,205 ichthyoplankton were removed, identified and counted. Of this total, 50.7 percent were fish larvae and 49.3 percent were fish eggs.

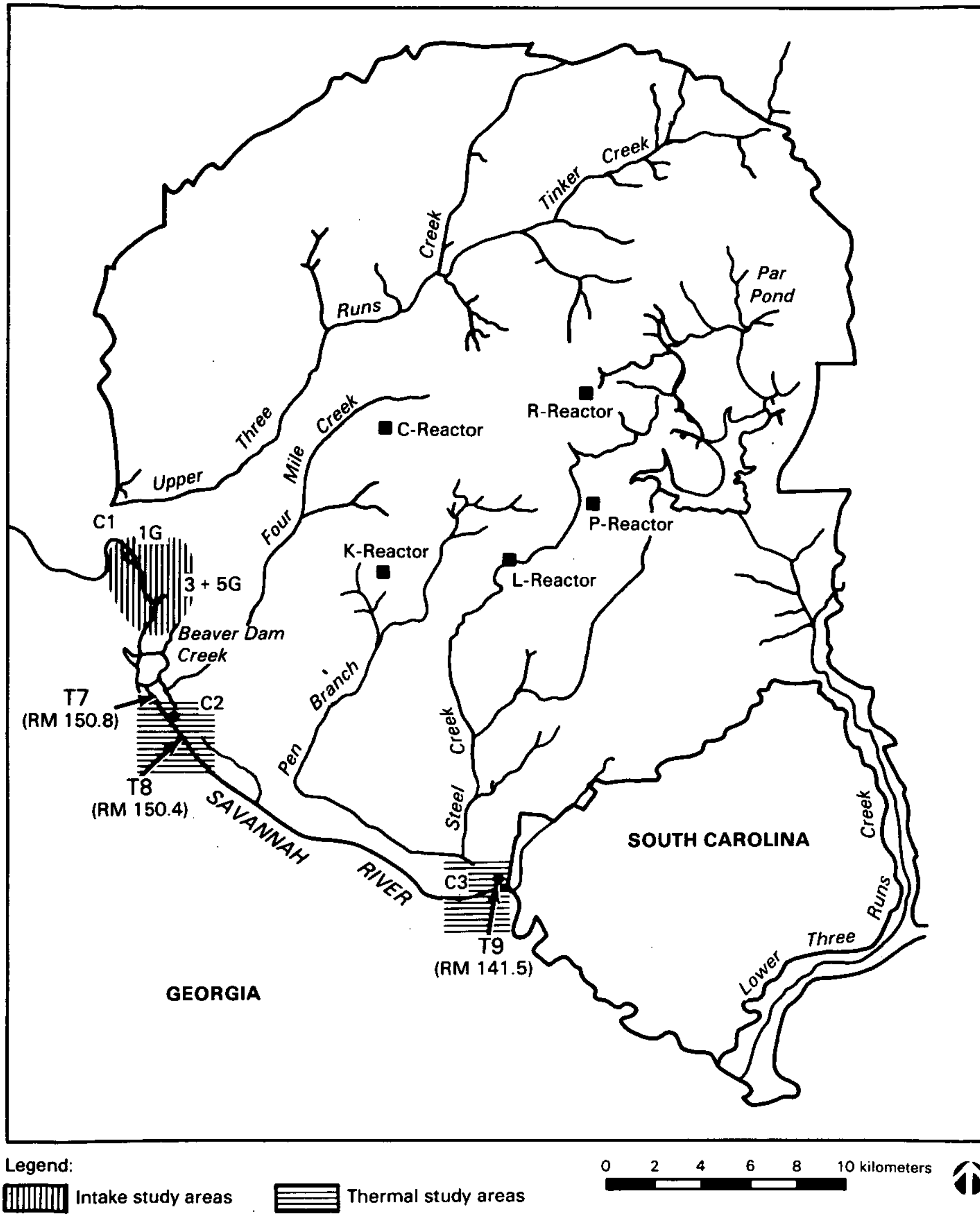
In 1982, spawning for most Savannah River fishes occurred between early March and late July. On March 11-12, only 12 larval fishes were collected, which indicates that this sampling was prior to the main spawning period for most species. On March 25-26, 285 larval fish were collected. At that time, spotted suckers were the dominant larval form, constituting 42.8 percent of the total collection. On April 7-8, the minnows, which had not been taken in the prior collection, constituted almost 50 percent of the collection. Spotted suckers were again very abundant in April, making up 28.2 to 41.4 percent of the fish larvae collected. Minnows continued to dominate the collections from early April until May 20-21, when the number of unidentified clupeids increased to 43.0 percent of the total of 2268 larval fishes collected. Unidentified clupeids continued to dominate the larval collection through June, while minnows were almost absent from these collections. In July and August, the number of fish larvae collected was low.

During the survey, eggs of several important species (American shad, striped bass, and blueback herring) were identified. Eggs of these three species constituted 90 percent of the total eggs collected (Table C-13). Of the 5029 fish eggs collected during this study, 3550 were those of the American shad, about 71 percent of the eggs collected. McFarlane et al. (1978a) reported that over 96 percent of the fish eggs collected in their 1977 study were American shad. In the 1982 investigation, striped bass was the second most abundant fish egg collected. A total of 494 striped bass eggs was collected, which represents about 10 percent of all eggs collected during the study. Striped bass spawning had not been documented in the central Savannah River prior to 1982.



Source: Du Pont (1982).

Figure C-12. Location of sampling transects T1 through T6 and station C1.



Source: Du Pont (1982)

Figure C-13. Location of sampling transects T7 through T9 and stations C1, C2 and C3.

AY-7, EZ-1, EZ-5

Table C-12. Number and relative abundance of larval fish collected at all stations in the Savannah River, March-August 1982[a] and February-July 1983[b]

Group	Total number collected		Percentage composition	
	1982	1983	1982	1983
Unidentified clupeids	1740	2957	33.6	6.9
Unidentified minnows	980	5557	18.9	13.0
Spotted sucker	825	1913	15.9	4.5
Dorosoma spp.	482	8234	9.3	19.3
Sunfish and bass	294	1778	5.7	4.2
Yellow perch	206	1658	4.0	3.9
Blueback herring	127	5648	2.5	13.2
American shad	110	653	2.1	1.5
Other	89	723	1.7	1.7
Unidentified suckers	88	321	1.7	0.8
Darter	88	1035	1.7	2.4
Carp	52	1370	1.0	3.2
Pirate perch	48	3105	0.9	7.3
Unidentified catfish	21	27	0.4	0.1
Sturgeon	15	10	0.3	<0.1
Gar	6	9	0.1	<0.1
Atlantic needlefish	4	6	0.1	<0.1
Swamp fish	1	7	<0.1	<0.1
Crappie		7257		17.0
Mud minnow		6		<0.1
Mosquito fish		4		<0.1
Pickerel		129		0.3
Silverside		160		0.4
Striped bass		88		0.2
Total	5176	42,655	100.0	100.0

[a]Adapted from ECS, 1982.
[b]Adapted from ECS, 1983d, which includes only daytime samples.

Table C-13. Number and relative abundance of eggs of each fish group collected in the Savannah River, March-August 1982[a] and February-July 1983[b]

Group	Total number collected 1982	Total number collected 1983	Percentage composition 1982	Percentage composition 1983
Clupeidae				
American shad	3550	3612	70.6	50.7
Blueback herring	380	417	7.5	5.9
Percidae				
Perch and darters	87	309	1.7	4.3
Percichthyidae				
Striped bass	494	852	9.8	12.0
Other	518	1928	10.4	27.1
Total	5029	7118	100.0	100.0

[a]Adapted from from ECS (1982).
[b]Adapted from ECS (1983d), which includes only daytime samples.

AY-2, EZ-1, EZ-5

Fish larvae were generally distributed uniformly at the river stations and were dominated by shad, herring, and spotted sucker larvae (Table C-13). Fish eggs tended to be more concentrated in the middle portion of the river and often near the bottom. The intake canals had high densities of larvae and low densities of eggs. The eggs entrained into the canals probably settled to the bottom because of low-flow rates in the canal. Steel Creek and Upper Three Runs Creek contained numerous larvae and were sites for blueback herring spawning. High temperatures in Four Mile Creek precluded any extensive spawning in these waters.

Peak spawning activity occurred in May 1982. In May and June the abundance of fish eggs and larvae was significantly higher in nighttime collections than in daytime collections. Fourteen sturgeon larvae were also collected in 1982; both the Atlantic and shortnose sturgeon were represented (Table C-14).

A total of 26 transects in the river and 2 in the SRP intake canals were sampled weekly from February 1 through July 31, 1983. The river transects were located between River Miles 187.1 and 29.6. The 1G and 3G intake canals are located at about River Miles 157.0 and 155.4, respectively. These stations were divided into three groups for the analysis of the results:

AY-2, EZ-1, EZ-5

<u>Lower Farfield</u> (downstream from SRP): River Miles 29.6 to 120.0 (ten stations)

<u>Nearfield</u> (adjacent to SRP): River Miles 128.9 to 157.3 (13 river stations plus the two intake canal stations)

Table C-14. Locations and dates where sturgeon larvae were collected in the Savannah River during 1982 and 1983[a]

	Date of collection	River Mile	Species
	3/12/82	157.3	Shortnose sturgeon
	3/26/82	157.3	Shortnose sturgeon
	4/22/82	155.2	Atlantic sturgeon
	4/22/82	155.2	Atlantic sturgeon
	4/22/82	155.2	Atlantic sturgeon
	4/22/82	157.0	Atlantic sturgeon
	4/22/82	157.0	Atlantic sturgeon
	4/22/82	150.8	Atlantic sturgeon
	4/22/82	157.0	Atlantic sturgeon
	5/21/82	155.4	Atlantic sturgeon
	5/21/82	155.4	Atlantic sturgeon
	5/21/82	157.0	Atlantic sturgeon
	5/21/82	157.3	Atlantic sturgeon
	8/12/82	157.3	Atlantic sturgeon
	3/09/83	79.9	Shortnose sturgeon
	3/22/83	155.4	Shortnose sturgeon
	3/22/83	157.1	Shortnose sturgeon
AY-3	3/22/83	155.3	Shortnose sturgeon
	3/22/83	155.2	Shortnose sturgeon
	3/23/83	97.5	Shortnose sturgeon
	3/29/83	155.2	Shortnose sturgeon
AY-3	4/26/83	129.1	Atlantic sturgeon
	5/03/83	157.0	Atlantic sturgeon
AY-3	5/10/83	155.4	Atlantic sturgeon
	5/17/83	150.4	Atlantic sturgeon
	5/18/83	69.9	Atlantic sturgeon
	6/14/83	150.8	Atlantic sturgeon

AY-3

[a]Adapted from Matthews and Muska (1983). These include all sturgeon taken during day and night sampling.

Upper Farfield (upstream of SRP): River Miles 166.6 to 187.1 (three stations)

A total of 36,941 fish larvae and 6308 fish eggs were collected during this period. The most abundant taxa were the Clupeidae, a family that contains the anadramous species blueback herring and American shad, as well as the forage species Dorosoma sp. Crappie and minnow larvae were also abundant (Table C-12).

AY-7, EZ-1, EZ-5

In general, during February, March, and April, densities of total ichthyoplankton (eggs and larvae combined) were highest in the lower reaches of the river and decreased in an upstream direction. May was a transitional month when densities were more uniform throughout the river. During June and July, densities were generally higher in the nearfield and upper farfield than in the areas downstream. The trend of generally higher densities nearer the river mouth earlier in the year is largely because the lower Savannah River warmed more rapidly than the upper reaches and provided suitable spawning conditions for a longer period of time. However, such factors as the migratory movement of spawning adults might also play a role in these trends.

The seasonal pattern observed was the same throughout the stretches of river sampled: low densities occurred in February, increased to peak values in May, and declined to low levels in July.

The eggs and larvae of the American shad were collected in all three river areas. A total of 3557 eggs and 512 larvae of this species were taken. Highest densities were observed during May at River Mile 157.3. Mean densities for the 6-month collection period were higher above River Mile 89.3 than below. Thus, the region of maximum spawning of this species in 1983 included, but was not limited to, the SRP area.

Blueback herring eggs and larvae were also collected in all three river areas. The highest densities were observed in April at River Mile 97.5. During all months, densities of this species were greater in the lower farfield than in the nearfield and upper farfield areas.

A total of 852 striped bass eggs and 88 larvae was collected during the 1983 river study. Striped bass ichthyoplankton were prevalent only in May and June, although a few were found in April. During May, eggs and/or larvae were collected at all 10 lower farfield transects; at 10 of the 15 nearfield transects, the greatest densities occurring between River Miles 155.4 and 152.0; and at one of three upper farfield transects. During June, ichthyoplankton of this species was collected at only eight transects overall. Densities were highest at River Miles 129.1 and 166.6. Striped bass were found at only two transects in April, both in the nearfield area. Based on these results, it appears that the entire length of the Savannah River that was sampled (from River Mile 29.6 to River Mile 166.6) was used by the striped bass for spawning in 1983. AY-7, EZ-1, EZ-5

Yellow perch larvae were collected in all three of the river areas sampled. Highest densities were observed in April between River Miles 97.5 and 141.7. Densities were also high in this area during other months. This maximum-density region included the section of river below and, in April, slightly above Steel Creek, which is a major producer of yellow perch ichthyoplankton.

Crappie were the second most numerous larvae in the collections; a total of 6126 were identified. No eggs of this species were identified. Crappie reached greatest densities in March and April. They were most numerous in the lower farfield during both months. Densities were somewhat lower in May and much lower during all other months.

Minnows, which are important as forage for predatory species, were present during all months sampled. A total of 5170 larvae were found. This species first appeared in significant numbers during March. During this month, mean densities of larvae (no eggs were identified as minnow) were highest in the lower farfield but were also high in the nearfield between Lower Three Runs Creek and River Mile 141.7. Minnow densities were much higher in April, but the same basic pattern of higher densities downstream of River Mile 141.7 was evident. Densities peaked in May, especially in the nearfield.

Ten sturgeon larvae were collected during the routine 1983 ichthyoplankton studies: four shortnose sturgeon (in March) and six Atlantic sturgeon (in April, May, and June). All were collected between River Miles 69.9 and 157.0. Three other shortnose sturgeon larvae were collected during other sampling in 1983 (Table C-14).

AY-3 During several months, some fish taxa exhibited somewhat higher densities in the intake canals than in the adjacent river. In March and May, crappie ichthyoplankton densities were higher in the canals than the nearby river, as were blueback herring in April and Dorosoma sp. in June. These data suggest that crappie, blueback herring, and Dorosoma were spawning in the intake canals in 1983. However, all three taxa exhibited comparable or higher densities elsewhere in the river, indicating that other locations were equally or more important as spawning sites.

Adult fish sampling stations for the 1982 studies were the same as those described for fish eggs and larvae. At the river stations, canal stations, and Upper Three Runs Creek, a 100-meter section of shoreline was measured and marked. On Four Mile Creek and Steel Creek, the lengths of the shocking transects were limited to less than 100 meters by fallen trees that blocked the creeks.

Electrofishing and hoopnet collections were made in each sample area on four occasions within a 12-day period in August and October 1982 and January 1983. The repeated sampling was conducted to obtain a more complete species list and to collect sufficient numbers of fishes for an estimate of their relative abundance. Most fish collected were returned alive to the river following analysis.

Over 2400 fishes in 55 species have been collected to date. The adult fish community was dominated by spotted sucker, bowfin, redbreast sunfish, catfish, and flat bullhead (Table C-15).

The numbers of fishes taken in the river station collections by both electrofishing and hoop netting were similar in August and October and more variable in January. Fishes congregated in the heated discharge areas in the colder months and were absent from them during warm months.

Intake canal collections generally contained smaller fishes than the river collections and were dominated by centrarchids.

Creek station collections differed markedly from each other. Steel Creek had the highest fish density in October while the heated Four Mile Creek had the highest density in January. Upper Three Runs Creek had fish densities similar to river stations.

These data were consistent with the results of electrofishing collections made by the Georgia Game and Fish Division (1982) in the Savannah River. The Georgia study listed redbreast sunfish, striped mullet, spotted sucker, and bluegill as the most abundant fishes, exclusive of miscellaneous minnows. McFarlane et al. (1978a) listed redbreast sunfish, bluegill, and spotted sucker as the three most common species, exclusive of minnows.

Table C-15. Relative abundance of fishes collected by electrofishing in the Savannah River, August 1982, October 1982, and January 1983[a]

Species	Percentage abundance August 1982	October 1982	January 1983
Longnose gar	0.6	0.5	4.0
Bowfin	5.5	13.6	15.1
American eel	4.2	3.6	0.3
Blueback herring	0.0	2.4	0.0
American shad	3.9	0.0	0.0
Gizzard shad	2.9	1.9	4.5
Threadfin shad	0.0	0.0	2.3
Redfin pickerel	0.0	0.7	5.4
Chain pickerel	1.3	1.3	3.4
Carp	1.6	0.3	1.4
Golden shiner	0.0	0.0	0.3
Spotted sucker	15.3	13.5	22.7
Silver redhorse	1.3	0.9	1.4
Flat bullhead	1.0	0.0	0.3
Channel catfish	0.0	0.2	0.0
Pirate perch	0.0	0.9	0.0
Flier	0.0	0.0	0.9
Redbreast sunfish	18.8	22.4	7.1
Pumpkinseed	0.0	0.0	0.3
Warmouth	0.6	1.2	0.0
Bluegill	4.5	11.2	2.6
Dollar sunfish	0.0	1.4	0.0
Redear sunfish	15.0	3.3	7.7
Spotted sunfish	1.3	7.1	4.8
Largemouth bass	7.1	7.9	8.5
White crappie	0.0	0.7	0.3
Black crappie	0.6	0.7	3.7
Striped mullet	11.7	1.5	1.1
Yellow perch	2.3	2.0	2.0
Hogchoker	0.6	0.8	0.0

[a]Adapted from ECS (1983b,c).

The Savannah River fisheries program was expanded in February 1983 to collect samples of fish eggs and larvae from the river and its major tributaries from Augusta to near Savannah. The results of the river portion of the study are given above. The information obtained from the sampling of the tributary creeks is given below.

A total of 27 creeks were sampled for ichthyoplankton from 5 to 23 times during the February through-July 1983 period. Five of these creeks drain portions of SRP: Beaver Dam Creek, Upper and Lower Three Runs Creeks, Four-Mile Creek, and Steel Creek. The remainder lie upstream or downstream of the site. AY-2, EZ-1, EZ-5

A total of 5714 fish larvae and 810 fish eggs were collected. Spirit Creek (River Mile 182.8) had the highest number of ichthyoplankton with 1530 eggs and larvae taken in 19 samples. The high number at this location was due to the unusually high number of eggs (primarily Dorosoma sp.) collected during May and June.

Steel Creek yielded 518 fish larvae and 103 eggs in 23 collections. The larvae were predominantly minnows, yellow perch, and sunfish and bass. Many blueback herring eggs were also collected. When compared to other creeks that were sampled ten or more times, Steel Creek ranked eighth in larval density of all species combined. This creek was distinctive in having minnows and yellow perch represent about 27 and 30 percent, respectively, of the fish larvae collected. In all other streams of a similar size, these two species made up no more than about 13 and 7 percent of the total larvae, respectively. In Steel Creek, densities of crappie and larvae relative to other species were much lower than in the other large streams sampled.

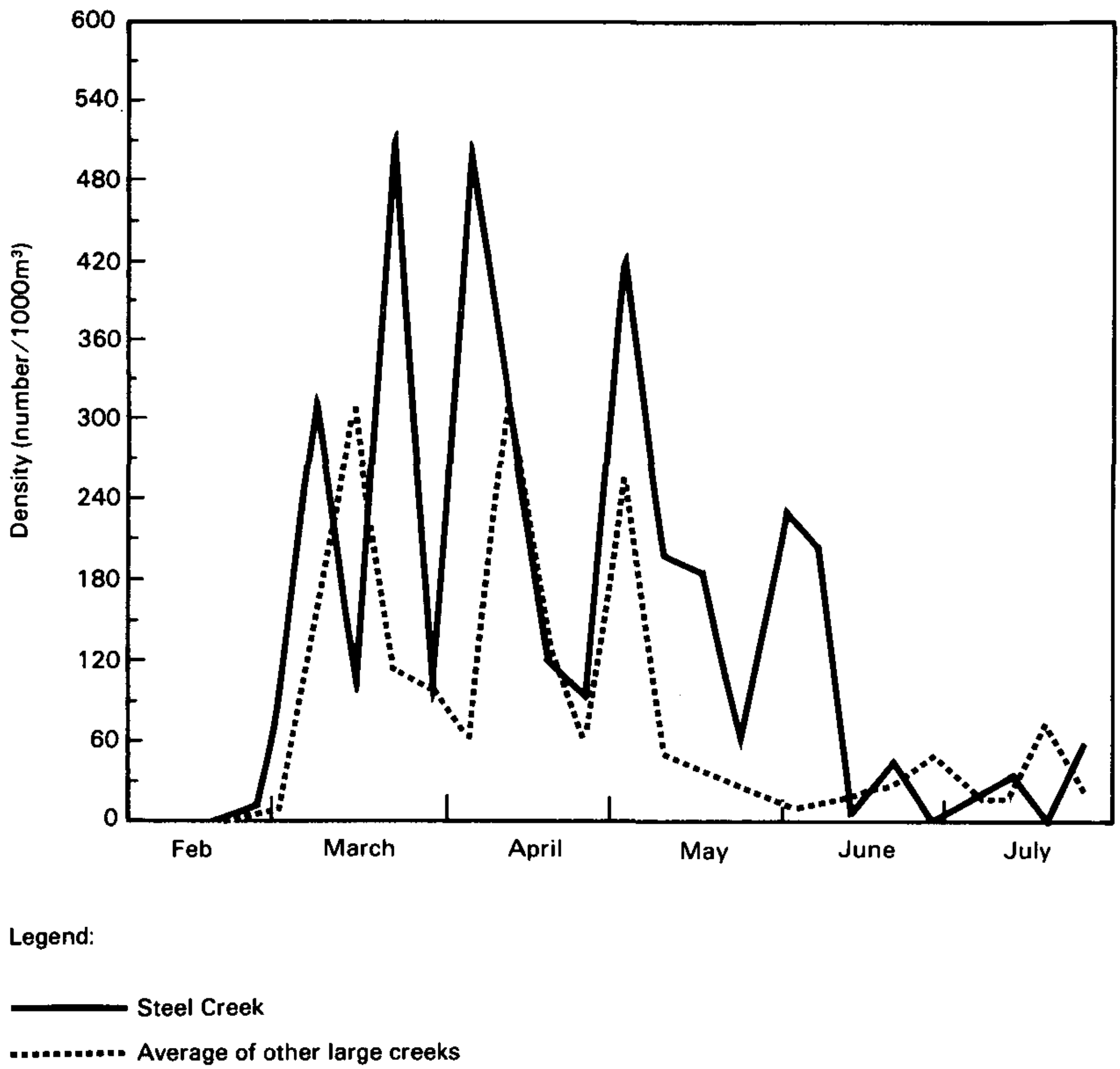
Seasonal trends in larval abundance in Steel Creek indicated peaks in density in March and April that were due to high numbers of yellow perch. Peaks
AY-2, in May and June were caused by sunfish and minnows. The maximum density
EZ-1, occurred on May 3, 1983. This sample period coincided with a sharp reduction in
EZ-5 river level; the high density probably reflects a large number of sunfish larvae in the water draining from the swamp.

Seasonal trends in larval density in Steel Creek were compared to seasonal trends in mean larval density at the six similar large creeks. Spawning peaks occurred both earlier and later in the season in Steel Creek than at the other locations. Larval density was generally higher than the mean of the other creeks.

There was much more fish spawning in Four Mile Creek in 1983 than in 1982, apparently because high river levels reversed stream flow sufficiently to allow fish to enter the creek. A high density of larvae, mostly of the blueback herring, was observed on April 4, 1983. However, similar medium-sized streams that were sampled had higher larval densities and longer spawning periods than Four Mile Creek. Apparently, the elevated water temperatures in this stream were a factor that limited spawning.

Beaver Dam Creek was sampled 13 times and larvae were collected on all but one date. The larvae were predominantly sunfish and silversides.

The seasonal trend of ichthyoplankton abundance in four select creeks (Ebenezer, Briar, Steel, and Spirit) was evaluated from weekly samples between February and May, 1983 (ECS, 1983d). Densities of ichthyoplankton were relatively constant in Steel Creek, whereas densities fluctuated markedly in the other creeks (Figure C-14). Blueback herring spawning was greatest in Briar Creek, with high densities occurring over a 4-week period. Steel Creek had a high density of blueback herring on one sampling date (Figure C-15). Yellow perch larval density was higher in Steel Creek than in any of the other three creeks (Figure C-16).

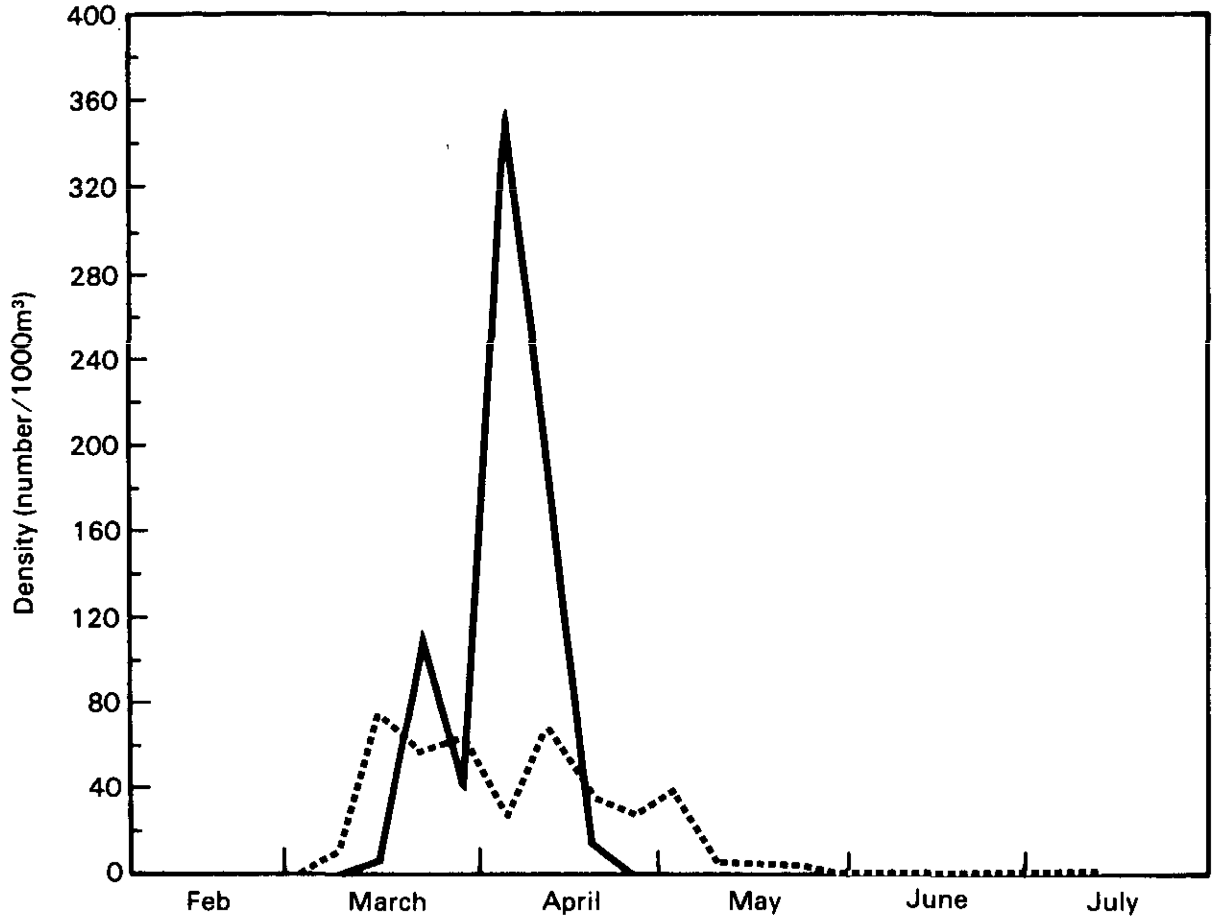


Adapted from ECS (1983d). Other large creeks include: Smith Lake (Rm 126.5), Briar (Rm 97.6), Ebenezer (Rm 44.8), Coleman Lake (Rm 40.3), Meyer's Lake (Rm 35.4) and Collins Creeks (Rm 30.0).

AY-2, EZ-1, EZ-5

Figure C-14. Average density of ichthyoplankton (eggs and larvae combined) for Steel Creek and all other large creeks, February-August, 1983.

AY-2,
EZ-1,
EZ-5



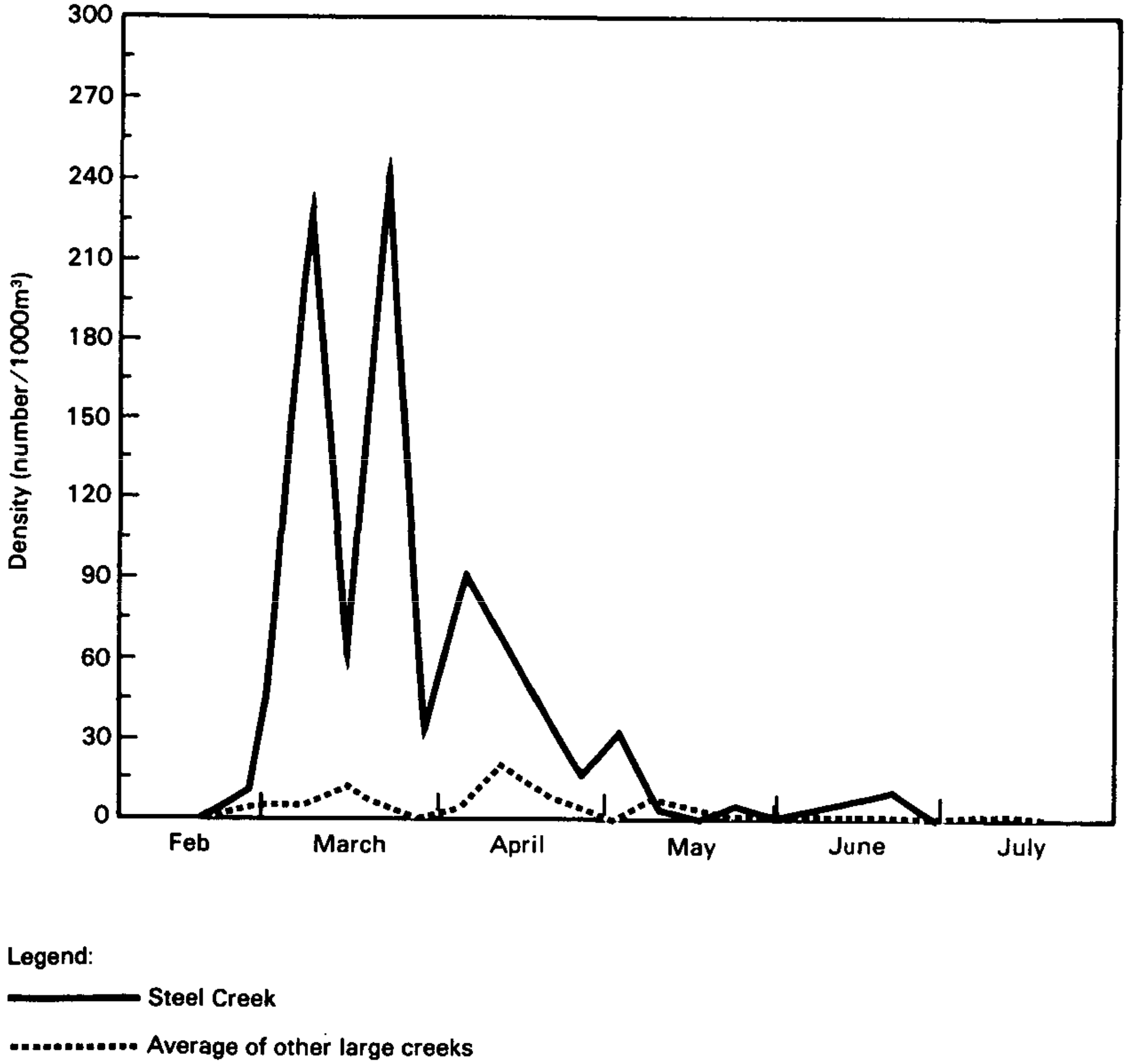
Legend:

——— Steel Creek

•••••••••••• Average of other large creeks

Adapted from ECS (1983d). Other large creeks include: Smith Lake (Rm 126.5), Briar (Rm 97.6), Ebenezer (Rm 44.8), Coleman Lake (Rm 40.3), Meyer's Lake (Rm 35.4) and Collins Creeks (Rm 30.0).

Figure C-15. Average density of blueback herring ichthyoplankton (eggs and larvae combined) for Steel Creek and all other large creeks, February-August, 1983.



Adapted from ECS (1983d). Other large creeks include: Smith Lake (Rm 126.5), Briar (Rm 97.6), Ebenezer (Rm 44.8), Coleman Lake (Rm 40.3), Meyer's Lake (Rm 35.4) and Collins Creeks (Rm 30.0).

AY-2, EZ-1, EZ-5

Figure C-16. Average density of yellow perch ichthyoplankton (eggs and larvae combined) for Steel Creek and all other large creeks, February-August, 1983.

Steel Creek fisheries program

The purpose of the 1982-1983 fish population studies in Steel Creek was to determine the use of the Steel Creek swamp and delta area by fishes and to characterize the fish community in terms of species use and relative abundance. Although some species known to occur within the Savannah River drainage are on the Federal or state lists of threatened and endangered species, no such fish have been collected in Steel Creek. Fish listed among South Carolina's commercially and recreationally important species have been collected. The commercially important species are primarily anadromous.

The Steel Creek area of the Savannah River swamp was divided into six sampling areas (Figure C-17) to determine habitat utilization by resident and anadromous fish (Smith et al., 1982a,b, 1983). The lower Steel Creek channel between the swamp and the Savannah River was also sampled. Sampling for anadromous fish began on January 30, 1982, and continued through 1983.

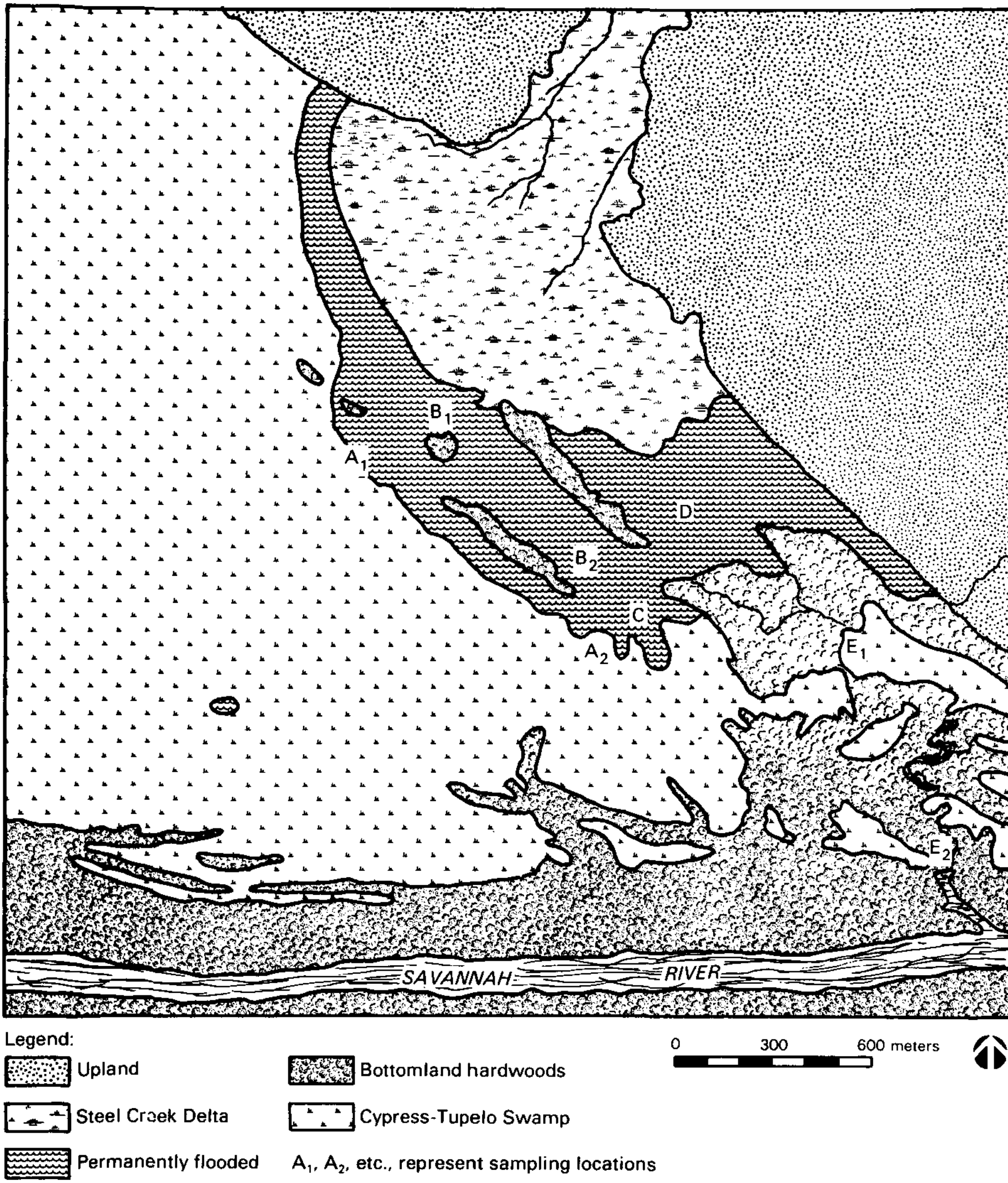
Fish of various sizes were collected for most species. The collections should be representative of both relative abundance and species composition of the swamp fish community. A total of 5313 fish representing 55 species were collected from the Steel Creek-river-swamp system from November 1981 through July 1982. A total of 1000 individuals representing 31 species was collected by fyke nets in Steel Creek from February through May of 1983 (Smith et al., 1982b) (Table C-16).

Figure C-18 shows the mean number of fish collected per 50-meter transect in the Steel Creek swamp area. The order of rankings of mean number of fish collected in each area were $B_1 > A_1 > B_2 > C > A_2$, with more fish collected in Area B_1 than in all other areas.

Areas B_1 and B_2 also appear to be important as spawning and/or nursery areas for resident fishes in the swamp. Young-of-year fishes were captured almost exclusively in these areas, although no spawning activity was ever observed. Young-of-year fish dispersed into other areas as they increased in size through the summer.

No major run of anadromous fish was detected in the Steel Creek area during 1982; a total of six American shad and four blueback herring was collected with fyke nets from February through April. To determine if the nets were an effective method for capturing clupeids, portions of lower Steel Creek were electrofished on selected dates; few fish were collected. Conversations with fishermen at the confluence of Steel Creek and the Savannah River also suggested that a major run did not occur in 1982 and that this year was atypical (Smith et al., 1982a). There was greater utilization of the Steel Creek delta-swamp area by adult shad and blueback herring in 1983 when compared to 1982 (76 shad in 1983 versus 6 in 1982; 124 blueback herring in 1983 versus 4 in 1982). Two striped bass were collected in this area in 1983 while none were collected in 1982 (Smith et al., 1983).

The 1982-1983 sampling provided information on which areas of the Steel Creek system are used by these species. The majority of fish were collected in lower Steel Creek channel with some fish being collected from the fast water



Source: Smith, Sharitz, and Gladden (1983).

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Figure C-17. Fish sampling locations in the Steel Creek delta and swamp, 1981-1983.

Table C-16. Total number of fish (by species) collected with fyke nets in Steel Creek and Upper Three Runs Creek, February-May 1983[a]

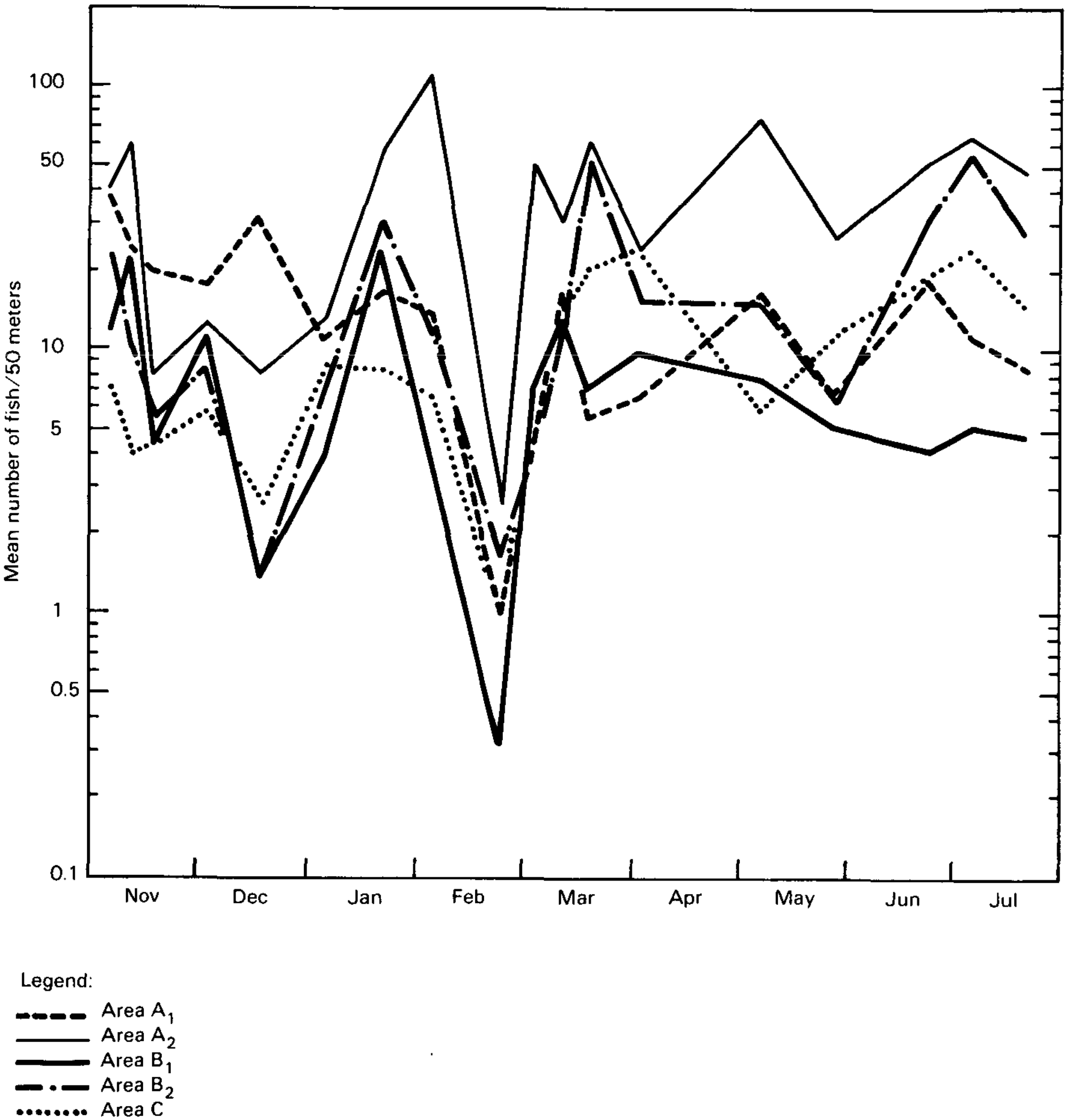
Species	Steel Creek		Upper Three Runs Creek
	Upper net	Lower net	
Bowfin	14	11	9
American eel	2	2	8
Atlantic needlefish	0	1	0
Lake chubsucker	2	0	0
Spotted sucker	8	3	4
Flier	0	4	25
Redbreast sunfish	0	2	6
Warmouth	0	0	1
Bluegill	1	0	9
Redear sunfish	0	2	3
Spotted sunfish	12	0	0
Largemouth bass	1	0	0
Black crappie	4	3	14
Hickory shad	21	10	20
American shad	35	41	5
Blueback herring	48	76	209
Gizzard shad	74	64	97
Carp	0	1	0
Golden shiner	1	3	5
Chain pickerel	1	0	1
White catfish	3	0	5
Yellow bullhead	6	0	0
Brown bullhead	4	1	0
Flat bullhead	4	3	2
Channel catfish	34	6	15
Unidentified Ictalurid	1	0	0
Longnose gar	223	319	228
Florida gar	12	23	49
Striped mullet	6	7	1
Striped bass	1	1	2
Striped bass (hybrid)	0	0	4
Total	518	583	722

[a]Adapted from Smith et al. (1983).

areas of the swamp. Other migratory fish that were collected included the Atlantic needlefish and striped mullet.

C.5 ENDANGERED AND THREATENED SPECIES

The Endangered Species Act of 1973 (Public Law 93-205) is administered by the U.S. Fish and Wildlife Service in conjunction with cooperating states and



Source: Smith et al. (1983).

Figure C-18. Mean number of fish per 50-meter transect, collected in areas of the Steel Creek swamp, November 1981-July 1982.

other Federal agencies, and affords protection to some 300 species of native American plants and animals. A species can be federally listed under either of two categories, endangered or threatened, depending on its status and the degree of the threat posed to it. Endangered refers to a species or subspecies that is in danger of extinction throughout all or a significant portion of its range. Threatened means any species or subspecies that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. When a species is proposed for the endangered or threatened status, areas essential to its survival or conservation are also proposed as "critical habitat," when appropriate. Compliance with the Endangered Species Act requires Federal agencies to consult with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service on potential impacts and mitigation and to conduct a biological assessment of any listed or proposed species that might be present in the area of the proposed action.

In addition to the Federal list, the State of South Carolina also recognizes and affords protection to fauna in accordance with the South Carolina Nongame and Endangered Species Conservation Act of 1974. However, the State does not afford protection to flora other than federally protected species.

The following section addresses those species that are protected by Federal
TC| and state law. These include 3 plants, 1 bivalve, 1 fish, 1 reptile, 11 birds, and 2 subspecies of mammals (Table C-17). Species with historic ranges that include the Savannah River Plant are mentioned briefly even though they are unlikely to occur in the impact area. Where possible, emphasis is given to the vicinity of L-Reactor, Steel Creek and its delta, and the Savannah River. (For listings of unprotected taxa such as those of "special concern" or "peripheral," consult Forsythe and Ezell (1979) and Rayner et al. (1979).)

C.5.1 Flora

Two endangered and one proposed endangered species of vascular plants are listed by the U.S. Department of the Interior (USDOI, 1983) for South Carolina. None have been identified on the SRP site or near Steel Creek during field studies conducted over the past 25 years.

Termed the rarest orchid in America, the small whorled pogonia (*Isotria medeoloides*) is currently proposed by the Fish and Wildlife Service as an endangered species; only 16 populations, which include 150 to 175 individual plants, are estimated to exist within its phytogeographical range, which extends from Canada to Georgia (Norkin, 1980). The only population known to exist in South Carolina is in the Sumter National Forest, where its habitat includes second-growth deciduous or deciduous/coniferous forests having an open canopy, sparse shrub and herbaceous layers, and proximity to streams, roads, or rights-of-way.

The persistent trillium (*Trillium persistens*), a member of the lily family, is known only from a 6.5-kilometer area of northern Georgia and South Carolina (Finnley, 1979a). Its preferred habitat consists of hemlock-dominated or yellow-poplar-dominated cove forests with an understory of great laurel (*Rhododendron maxima*) of varying density. The occurrence of this plant anywhere on the SRP site is doubtful (Rayner, personal communication with G. P. Friday).

Table C-17. Endangered and threatened species inhabiting or potentially occurring on Savannah River Plant site

Common name	Scientific name	Status	Listing agency[a]	Critical habitat designation	Occurrence on SRP[b]	Preferred habitat
Arrowhead, bunched	Sagittaria fasiculata	Endangered	USDI	No	Unknown	Swamps and bogs (Radford et al., 1964); hemlock- or yellow-poplar-dominated coves having an understory of great laurel (Rayner et al., 1979)
Persistent trillium	Trillium persistens	Endangered	USDI	No	Unknown	
Small-whorled pogonia	Isotria medeoloides	Endangered (proposed)	USDI	No	Unknown	Wooded slopes and along streams (Radford et al., 1964); deciduous/coniferous forest having an open canopy, open shrub layer, and sparse herbaceous layer
Brother spike mussel	Ellipio fraterna	Endangered	SC	No	Unknown	Sandy, freshwater shallows; collected in 1972 near SRP (Fuller, 1979)
Shortnose sturgeon	Acipenser brevirostrum	Endangered	USDI	No	Unknown	Historically, spawns in rivers from New Brunswick to Florida (Forsythe and Ezell, 1979)
American alligator	Alligator mississippiensis	Endangered	USDI, SC	No	Confirmed	Swamps, creeks, impoundments, or other wetland areas
Cooper's hawk	Accipiter cooperii	Threatened	SC	No	Confirmed	Open woodlands and wood margins (Robbins et al., 1966); a probable resident on SRP (Du Pont, 1982)
Golden eagle	Aquila chrysaetos	Endangered	SC	No	Unknown	Mountains, grasslands, remote areas; winter range includes SRP (Robbins et al., 1976)

Table C-17. Endangered and threatened species inhabiting or potentially occurring on Savannah River Plant site (continued)

Common name	Scientific name	Status	Listing agency[a]	Critical habitat designation	Occurrence on SRP[b]	Preferred habitat
Ivory-billed woodpecker	*Campephilus principalis*	Endangered	USDI, SC	No	Unknown; probably extinct (Gauthreaux et al., 1979)	Undisturbed, mature hardwood forest
Kirtland's warbler	*Dendroica kirtlandii*	Endangered	USDI, SC	No	Unknown	Jackpine in Michigan (nesting); winters in the Bahamas (Robbins et al., 1966); perhaps an infrequent transient in South Carolina
Swallow-tailed kite	*Elanoides forficatus*	Endangered	SC	No	Unknown	Swamps, marshes, river banks, and open forests (Robbins et al., 1966); breeds in swamplands of South Carolina's coastal plain (Forsythe and Ezell, 1979)
American peregrine falcon	*Falco peregrinus anatum*	Endangered	USDI, SC	California	Unknown	Coasts, mountains, and woods (Robbins et al; 1966); regularly reported in South Carolina during migration and winter (Gauthreaux et al., 1979)
Bald eagle	*Haliaeetus leucocephalus*	Endangered	USDI, SC	No	Confirmed	Wooded or mountainous areas near water, including swamps and bottomlands; winters and breeds in South Carolina (Forsythe and Ezell, 1979)
Wood stork (ibis)	*Mycteria americana*	Endangered	USDI, SC	No	Confirmed	Swamps, marshes, and ponds (Robbins et al., 1966)

Table C-17. Endangered and threatened species inhabiting or potentially occurring on Savannah River Plant site (continued)

Common name	Scientific name	Status	Listing agency[a]	Critical habitat designation	Occurrence on SRP[b]	Preferred habitat
Osprey	*Pandion haliaetus*	Threatened	SC	No	Confirmed	Near fresh- or saltwater; may be seen in spring or fall but doesn't breed or winter in South Carolina (Robbins et al., 1966); an occasional migrant on SRP (Du Pont, 1982)
Red-cockaded woodpecker	*Picoides borealis*	Endangered	USDI, SC	No	Confirmed	Open, mature (averaging 75 years) pine forests having sparse ground cover (Finnley, 1979b)
Backman's warbler	*Vermivora bachmanii*	Endangered	USDI, SC	No	Unknown	Moist, deciduous woodlands (Robbins et al., 1966)
Eastern cougar	*Felis concolor cougar*	Endangered	USDI, SC	No	Unconfirmed	Isolated and remote areas, especially near swamps of the larger rivers (Golley, 1966)
Florida panther	*Felis concolor coryi*	Endangered		No	Unconfirmed	

[a]Key: USDI = U.S. Department of the Interior; SC = South Carolina.
[b]Savannah River Plant.

Only two populations of the endangered bunched arrowhead (*Sagittaria fasiculata*) have been confirmed--one in Henderson County, North Carolina, and the second in Greenville County, South Carolina. The latter population occupies a transmission line right-of-way along the headwaters of a river (Finnley, 1979a). The habitat of this plant is somewhat unique and consists of nearly level seepage areas that have a year-round, continuous supply of gently flowing cold water. The existence of this species on or near Savannah River Plant is very doubtful.

C.5.2 Fauna

C.5.2.1 Mussels

Listed as endangered by the State, the brother spike mussel (*Ellipio fraterna*) has been identified only in the Chattahoochee and Savannah Rivers from sandbars beneath 0.3 to 0.6 meter of water (Britton and Fuller, 1980). The 1972 discovery of this bivalve in the Savannah River approximately 15 river miles downstream from the mouth of Steel Creek was the first documented collection in 130 years. The distribution and ecology of this species, particularly in the Savannah River, are poorly understood.

TC

C.5.2.2 Fish

The shortnose sturgeon (*Acipenser brevirostrum*) is listed by the Federal Government as an endangered species in the United States (USDOI, 1983). The species is found only on the east coast of North America in tidal rivers and estuaries. Prior to 1982, the shortnose sturgeon had not been reported in the middle reaches of the Savannah River in the vicinity of the Savannah River Plant. However, shortnose sturgeon larvae were found in ichthyoplankton samples collected in the Savannah River above Upper Three Runs Creek and 3G pumphouse intake canal as part of the Savannah River Biological Measurement Program (ECS, 1983a). As a result, DOE initiated a consultation process with the National Marine Fisheries Service (NMFS) to comply with the Endangered Species Act of 1973 (ESA, Public Law 93-205, as amended). Based on the results of this consultation process, the NMFS concurred in DOE's determination that the population of the shortnose sturgeon in the Savannah River would not be adversely affected (Oravetz, 1983).

AY-3

C.5.2.3 Amphibians

TC

No amphibians inhabiting the SRP are currently listed as endangered or threatened.

C.5.2.4 Reptiles

Listed as endangered by USDOI (1983) and by the State, the American alligator (Alligator mississippiensis) is locally common on the Savannah River Plant; it breeds in Par Pond and the Savannah River swamp (Gibbons and Patterson, 1978). The ecology of this species has been examined intensively on the Savannah River Plant, and is presented in Section C.3.1.

Formal consultation on the American alligator was held under the Endangered Species Act in September 1982 with representatives of DOE-SR, Du Pont, NUS Corporation, the Savannah River Ecology Laboratory (SREL), and the U.S. Fish and Wildlife Service (FWS). In a biological opinion, FWS judged that protection of the lagoons at SRP Road A should provide sufficient mitigation for the American alligator potentially impacted by L-Reactor restart. Protection of these lagoons has been completed.

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Because of the delayed restart schedule for L-Reactor, the Fish and Wildlife Service requested reconsultation. DOE has subsequently reinitiated the consultation process, and has transmitted the most recent information and impact projections for this species (Sires, 1983, 1984a). DOE is awaiting a decision on its conclusion that the impacts resulting from the delayed restart of L-Reactor will not jeopardize the continued existence of the species.

C.5.2.5 Birds

The Cooper's hawk (Accipiter cooperii) is listed as threatened by the State, and has been documented on the Savannah River Plant during Christmas bird counts (Angerman, 1979, 1980).

The winter range of the golden eagle (Aquila chrysaetos), an endangered raptor of South Carolina, includes Savannah River Plant. The number of breeding birds in the mountains of the eastern United States has declined significantly recently, but management efforts should enhance its survival (Forsythe and Ezell, 1979). Its presence on the SRP site has not been confirmed, but it might overwinter in the Savannah River swamp.

According to the most recent information, the ivory-billed woodpecker (Campephilus principalis) is probably extinct (Gauthreaux et al., 1979). There have been no confirmed reports of this large woodpecker on the SRP site and it is extremely unlikely that it exists. Its preferred habitat is dense, isolated mesic or swamp hardwood forests.

The endangered Kirtland's warbler (Dendroica kirtlandii) is apparently very habitat-specific, and has never been found to nest anywhere except in northern lower Michigan; specifically, it nests among dense stands of young jack pine on Grayling sand (Senecal, 1981). It winters in the Bahama islands and could possibly occur on the SRP site as a transient, although its presence has never been confirmed.

The summer or breeding range of the swallow-tailed kite (Elanoides forficatus), an endangered hawk of South Carolina, includes Savannah River Plant, but its presence has never been confirmed. Its preferred habitat includes swamps, marshes, river banks, and open forests (Robbins et al., 1966).

The endangered peregrine falcon (Falco peregrinus) has been extirpated as a naturally occurring breeding bird in the eastern United States. Since the 1950s, captive breeding of peregrines and subsequent releases by Cornell University have spearheaded recent management efforts to reestablish this raptor (Finnley, 1979c). This species is reported regularly during migration and winter in South Carolina (Gauthreaux et al., 1979), but it has not been reported on the Savannah River Plant.

The bald eagle (Haliaeetus leucocephalus), an endangered species, has declined dramatically in number in recent years. During the 1980-1981 season, 20 active bald eagle nesting territories were observed in South Carolina (Kearney, 1981). The bald eagle has been observed over Par Pond (Patterson, 1981), but its presence near L-Reactor and Steel Creek is unknown.

TC The wood stork (Mycteria americana) is designated as endangered by South Carolina and the Fish and Wildlife Service. As many as 386 individuals were observed in 1983 feeding in the Savannah River swamp of Savannah River Plant. This species is discussed in greater detail in Section C.3.2.

The osprey (Pandion haliaetus), which is listed as threatened by the State, has been observed on Savannah River Plant (Du Pont, 1982) but is considered an occasional migrant. It typically does not breed or winter in South Carolina (Robbins et al., 1966), but might use the swamp and riverine habitats on the Savannah River Plant briefly during migration.

The endangered and nonmigratory red-cockaded woodpecker (Picoides borealis), first listed in 1970, is estimated to number less than 10,000 individuals (Finnley, 1979b). Also habitat-specific, this woodpecker nests in cavities in living upland pine trees averaging 75 years of age. The nearest colony to Steel Creek is approximately 0.8 kilometer from SRP Road A-19 (Du Pont, 1982). Because upland stands of mature conifers will not be affected by thermal discharge from L-Reactor, no indirect adverse impacts will occur to this species due to habitat degradation. The U.S. Fish and Wildlife Service has issued a biological TC opinion that the red-cockaded woodpecker will be unaffected by L-Area operations.

The endangered Bachman's warbler (Vermivora bachmanii), one of the rarest and least known of North American warblers, might be extinct. If the species still occurs in the United States, it probably is restricted to swamplands of South Carolina's coastal plain (Gauthreaux et al., 1979). Systematic surveys of the I'On Swamp, its last confirmed sighting, have been unsuccessful; its presence has never been recorded on the Savannah River Plant.

C.5.2.6 Mammals

Two subspecies of the cougar (Eastern cougar (Felis concolor cougar) and the Florida panther (Felis concolor coryl)) have historic ranges which include South Carolina. While the swamp bottomlands could provide habitat for individuals of either subspecies, there is no indication that either the Eastern cougar or the Florida panther occurs at Savannah River Plant.

C.6 AREAS OF SPECIAL CONCERN

Areas of special concern include environments that are recognized by a government agency or the scientific community as having unique or exceptional value as natural resources. This category includes (1) wetlands, (2) critical wildlife habitat, (3) state and national forests, (4) state and national game management areas (i.e., sanctuary, reserve, refuge, or preserve), (5) prime agricultural land, (6) designated natural areas, and (7) wild and scenic rivers. Of the areas listed above, only wetlands will be impacted by the proposed action. A description of the wetlands is given in Section C.2, above.

C.7 COMMERCIALLY AND RECREATIONALLY VALUABLE BIOTA

The utilization of fish and wildlife resources in South Carolina for commercial or recreational purposes is regulated by the South Carolina Wildlife and Marine Resources Department. This agency designates game species and season's creel and bag limits, and essentially regulates the fish and wildlife resources throughout the State.

Although the ecosystems of the Savannah River Plant support many populations of game and fish, commercial exploitation is prohibited and recreational use is restricted to controlled hunts of the white-tailed deer and feral hog. Despite restricted public access, poaching has been reported near the site's boundary and in the Savannah River swamp.

Commercially valuable plant biota on the Savannah River Plant include approximately 175,000 acres of timber that are managed by the U.S. Forest Service. The commercial value of timber on the Savannah River Plant that was managed and sold by the Forest Service was 1.7 million dollars in 1982; this included pine and hardwood sawtimber, pine pulpwood, and cordwood hardwoods. Approximately 71 percent of the timber sales consisted of pine pulpwood. The long-term trend in planting activities has been an increase in the number of loblolly pine and a decrease in slash pine. The latter is more susceptible to injury from ice glazing and has not been planted since 1970. Over 1,530,000 seedlings of loblolly pine and 160,000 seedlings of longleaf pine were planted in 1980 (USDA, 1983). DY-1

Public hunting of deer and feral hogs on the SRP site has been managed by the Forest Service since 1966 to minimize deer-car accidents and to maintain habitat quality. Beginning in 1981, the planning and management responsibility of these hunts was given to E. I. du Pont de Nemours & Co.

The annual number of hunter-days increased from 700 in 1966 to 6325 in 1980; paralleling this trend was an increase from 198 deer killed in 1966 to 961 in 1980. The harvest of feral hogs ranged from 10 in 1972 to 32 in 1980. There also has been a relatively consistent decline in the number of deer-car TE accidents. In the late 1960s and early 1970s, deer-car accidents ranged in the 50s; only 11 incidents were reported in 1980.

Other game species that have commercial and recreational value but that are protected from hunting include the bobcat, fox, mink, muskrat, opossum, otter, rabbit, raccoon, skunk, squirrel, migratory waterfowl, bobwhite quail, mourning dove, wild turkey, Wilson's snipe, and woodcock.

The Savannah River supports both commercial and sports fisheries. Table C-18 lists the species and catches of fish taken commercially from the river from 1970 to 1979. Many of these fisheries are confined to the marine and brackish waters of the coastal regions of South Carolina and Georgia. Table C-19 lists the total weight of shellfish caught in the lower Savannah River and adjacent coastal waters between 1972 and 1979.

The only commercial fishes of significance near the Savannah River Plant are the American shad (Alosa sapidissima), the channel catfish (Ictalurus punctatus) and the Atlantic sturgeon (Acipenser oxyrhnchus). These species, except for sturgeon, are exploited to a limited degree by nonprofessional local fishermen. There is no fishery specifically for hickory shad (Alosa mediocris) in South Carolina or Georgia; however, many are taken each year incidental to the catch of American shad (Ulrich et al., 1978).

Sport fishermen are the principal consumers of river fishes, primarily sunfish and crappie. Striped bass, which is classified as game fish in South Carolina and Georgia (Ulrich et al., 1978), is a favorite quarry of fishermen in the Augusta area.

Commercial and recreational fisheries for blueback herring (Alosa aestivalis) exist in South Carolina (Ulrich et al., 1978) but none are taken commercially in Georgia because of State netting restrictions.

Although species of commercial or sports importance in the Savannah River might use SRP streams, fishing or other exploitation of commercial species is not allowed on the site.

Anglers in the freshwater section of the Savannah River fish predominantly for bream and largemouth bass. Based upon electrofishing studies, the relative abundance of bream in the freshwater section of the river is high, as is the actual angler success rate. The lesser abundance of largemouth bass in the freshwater section results in a relatively low angler harvest of this species (Figure C-19).

Anglers in the estuarine section of the Savannah River fish predominantly for sea trout and striped bass. Electrofishing results indicate that these two species are not very abundant in the estuary. Actual angler success rates for these species are low (Figure C-20).

The Fisheries Section of the Georgia Department of Natural Resources recently published the results (Table C-20) of a fisheries study conducted on the Savannah River during the period July 1, 1981, to June 30, 1982 (Georgia Game and Fish Division, 1982). The study consisted of a creel survey of sports anglers and an electrofishing study. Together these studies provide data on the fish species most sought by anglers and on the probabilities of catching those species.

Table C-18. Commercial landing data for fish taken from Savannah River, 1970-1979[a]

Species	Combined catches in Georgia and South Carolina (kg)									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Carp	0	250	252	1,503	590	998	136	453	136	363
Catfish	544	157	222	518	726	1,814	1,043	1,043	363	1,043
Black drum	0	0	0	0	0	227	272	0	0	0
Red drum	0	0	0	0	45	0	181	499	136	0
Hickory shad	318	384	291	725	91	227	91	136	181	91
Spotted sea trout	0	0	0	324	227	2,500	1,800	181	181	0
American shad	43,591	25,568	25,439	33,912	26,263	20,412	8,618	20,820	54,432	57,607
Sturgeon	726	23	1,967	551	136	45	363	862	454	227
Suckers	0	0	0	0	0	0	91	0	0	0
Common eels	0	0	0	0	0	91	0	45	0	45
Mullet	0	0	0	0	0	227	0	91	0	0
Striped bass	816	735	1,013	1,071	0	0	0	0	0	0

[a]Adapted from Du Pont (1982).

Table C-19. Commercial landing data for shellfish taken from coastal regions of Savannah River, 1972-1979[a]

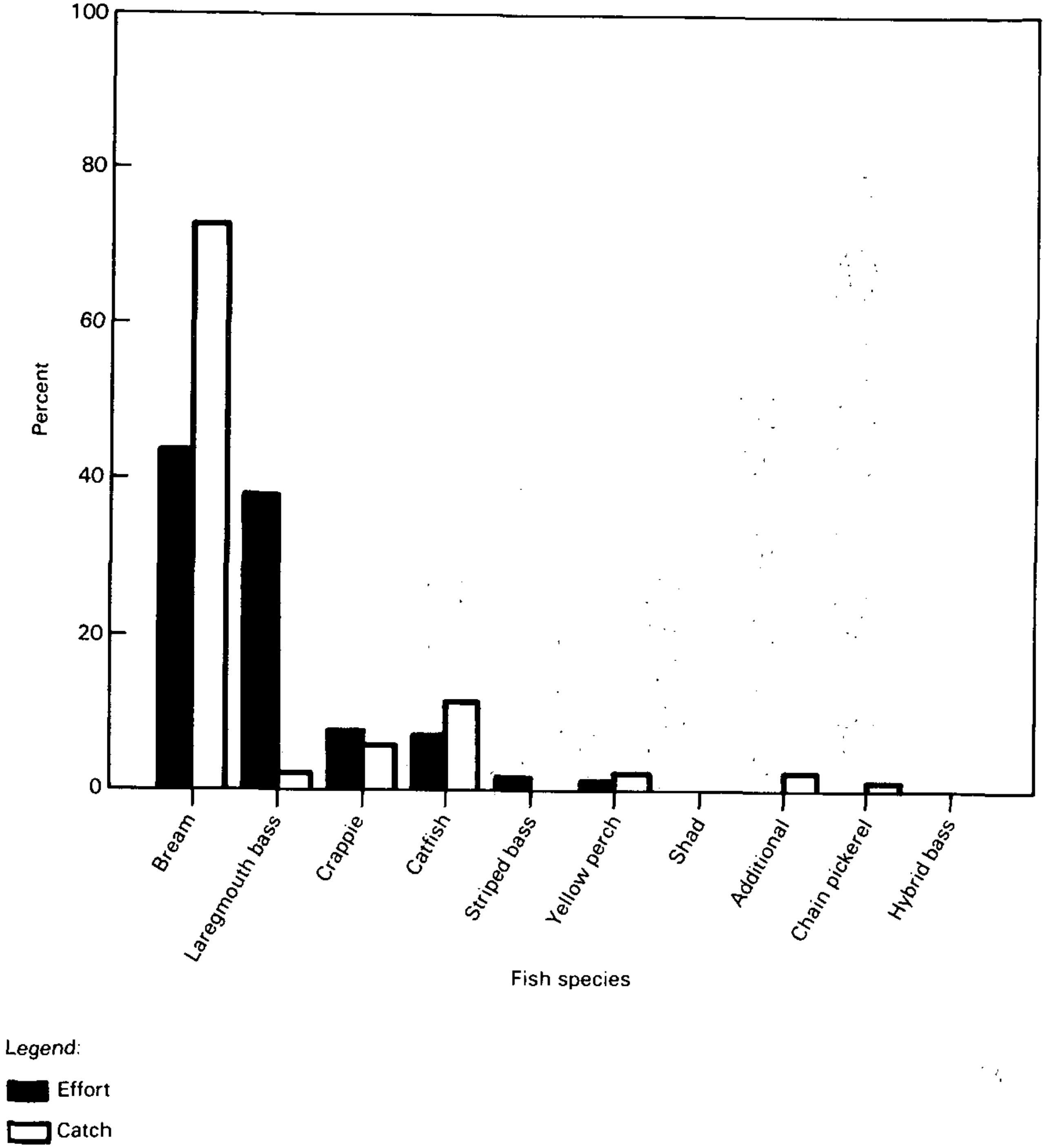
Year	Shellfish catch (kg)			
	Clams	Blue crabs	Oysters	Shrimp
1972	--	419,489[b]	1,451[c]	115,940[c]
1973	862[d]	543,957[b]	2,858[c]	222,128[c]
1974	--	1,252,072[e]	6,804[e]	1,141,530[e]
1975	--	17,237[b]	3,447[e]	1,264,818[e]
1976	--	--	--	--
1977	--	63,504[b]	19,051[e]	626,286[e]
1978	1,860[d]	68,040[b]	--	731,475[e]
1979	454[d]	104,781[b]	9,072[b]	--

[a]Adapted from Du Pont (1982).
[b]Wassaw Sound plus Ossabaw Sound.
[c]DOE (1982); T. Flowers, NMPS, personal communication.
[d]Savannah River landings.
[e]Northern District, Georgia.

Table C-20. Sports fishing on the Savannah River below New Savannah Bluff Lock and Dam

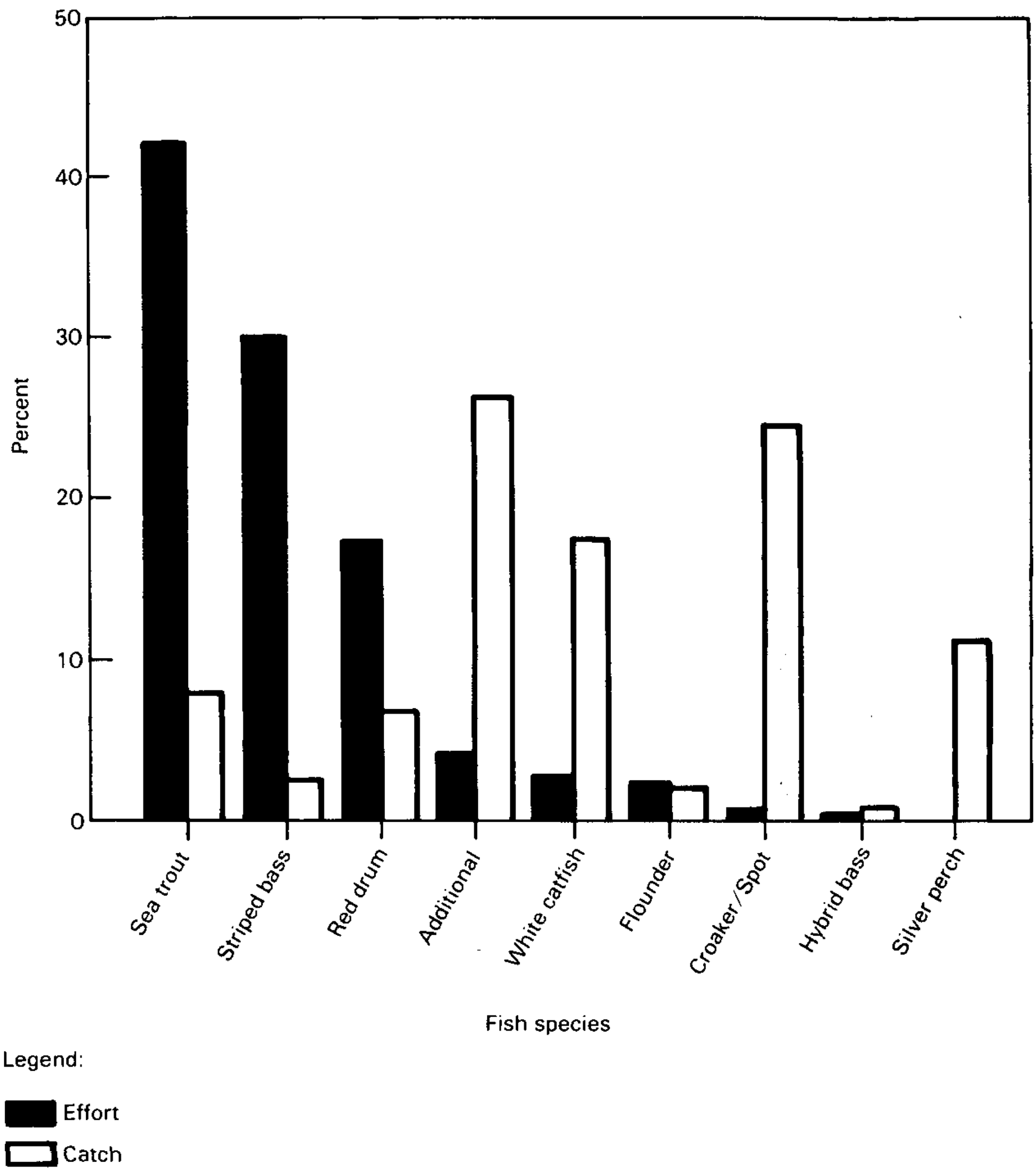
Fishing effort	Range[a]
Number of trips	70,054-85,848
Number of hours	305,398-399,222
Number of fish caught	456,235-644,329
Kilograms of fish	86,585-120,779
Total anglers	3,006-6,164
Trips per angler	12-22

[a]Range is one standard deviation about the mean.



Source: Du Pont (1983).

Figure C-19. Comparison of freshwater angler relative fishing effort and fish harvest by species.



Source Du Pont (1983)

Figure C-20. Comparison of estuarine angler relative fishing effort and fish harvest by species.

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APPENDIX D

RADIOCESIUM AND RADIOCOBALT INVENTORY AND TRANSPORT

This appendix discusses the releases of radiocesium (principally cesium-137) and radiocobalt (cobalt-60) to the Steel Creek system; describes the estimated distribution and inventory of these materials in the sediments, biota, and water of the creek, swamp, and Savannah River; examines their transport offsite; and predicts the concentrations in the Savannah River and downstream water treatment plants as a result of resumption of L-Reactor operation (reference case--direct discharge). This appendix is also the basis for discussions associated with the preferred cooling-water alternative (see Appendix L). TC

D.1 RELEASES OF RADIOCESIUM AND RADIOCOBALT

D.1.1 SRP releases

The principal sources of radiocesium and radiocobalt in the environment at SRP have been the reactor effluent discharges to onsite streams. These releases began in 1955, with the period of major reactor discharges occurring between 1955 and 1968.

From 1955 through 1980, about 560 curies of radiocesium have been discharged to onsite streams, approximately 284 curies of which were discharged to Steel Creek (Table D-1). These discharges resulted from leaching of reactor fuel elements with cladding failures which exposed the underlying fuel to water. The direct sources of these releases were heat exchanger cooling water, spent fuel storage and disassembly basin effluents, and process water from P- and L-Reactor areas (Figure D-1). A sharp decrease in the release of radiocesium (cesium-134 and cesium-137 in a ratio of 1:20, respectively; for ease of discussion, radiocesium will usually be referred to as cesium-137) occurred in the late 1960s and early 1970s when, (1) P-Reactor basin was fitted with sand filters and the basin water was demineralized before its release; and (2) the leaking fuel elements were removed to an environmentally safe storage area (L-Reactor is now equipped with a sand filter and ion exchange resin beds like those at P-Reactor).

A total of 66 curies of cobalt-60, formed by neutron activation of stainless steel in the reactors, has been discharged to SRP streams in the years following L-Reactor startup. An estimated 27 curies (15 from L-Reactor and 12 from P-Reactor) of this total was discharged to Steel Creek. Most of the cobalt-60 (half-life 5.26 years) has been eliminated through radioactive decay; however, an estimated 2.1 curies remain today either in Steel Creek or transported to the Savannah River system in a manner similar to radiocesium. This inventory is significantly less than the remaining cesium inventory in Steel Creek of 67 curies, 14 percent of which occurs above the L-Reactor outfall.

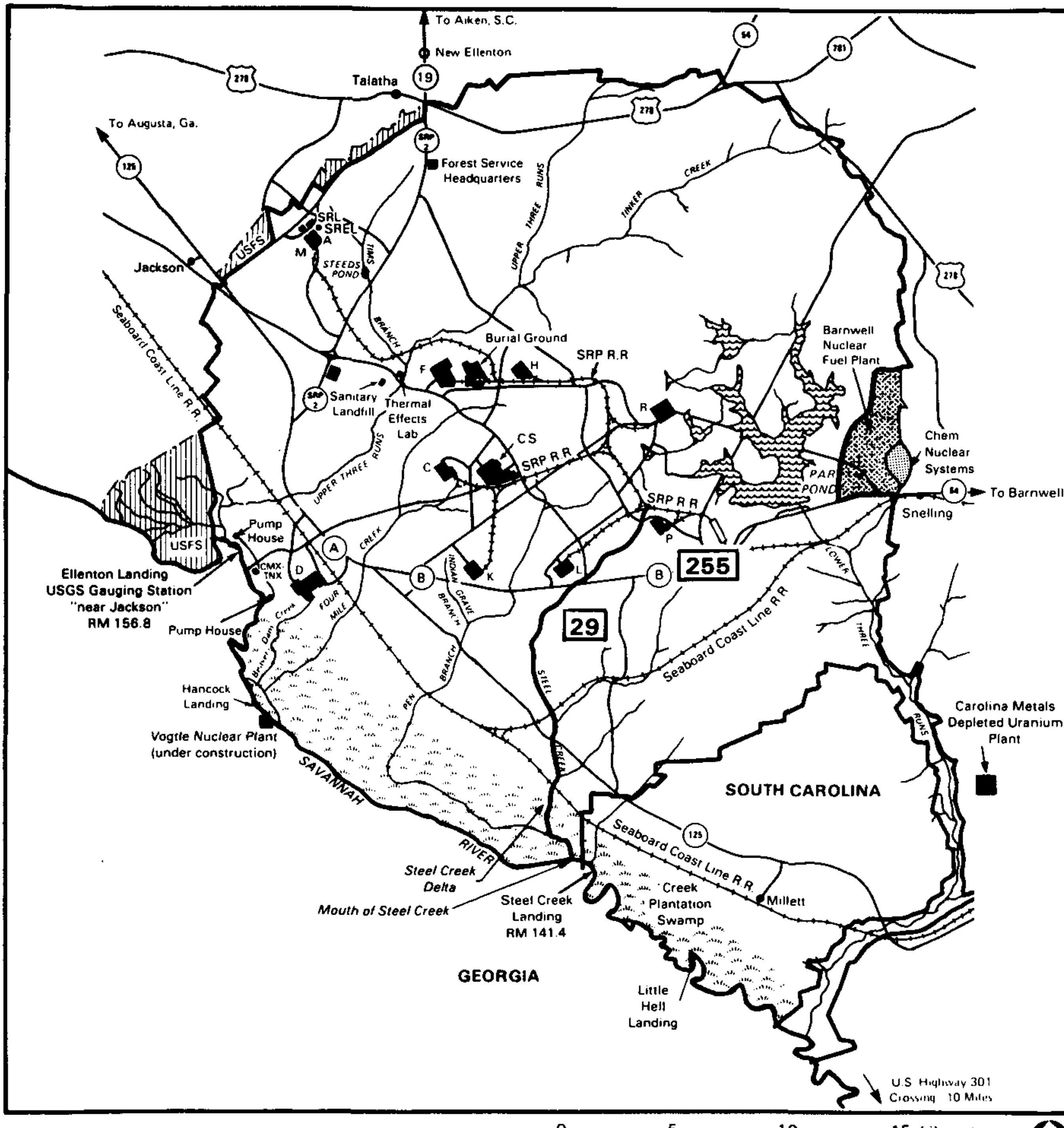
After their discharge to Steel Creek, the cesium-137 and cobalt-60 became primarily associated with the silts and clays in the Steel Creek system. The sediments and associated radionuclides have been subjected to continued resuspension, transport, and deposition according to the flow regime in the creek.

Table D-1. Cesium-137 release, transport, and accumulation in Steel Creek[a]

Year	Incremental releases P-Area (Ci/year)	Incremental releases L-Area (Ci/year)	Cumulative Cs-137 discharge corrected for decay (Ci)	Incremental Cs-137 transported past Road A in Steel Creek (Ci/year)
1955	0.2	0.2	0.4	--[b]
1956	0.4	0.3	1.1	--
1957	1.1	0.7	2.9	--
1958	0.5	0.6	3.9	--
1959	0.7	1.6	6.1	--
1960	4.8	5.2	16.0	4.5
1961	4.2	1.0	20.8	6.1
1962	13.7	1.3	35.3	11.8
1963	9.0	0.9	44.4	9.2
1964	45.6	7.7	96.7	23.0
1965	29.8	1.3	125.6	20.0
1966	35.7	0.9	159.4	25.2
1967	45.1	0.7	201.5	20.3
1968	40.9	0.2	238.0	22.2
1969	13.1	3.4	249.1	14.7
1970	7.7	3.2	254.4	9.2
1971	1.3	0	249.9	1.6
1972	0.2	0	244.4	0.8
1973	0.2	0	239.0	0.8
1974	0.07	0	233.6	0.6
1975	0.04	0	228.4	0.5
1976	0.07	0	223.2	0.8
1977	0.09	0	218.2	0.3
1978	0.02	0	213.3	0.3
1979	0.02	0	208.5	0.4
1980	0.02	0	203.7	0.7
Total	255	29		

[a]Adapted from Du Pont (1982a).

[b]Not measured; assumed to be 0 in calculating the inventory above Road A. However, assuming that the fraction of the total release transported over the 1960-1980 period is applicable to the earlier period, it is estimated that 3.9 curies were transported past Road A from 1955 to 1959.



Legend:

C, K, R, L, P Reactor Areas (C, P, K are operating)
F, H Separations Areas
M Fuel and Target Fabrication
D Heavy Water Production
A Savannah River Laboratory and Administration Area
CS Central Shop
RM River Mile

Road A = Highway 125

Note: See Table D-1 for listing of the annual releases to Steel Creek.

Figure D-1. Savannah River Plant site showing total radiocesium releases to Steel Creek from L- and and P-Areas.

D.1.2 Weapons test fallout

Atmospheric testing of nuclear weapons, mainly before the test ban treaty of 1963, caused 25,600,000 curies of cesium-137 to be deposited on the surface of the earth (United Nations, 1977; Miskel, 1973; Hayes, 1983c). The total resultant deposition was 2850 curies and 80 curies of cesium-137 in the 27,400 square kilometers of the Savannah River watershed and the 780 square kilometers of SRP, respectively. The deposited cesium-137 became attached to soil particles and has undergone only slow transport off the watershed. Results of routine monitoring by SRP indicate that since 1963 about 1 percent (about 32 curies) of the 2850 curies of cesium-137 deposited on the total Savannah River watershed has been transported down the river.

D.2 DISTRIBUTION OF RADIOCESIUM AND RADIOCOBALT

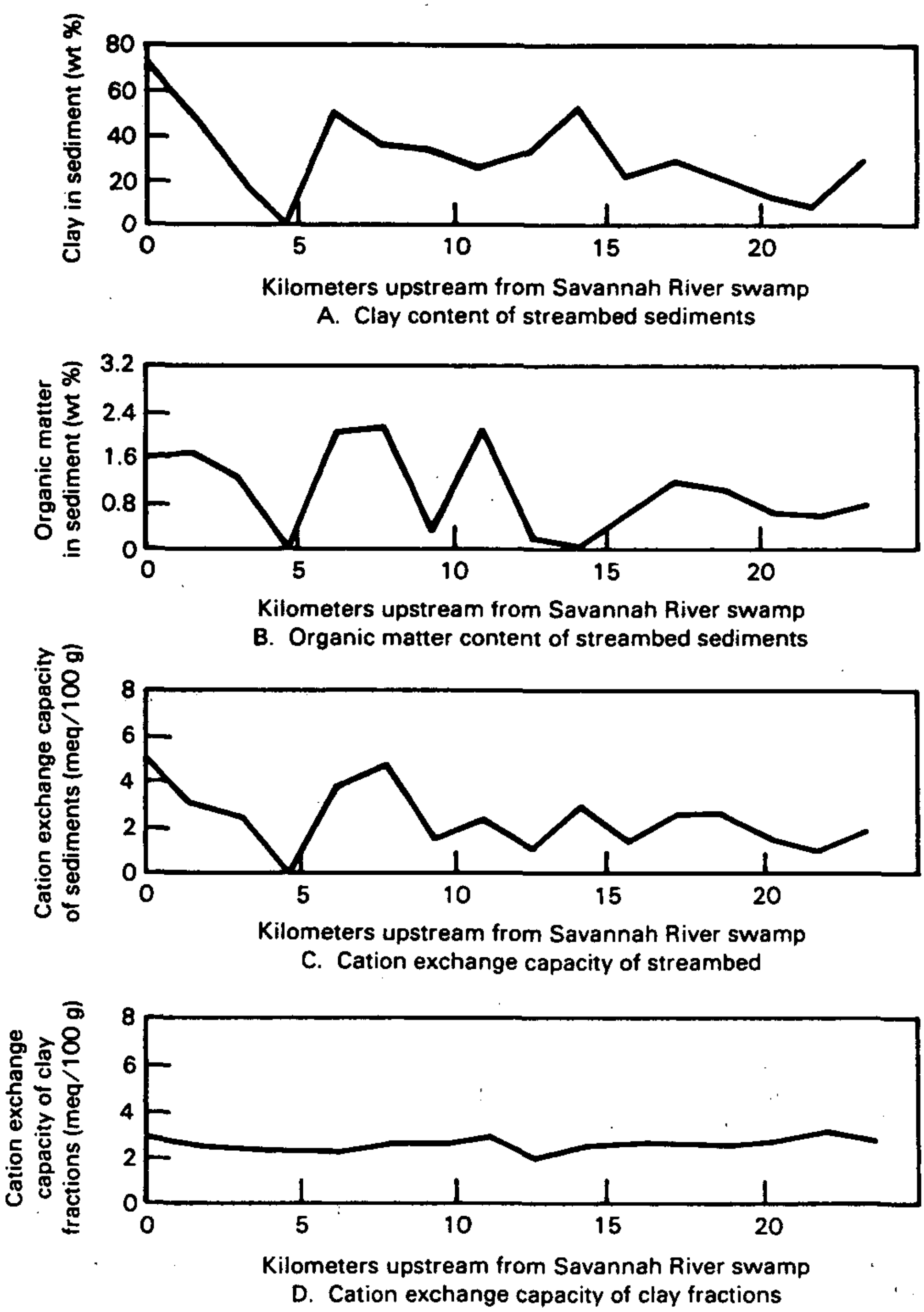
D.2.1 Sediments

D.2.1.1 Steel Creek sediments

Most of the cesium-137 that has been discharged to Steel Creek by SRP operations and weapons testing became associated with the silts and clays found in the streambed and suspended solids. The principal mechanisms for this association were (1) cation exchange with kaolinite and gibbsite clay minerals; (2) sorption on minerals; and (3) chelation with naturally occurring organic material. Figure D-2 shows the variation in ion-exchange capacity, clay content, and content of organic materials along the course of Steel Creek. A distribution coefficient of K_d = 3960, measured for sediments from Four Mile and Steel Creek (Kiser, 1979), and the work by Prout (1958), demonstrate the affinity of cesium-137 for the sediments and suspended solids in the Steel Creek system. Radiocobalt, because of its similar distribution coefficient, is expected to be associated with the sediment in the Steel Creek system in a manner similar to that of cesium-137.

As a result of these affinities, sedimentation and sorption processes control the distribution of cesium-137 and cobalt-60 in Steel Creek, its delta, and the adjoining Savannah River swamp. The resuspension, transport, and deposition of sediment are governed by the hydraulic properties of the sediment and streambed and by the creek's flow regime. Studies of Steel Creek (Ruby et al., 1981) indicate (1) erosional conditions exist in the reach from P-Reactor to about 2.5 kilometers above Road A; (2) neutral conditions exist in the reach from 2.5 kilometers above Road A to about 1.8 kilometers below Road A; and (3) depositional conditions exist in the 4- to 5-kilometer reach from 1.8 kilometers below Road A across the delta to the creek's mouth at the breach in the Savannah River levee.

Almost all sediment redistribution occurred during the period of major reactor discharges, between 1955 and 1968. Since 1968, little change has occurred in the sedimentation patterns or in the channel-delta configuration of Steel Creek (Ruby et al., 1981).



Source: Hawkins (1971).

Figure D-2. Variation of clay content, organic matter, and cation exchange capacity in Steel Creek as a function of distance.

Soil cores collected in 1974 in lower Steel Creek (Table D-2; Figure D-3) showed that (1) 69 percent of the cesium-137 was in the upper 20 centimeters; (2) 86 percent in the upper 40 centimeters; and nearly all of it was confined to the upper 100 centimeters (Brisbin et al., 1974). More extensive coring conducted in 1981 within the Steel Creek corridor and delta areas (Figure D-3; Table D-3; Figure D-4) confirmed these results; about 61 percent of the cesium-137 was found in the upper 20 centimeters and 83 percent in the upper 40 centimeters (Smith et al., 1982). Sediment samples taken in 1981 from the center of Steel Creek had lower cesium-137 concentrations than sediments taken from either bank (Figure D-5) (Smith et al., 1981). In addition, the fine-grained (clay and silt) creekbed and floodplain sediments are usually associated with higher cesium-137 concentrations than the coarser-grained sediments (Tables D-4 and D-5).

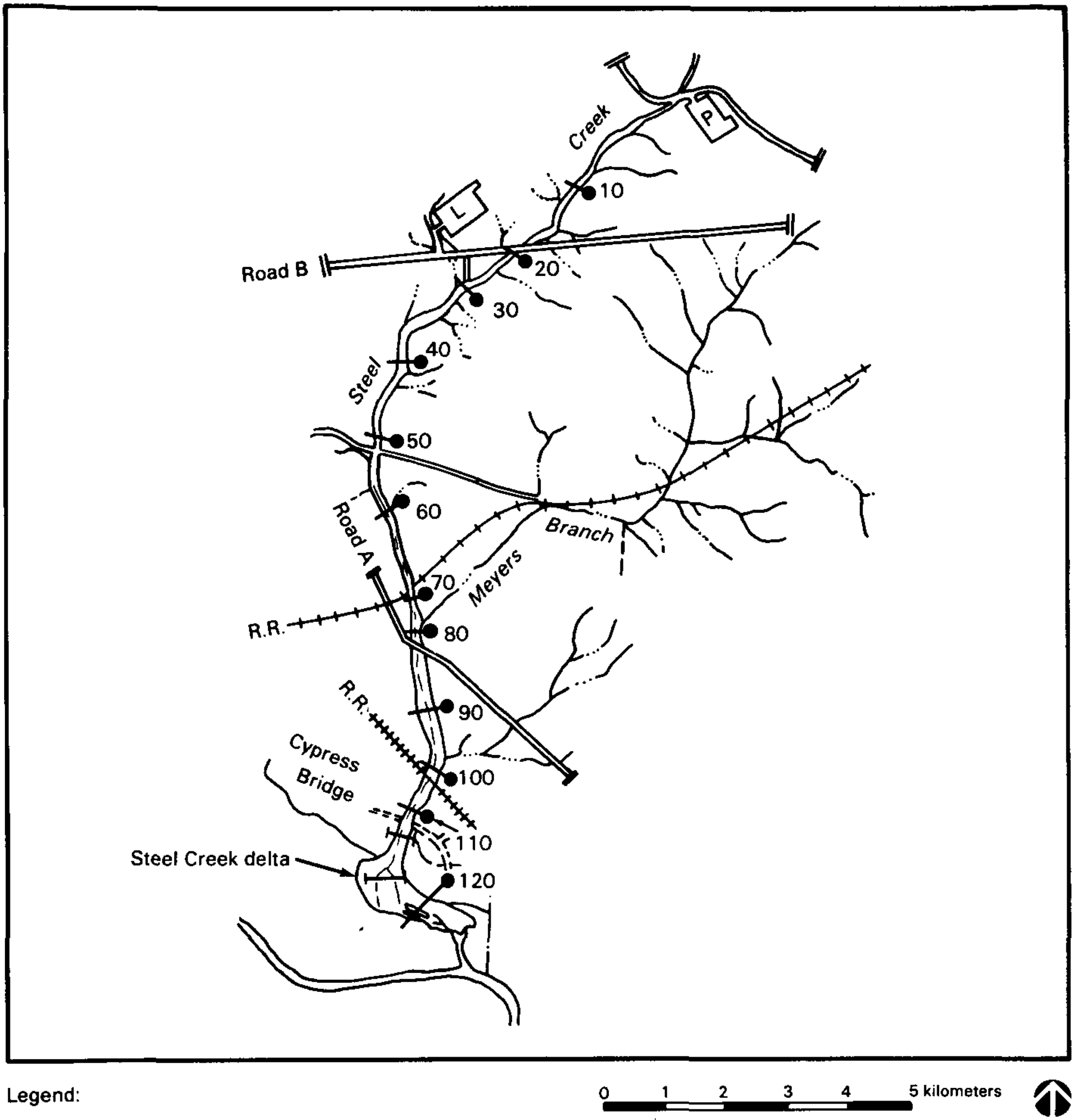
Table D-2. Distribution of radiocesium (pCi/g dry weight) in Steel Creek soils[a]

Depth interval (cm)	Mean	Standard error	Range	Percentage of total Cs-137 inventory in interval
0-10	93.5	32.3	5.6-516.4	55
11-20	24.5	6.8	3.1-137.5	14
21-30	15.1	4.1	2.3-75.1	9
31-40	13.0	3.8	1.4-60.6	8
41-50	7.1	2.1	1.0-42.8	4
51-60	3.8	0.6	0.5-10.9	2
61-70	3.4	0.4	0.8-7.2	2
71-80	4.0	0.9	0.2-15.5	2
81-90	3.3	0.7	0.1-14.0	2
91-100	2.1	0.4	0.0-6.9	1
Total				100

[a]Adapted from Brisbin et al. (1974); see Figure D-3 for sampling locations.

EV-6 Studies between 1978 and 1981 showed concentrations of cobalt-60 in the Steel Creek floodplain sediments to be, on the average, about 15 times less than cesium-137 concentrations (Table D-6). No other man-made gamma activity radionuclides were detected above measurement sensitivities.

Gamma exposure measurements at one meter above ground level were conducted in Steel Creek along the 12 soil-sampling transects, and the results compared with radiocesium concentrations in one-meter-deep soil cores and vegetation



Legend:

Transect by Brisbin et al.

Transect by Smith et al.

Sources: Brisbin et al. (1974); Smith et al. (1981).

Figure D-3. Location of transects used for collection of soil cores, gamma dosimetry measurements, and vegetation samples in Steel Creek.

Table D-3. Estimated radiocesium concentrations at the sampled soil depths for the major Steel Creek sections and total Cs-137 for each section[a]

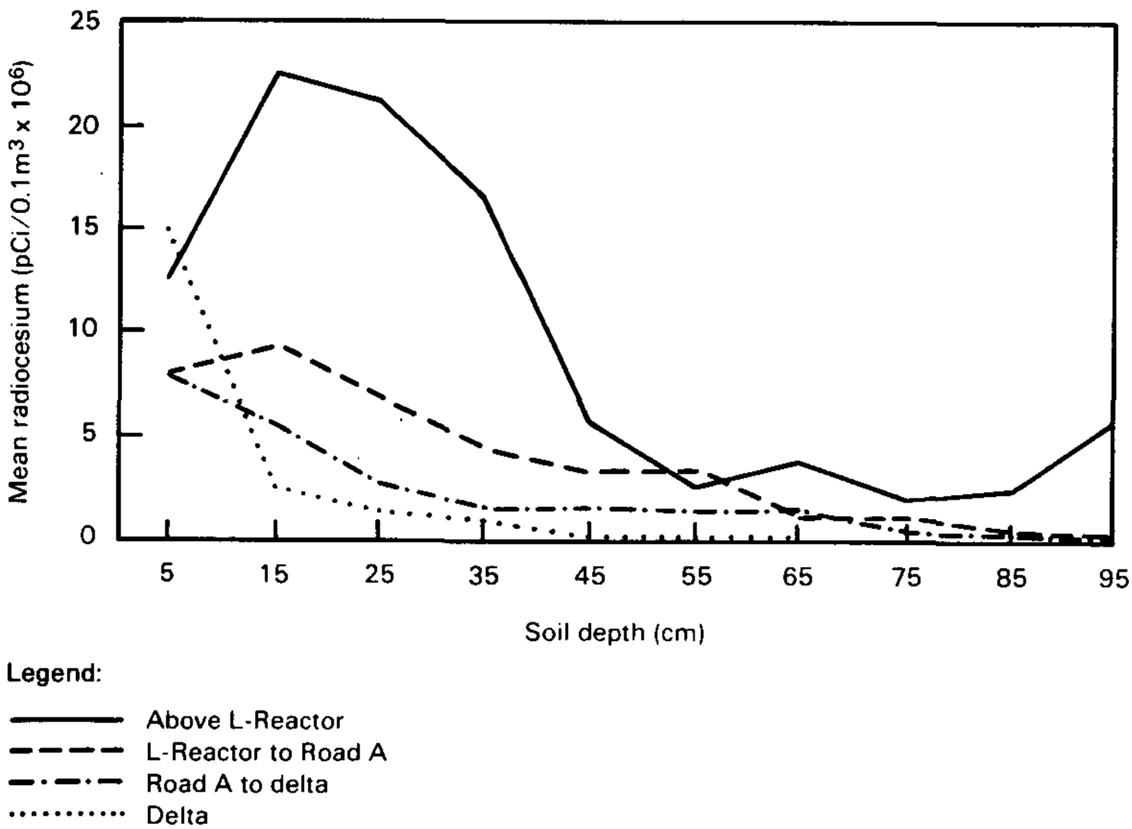
EV-4

	Major sections of Steel Creek[b]					
Depth (cm)	P-Reactor to L-Reactor ($\mu Ci/m^2$)	L-Reactor to Road A ($\mu Ci/m^2$)	Road A to delta ($\mu Ci/m^2$)	Steel Creek delta ($\mu Ci/m^2$)	Total curies	Percent of total
0-10	12.51	8.13	8.10	15.02	27.27	41
10-20	22.21	9.45	5.35	2.63	13.70	20
20-30	21.27	6.29	2.48	1.03	8.44	13
30-40	16.80	4.67	1.56	0.85	6.33	9
40-50	5.91	3.47	1.65	0.24	3.84	6
50-60	2.41	3.45	1.31	0.15	3.23	5
60-70	2.66	0.85	1.33	0.22	1.67	2
70-80	1.88	0.93	0.56	0.17	1.23	2
80-90	2.48	0.37	0.28	--	.61	1
90-100	5.80	0.21	0.14	--	.76	1
Total	93.93	37.82	22.76	20.31		100
Area $m^2 \times 10^3$	97.48 (4%)	644.74 (28%)	458.02 (20%)	1138.71 (49%)	--	--
Curies	9.16 (14%)	24.38 (36%)	10.42 (15%)	23.13 (34%)	67.09	--

[a]Adapted from Smith et al., 1982; soil samples collected along transects shown in Figure D-3, as described in the reference.

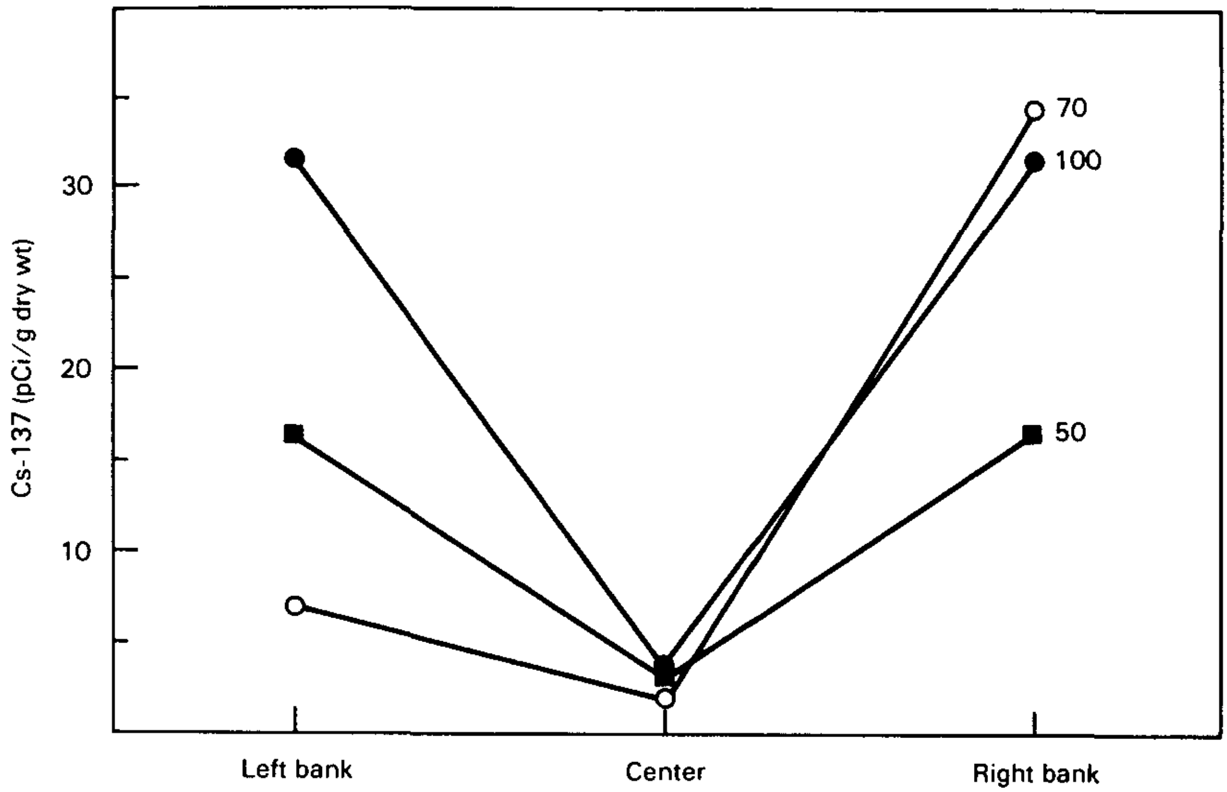
[b]Figures D-1 and D-3 show the locations of these features.

samples (Gladden et al., 1982). Maximum exposure rates (Table D-7) were found at upstream transects near the sources of the contamination and downstream in the Steel Creek delta area. Mean exposure rates of 0.057 to 0.100 mR/hr were observed in the transects nearest P- and L-Reactors, and 0.092 mR/hr in the delta area. In general, the radiocesium content (pCi/0.1 m^3) in the surface soils was the most important variable for explaining variations in exposure rates. The relative importance of the other variables [plant concentration (pCi/g), soil concentration (pCi/g) as a function of depth, and soil texture] varied substantially along the length of Steel Creek (Gladden et al., 1982). Based on the gamma exposure rate data, radiocesium concentrations in the Steel Creek system can be characterized as nonuniformly distributed across the floodplain. Replicate transects within locations (any of the 12 transect locations) show little similarity in either the locations or magnitudes of the gamma exposure rates.



Source: Smith et al. (1982).

Figure D-4. Radiocesium concentrations in soil cores collected in Steel Creek (1981).



Legend:

○ Transect 70

● Transect 100

■ Transect 50

Note: Sampling transects shown on Figure D-3.

Source: Smith et al. (1981).

Figure D-5. Concentrations of radiocesium in midstream and stream bank sediment samples collected in Steel Creek (1981) at locations 50, 70, and 100.

Table D-4. Range of Cs-137 concentrations (pCi/g dry weight) of soil types in Steel Creek (1981)[a]

Soil type[b]	N[c]	% total	Mean	Standard error
1 (clay)	101	19.24	137.08	19.82
2	108	20.57	80.47	15.52
3	127	24.19	38.50	7.10
4	83	15.81	54.86	12.02
5 (sand)	106	20.19	17.23	2.99

[a]Adapted from Smith et al. (1981); data represent all soil samples collected along the 12 transects shown in Figure D-3.

[b]Soil samples were graded visually from 1 to 5, according to their "average" particle size; samples with the highest clay content are type 1 and those with the least clay and silt (i.e., predominantly sand) are type 5.

[c]N = Number of soil samples.

EV-11

Table D-5. Mean radiocesium concentration (pCi/g) in soil column by soil size category[a]

Location[c]	Soil type[b]				
	1(fine)	2	3	4	5(coarse)
Above L-Reactor	166	104	62	117	43
L-Reactor to Road A	171	112	38	36	8
Road A to delta	78	46	18	21	9
Delta	219	59	13	24	17

[a]Adapted from Smith et al., 1982.

[b]Soil samples were graded visually from 1 to 5, according to their "average" particle size; samples with the highest clay content are type 1 and those with the least clay and silt (i.e., predominantly sand) are type 5.

[c]Figures D-1 and D-3 show the locations of these features.

EV-8

Table D-6. Co-60 and Cs-137 in Steel Creek sediments[a]

Year	Road B Co-60 pCi/g	Road B Cs-137 pCi/g	Road B Co-60/Cs-137	Steel Creek at Swamp Co-60 pCi/g	Steel Creek at Swamp Cs-137 pCi/g	Steel Creek at Swamp Co-60/Cs-137
1978	1.7	45	0.038	7.5	67	0.112
1979	1.7	50	0.034	1.5	61	0.025
1980	0.6	3.5	0.171	---	10	---
1981	0.9	42	0.021	1.2	2	0.6[b]
	Rd B + at swamp average is 0.067 ± 0.061					

EV-8

[a]Source: Hayes and Watts, 1983; locations of Road B and Swamp shown in Figure D-1.

[b]Outlier, not used to develop average ratio.

EV-13

Table D-7. Mean and range of gamma exposure readings at sampling locations along Steel Creek[a]

Transect location[b]	Number of observations	Mean (mR/hr)	Range
10	60	0.057	0.010-0.500
20	63	0.132	0.005-0.950
30	86	0.091	0.015-0.350
40	93	0.100	0.020-0.375
50	122	0.039	0.010-0.129
60	76	0.040	0.016-0.073
70	97	0.053	0.015-0.400
80	166	0.044	0.015-0.375
90	160	0.054	0.013-0.375
100	198	0.051	0.010-0.150
110	138	0.033	0.014-0.129
120	592	0.092	0.002-0.550
10-120	1851	0.068	0.002-0.950

EV-13

[a]Adapted from Gladden et al., 1982.

[b]Location of transects shown in Figure D-3.

D.2.1.2 Savannah River swamp sediments

Beginning in 1974, comprehensive radiological surveys were made in the Savannah River swamp, including the 1235-acre uninhabited, privately owned Creek Plantation Swamp (Figure D-6), and of the soil and the vegetation. Because no significant changes were observed in the mean concentration of cesium-137 in soil samples from 1976 (34.1 ± 50.3 picocuries per gram) to 1977 (39.9 ± 57.4 picocuries per gram), the 1978 survey included only thermoluminescent dosimeter (TLD) measurements. Provisions were made to conduct comprehensive surveys at 5-year intervals (Ashley and Zeigler, 1981). Soil cores collected in 1974 showed that about 70 percent of the cesium-137 was confined to the upper 6 to 7 centimeters, but that cesium was detectable at depths of 25 centimeters (Ashley and Zeigler, 1975). The 1982 values are appreciably less than those for 1974, but slightly lower on the average than those for 1977. Mean values at comparable locations averaged 33.3 (1982), 39.8 (1977), and 75.9 picocuries per gram (1974) (Du Pont, 1983b). In 1982, TLD measurements ranged from a minimum of 0.14 milliroentgen per day to maximum of 1.09 milliroentgen per day, both measured on Trail 1 (Figure D-6). The 1972-to-1980 average values ranged from 0.20 milliroentgen per day on Trail 9 to 1.46 milliroentgen per day on Trail 1 (Du Pont, 1983b).

EV-14

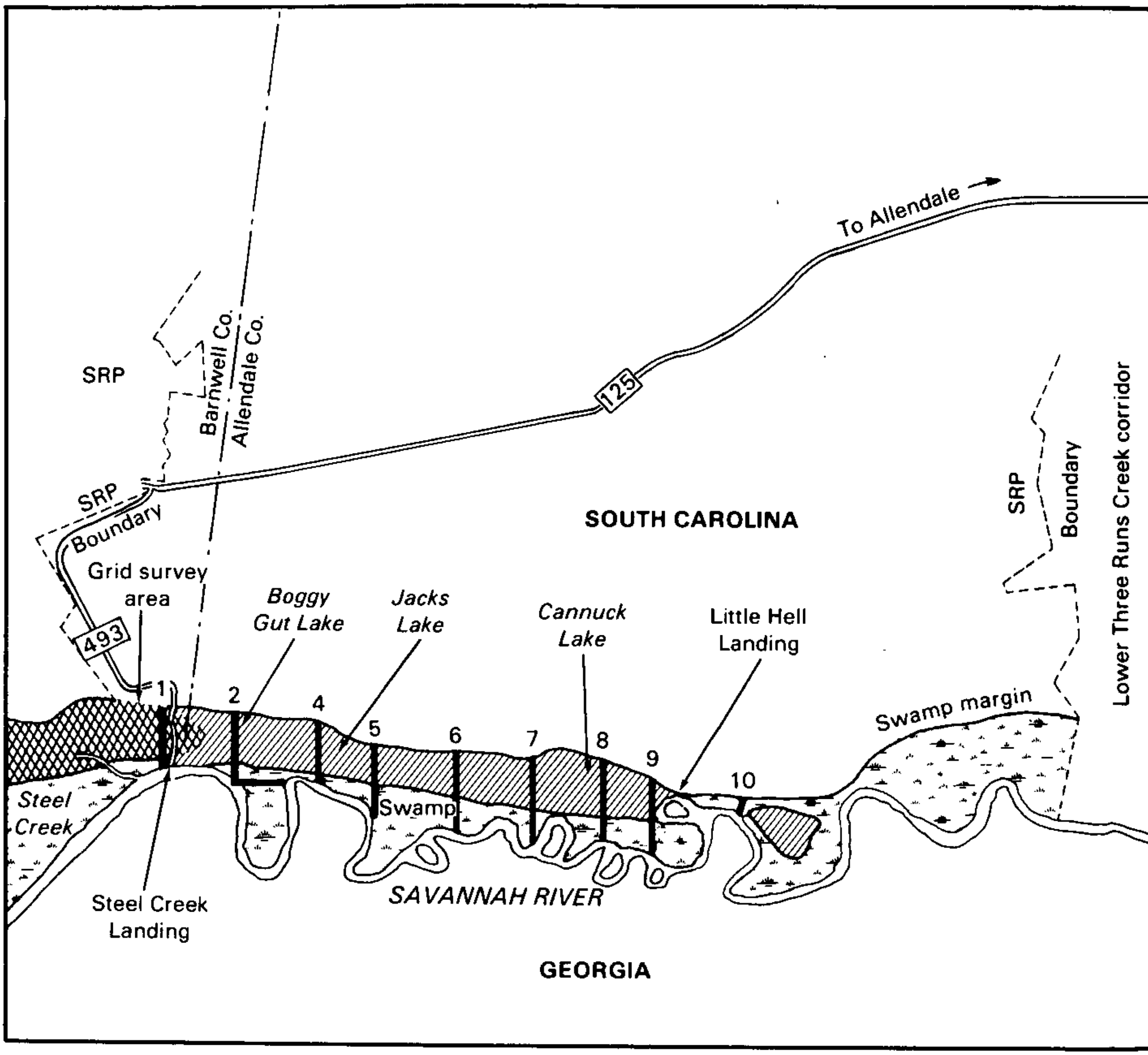
EV-14

D.2.1.3 Savannah River sediments

Turbulence in the Savannah River generally keeps the fine soils particles in suspension. These particles are deposited where the river velocity and turbulence are low, such as inside river bends and downstream from obstructions, Oxbow Lakes, and portions of the floodplain. Sediments from such locations upstream from the Savannah River Plant normally have about 1.0 picocurie per gram or less of radiocesium (Du Pont, 1982a). In 1974, riverbed sediments from downstream of the Savannah River Plant contained radiocesium concentrations from about 2.0 picocuries per gram at the U.S. Highway 301 bridge (River Mile 118.7 near Millhaven, Georgia) to 6.5 picocuries per gram at the Georgia Highway 119 bridge (River Mile 61.5, near Clyo, Georgia). Table D-8 summarizes more recent monitoring data for the Savannah River.

D.2.1.4 Holding pond sediment

A radiological survey of the raw water and backwash holding pond sediments at the Beaufort-Jasper water treatment plant was performed in November 1982. Cesium-137 concentrations in the sediment from the raw water holding pond are about one-tenth those from the backwash pond sediment, which is principally floc (Table D-9). Backwash floc from the North Augusta water treatment plant has cesium-137 and K-40 concentrations similar to those at the Beaufort-Jasper plant. These cesium-137 concentrations are low and within the concentration range of cesium-137 in sediments from other locations in South Carolina not influenced by SRP (Hayes, 1983d).



Legend:

Detectable Cs-137 deposition

Area of highest Cs-137 deposition

DR-4 Total contaminated offsite area is 940 acres

Source: Du Pont (1983b).

Figure D-6. Location of transects used for collection of soil cores and vegetation samples in Savannah River Swamp, including the 1235-acre Creek Plantation Swamp.

Table D-8. Cesium-137 concentration (pCi/g dry weight) in Savannah River sediments (8-cm depth)[a]

Location	River mile	Average 1975-1979	1980	1981	1982
Dernier's Landing[b]	160.5	0.5	0.2	0.07	0.03
Below Four Mile Creek	150.2	0.7	0.2	0.4	0.25
Above Little Hell Landing	136.6	0.8	0.2	0.7	0.7
Below Little Hell Landing	134.0	3.9	0.4	0.5	0.1
Above Lower Three Runs Creek	129.5	0.8	0.4	0.5	-
U.S. Highway 301 bridge	118.7	1.7	1.1	0.07	0.5
S.C. Highway 119 bridge	61.5	6.5[c]	-[d]	-	-

EV-16

[a]Source: Ashley and Zeigler, 1976, 1978a, 1978b, 1981.
[b]Control above Plant.
[c]Based on 1975 data only.
[d]No analysis performed.

Table D-9. *Gamma pulse height analyses of sediment core samples* Beaufort-Jasper and North Augusta water treatment plants, 11/8/82[a]

Location	Depth (cm)	Dry Weight gms	Cs-137 pCi/gm	K-40 pCi/gm
Beaufort-Jasper				
Raw Water Holding	0 - 2.4	504	0.08 ± 0.07	2.8 ± 0.9
Pond	2.4 - 4.7	164	0.05 ± 0.16	4.0 ± 2.3
Backwash Pond #1[b]	0 - 2.4	5	0.20 ± 5.2	5.4 ± 73
	2.4 - 4.7	10	.96 ± 2.5	0 ± 34
	4.7 - 7.1	57	.29 ± 0.44	1.6 ± 6.0
	7.1 - 9.4	39	.52 ± .64	0.3 ± 8.7
	9.4 -11.8	14	.71 ± 1.7	0 ± 23
Backwash Pond #2[b]	0 - 2.4	5	0.92 ± 4.5	0 ± 62
	2.4 - 4.7	12	.72 ± 2.0	2.3 ± 27
	4.7 - 7.1	20	.46 ± 1.2	0 ± 17
	7.1 - 9.4	24	.96 ± 1.0	0 ± 14
	9.4 -11.8	25	.92 ± 1.0	0 ± 14
	9.4 -14.2	54	.44 ± 0.5	4.2 ± 6.5
	14.2 -16.5	19	.79 ± 1.3	5.6 ± 18
	16.5 -18.9	8	1.1 ± 3.0	3.6 ± 42
Composite Backwash Ponds Ponds 1 & 2		291	0.48 ± 0.03	3.3 ± 0.5
North Augusta (Primarily Floc)		41	0.54 ± 0.12	2 ± 1.5

[a]Adapted from Du Pont (1983b).
[b]The backwash pond sediments contained primarily floc which when dried contained only small quantities of material.

D.2.2 Biota

During the period of major reactor discharges of cesium-137, 1955 to 1968, Steel Creek was subjected to heated discharges as much as 20 times its normal unheated flow. There was pronounced vegetation mortality; most arboreal species on the Steel Creek floodplain and delta were lost. The vegetation kill zone projected well beyond the distal end of the Steel Creek delta and downstream in the Savannah River swamp (Smith et al., 1982). When the reactor discharges were discontinued, natural succession began to revegetate. This process is still active, but slow (Martin et al., 1977; Ruby et al., 1981).

Vegetation samples collected in Steel Creek (Figure D-7) from 1970 to 1979 show (Table D-10) annual reductions in cesium-137 concentrations from 1970 through 1973. Concentrations remained fairly constant from 1973 to 1976 (Ashley and Zeigler, 1981; Du Pont, 1982a). Du Pont (1982a) suggested that the high concentrations in 1977 were due to the uptake of cesium-137 desorbed and resuspended during the 1976 heated discharge to Steel Creek from P-Area (see Section D.4). Results of additional vegetation samples collected (Figure D-3) in 1981 are presented in Smith et al. (1982), and summarized in Table D-11.

/-22

Table D-10. Average radiocesium concentrations in vegetation from Steel Creek[a]

Sample Point[b]	Average Cs-137 concentration (pCi/g dry weight)[c]									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	600	310	150	210	380	240	420	1000	160	110
1	2200	360	20	340	280	220	250	1300	520	270
2	1000	890	150	120	160	240	400	1800	770	310
3	1300	660	450	360	210	380	360	420	270	250
4	220	1100	340	280	310	180	230	410	250	200
5	1960	510	360	210	210	200	100	420	220	200
6	1100	1100	770	220	260	160	390	220	150	130
7	1600	660	290	240	220	220	180	250	210	83
8	1100	570	460	190	130	110	170	220	160	110
9	260	160	380	210	190	190	190	210	170	140
Mean	1134	632	337	238	235	214	269	625	288	180
Standard deviation	664	320	208	71	74	70	114	553	201	77

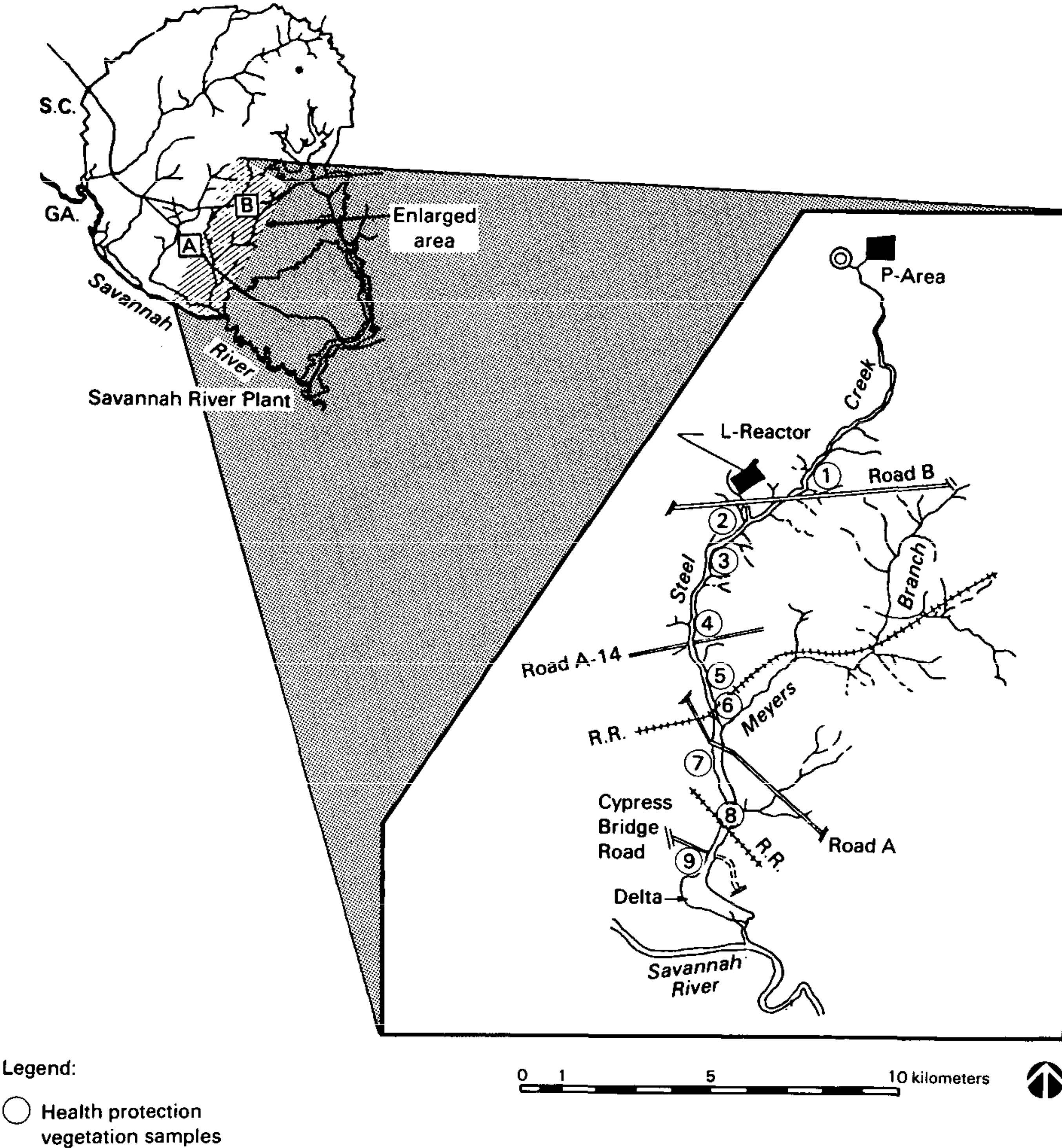
V-21
:V-22

[a]Adapted from Du Pont (1982a).

:V-18

[b]Location of transects are shown on Figure D-7; vegetation sampled was primarily cattails, duckweed, and knotweed.

[c]The period from 1962-1969 was associated with high release rates to Steel Creek, averaging 31.2 Ci/year; thereafter, the releases were substantially less, averaging 0.58 Ci/year (see Table D-1).



Source: DuPont (1982a).

TC

Figure D-7. Location of transects used for collection of vegetation samples in Steel Creek (1970 to 1979).

Table D-11. Cesium-137 concentration in vegetation samples (1981)

EV-22

Vegetation type	Concentration (pCi/g dry wt) Herb. leaf	Herb. stem	Woody leaf	Woody stem
Mean	228.6	142.7	131.5	98.8
Standard error	23.4	8.8	9.7	7.6
Sample size	145	145	123	122

Changes in the cesium-137 concentrations that have occurred in selected plants and insects from the Steel Creek watershed between 1971 and 1981 are listed in Table D-12.

From 1974 to 1977, annual surveys in the Savannah River swamp (Figure D-6) included soil, vegetation, and TLD measurements. Results of the 1982 comprehensive vegetation survey are compared in Du Pont (1983b) with those from 1977 and previous years. The average cesium-137 concentrations in vegetation from the Savannah River swamp are generally less than those in vegetation from Steel Creek (Ashley and Zeigler, 1981; Du Pont, 1983b). In 1983, the maximum concentration in the swamp was 58 ± 16 picocuries per gram (dry weight), or about one-third the mean value listed in Table D-10 for the Steel Creek corridor.

EV-23

Table D-12. Cesium-137 concentrations in selected plants and insects (picocurie per milligram dry wt)[a]

EV-22

	1971 Floodplain			1971 Islands			1981		
	N	$\bar{X}$	(SE)	N	$\bar{X}$	(SE)	N	$\bar{X}$	(SE)
Plant genera									
<u>Alnus</u>	10	0.37	(0.06)	8	1.00	(0.28)	13	0.12	(0.01)
<u>Myrica</u>	10	0.54	(0.28)	8	1.50	(0.78)	15	0.07	(0.008)
<u>Salix</u>	10	0.51	(0.28)	10	1.60	(0.59)	17	0.26	(0.04)
Arthropod orders									
Araneae	25	0.26	(0.07)	25	0.97	(0.17)	16	0.06	(0.002)
Coleoptera	25	0.44	(0.29)	24	0.99	(0.19)	13	0.02	(0.005)
Orthoptera	25	0.40	(0.08)	25	1.50	(0.28)	18	0.09	(0.01)

[a]Source: Brisbin et al., 1982.
Abbreviations: N = sample size
$\bar{X}$ = mean value
SE = standard error

Cesium-137 concentrations in the muscle tissue (edible parts) of deer and hogs killed by hunters at SRP are reported annually; concentrations in 1982 averaged 13.8 pCi/g for deer and 5.8 pCi/g for hogs (Du Pont, 1983b). In a recent study, Watts et al. (1983) found that the cesium-137 distributions for

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deer (from 1975 to 1979) at SRP and the South Carolina Coastal Plain are quantitatively described by a log normal distribution. For these five years, deer on the Coastal Plain exhibited concentrations that were higher statistically than those at SRP, at the 0.005 significance level for three years and at the 0.05 significance level for two years. EV-25

Domby et al. (1977) found that heron nestlings near Par Pond had body burdens ranging from less than 5 pCi/g wet weight to 27.4 pCi/g wet weight, depending on the species. Waterfowl have been shown to be effective vectors of radionuclide transport from systems and to display dramatic changes in body burden due to subtle migratory patterns (Brisbin et al., 1973; Hanson and Case, 1963). Differences in radiocesium body burdens of birds at the SRP is discussed by Staney et al. (1975) and shown to be related to season, diet, and location (see also Willard, 1960).

The Steel Creek delta and the Savannah River swamp provides roosting and feeding habitat for migratory ducks. Several areas in Steel Creek near Road A and Road B are wide and shallow, have slow-moving water, and are relatively unobstructed by trees. Wood ducks are known to nest in these areas, and the cesium concentration in flesh from these ducks reflects their cesium-contaminated environment, with average cesium-137 concentrations of 25 to 67 pCi/g in Steel Creek and somewhat lower in the swamp (Marter, 1974). Transient ducks from the Steel Creek Swamp have cesium-137 concentrations of 8 pCi/g, comparable to the concentrations in transient ducks obtained from Par Pond (Marter, 1974).

Concentration of cesium-137 in wildlife from Creek Plantation Swamp is reported to be less than 3.8 pCi/g wet weight (Du Pont, 1982a). Concentration of cesium-137 in muscle tissue and liver samples from furbearing animals captured near Steel Creek averaged 6 pCi/g and 5 pCi/g, respectively, comparable to concentrations found in similar animals captured near Upper Three Runs Creek (Marter, 1974).

Table D-13 lists the average values of cesium-137 in fish taken from Steel Creek and the Savannah River below the creek. In general, the concentrations of cesium-137 decrease with increasing distance from the contaminated creekbed sediments.

Concentrations in Savannah River fish are lower than those measured in fish from Steel Creek (Du Pont, 1982a). Whole-body bioaccumulation factors (cesium-137 concentrations in fish/cesium-137 concentrations in water) for fish taken from the river at the U.S. Highway 301 bridge from 1965 to 1970 average about 2300 (Table D-14). The mean bioaccumulation factor for 20 species of fish (527 specimens) from Steel Creek was found to be 2019 (whole-body) and 3029 (flesh) (Smith et al., 1982; Ribble and Smith, 1983). In contrast, largemouth bass from Par Pond exhibit bioaccumulation factors (flesh) that average about 1200 (Harvey, 1964). Whole-body bioaccumulation factors determined for fish from Lower Three Runs Creek are reported in Table D-15. A fish flesh bioaccumulation factor of 3000, 1.5 times the value recommended in the NRC LADTAP-II computer code (Simpson and McGill, 1980), was chosen for dose assessment analyses in this document.

Table D-13. Measured annual mean radiocesium concentration in fish from Steel Creek, swamp, and the Savannah River[a]

Year	Species	N[b]	Mean radiocesium content, pCi/g wet weight: Steel Creek Road A	Steel Creek Mouth	Swamp	Savannah River Steel Creek to Hwy 301 bridge[c]
1962	--[d]	--[d]	--[d]	--[d]	10	2[e]
1963	--	--	--	--	10	2[e]
1964	--	--	--	--	13	1[e]
1965	--	--	--	--	66	5-8[f]
1966	--	--	--	--	27	8-3[f]
1967	--	--	--	--	40	17-3.5[f]
1968	--	--	1250	--	43	7-2.5[f]
1969	--	--	1500	--	64	4-4[f]
1970	--	--	590	--	44	2-1.5[f]
1977	Bream	1	3.9	--	--	--
1977	Bream	5	--	0.4	--	--
1977	Catfish	1	2.8	--	--	--
1978	Bream	8	20	--	--	--
1978	Bream	4		2	--	--
1978	Bass	4		1	--	--
1981	Largemouth bass	53	20.1	--	--	--
1981	Blackband darter	36	15.0	--	--	--
1981	American eel	44	10.0	--	--	--
1981	Shiners	57	9.5	--	--	--
1981	Pirate perch	48	8.2	--	--	--
1981	Creek chubsucker	41	8.5	--	--	--
1981	Spotted sunfish	49	8.0	--	--	--
1981	Redbreasted sunfish	45	7.5	--	--	--
1981	Savannah darter	31	3.4	--	--	--
1981	Mean fish (20 species)	527	10.7	--	--	--
1981	Bream	31	--	--	--	0.09
1981	Bass	3	--	--	--	0.12
1981	Catfish	13	--	--	--	0.10
1981	Carp	2	--	--	--	1.45
1981	Eel	1	--	--	--	0.06
1981	Other species	18	--	--	--	0.05

7-25 [a]Adapted from Marter, 1970a; Du Pont, 1982a,b; Ribble and Smith, 1983.

[b]N is the number of specimens analyzed.

[c]At U.S. Highway 301 bridge (near Millhaven, Georgia) unless otherwise noted.

[d]Data not available or not provided.

[e]Below mouth of Steel Creek.

[f]Value for below mouth of Steel Creek is listed first followed by the value for Hwy 301 bridge.

Table D-14. Radiocesium whole body bioaccumulation factors for fish from Steel Creek and the Savannah River[a]

Year	Steel Creek Road A		Savannah River	
	Maximum	Average	Below Steel Creek Average	Hwy 301 bridge Average
1965			1626	3902
1966			1975	1111
1967			5528	1707
1968	2385	1355	4058	2174
1969	5490	2353	4848	7273
1970	3958	1639	1111	1250
1981	3792[b]	2019[c]	--	--
Arithmetic mean	--	1842	3191	2903
Geometric mean	--	1802	2700	2295

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Weighted average of arithmetic means[d] = 2565

Weighted average of geometric means[d] = 2188 TC

[a]Adapted from Marter, 1970a,b; Du Pont, 1982a; Smith et al., 1982.

[b]Mean of 53 specimens of largemouth bass; this species had the maximum whole-body bioaccumulation factors measured in 1981. The maximum bioaccumulation factor measured for largemouth bass was 4780. One specimen of American eel had a bioaccumulation factor of 8300.

[c]Mean of 527 specimens representing 20 species.

[d]Steel Creek data are weighted by a factor of 2 because the fish lived in an environment more highly contaminated by cesium-137 than the Savannah River. TC

Table D-15. Radiocesium whole-body bioaccumulation factors for fish from Lower Three Runs Creek[a]

Species	Mean bioaccumulation factor (1971-1974)	Number of individuals
Dollar sunfish	691	5
Pike/pickerel	908	6
Redbreast sunfish	1334	3
Bass	2803	4

[a]Adapted from Shure and Gottschalk, 1976.

D.2.3 <u>Water</u>

D.2.3.1 Steel Creek

During 1982, the concentration of cesium-137 in Steel Creek at the Cypress Bridge monitoring station averaged about 3 pCi/l. This concentration is about the same as during the previous 5 years.

In November and December 1981, seven water samples from Steel Creek between
Road A and the delta were analyzed for their cesium-137 content (Ribble and
Smith, 1983). The concentrations ranged from 3.9 to 7.9 pCi/l and had a mean
V-30 value of 5.3 ± 1.81 picocuries per liter (with a mean potassium concentration of
0.99 mg/l). About 84 percent of this value was associated with the dissolved
fraction and 16 percent with the suspended solid fraction. Shure and Gottschalk
(1976) similarly found that about 20 percent or less of the cesium-137 in water
samples from Lower Three Runs Creek was associated with the suspended solid
fraction.

It is estimated that November and December 1981 concentrations of cobalt-60 averaged about 0.3 picocurie per liter. This estimate is based on cesium-137 and cobalt-60 measurements made during testing of the L-Reactor secondary cooling-water system conducted in the spring of 1982 (Hayes and Watts, 1983).

More recently, Hayes (1983e) reported the results of cesium-137 measurements in Steel Creek made from April through August 1983. During this period, the average transport of cesium-137 was 3.2 ± 1.5 microcuries per week at Cypress Bridge, just upstream from the delta (Figure D-3). On this basis, the annual transport would be about 0.17 ± 0.08 curie per year. These measurements indicate that about half the cesium-137 transported was due to remobilization from the creek floodplain system above L-Reactor.

In addition, Hayes (1983e) reported that the water that enters Steel Creek
from L-Area and Meyers Branch (the principal tributary of Steel Creek) and as
local rainfall contained concentrations of cesium-137 of less than 1 picocurie
IV-47 per liter. However, the measured cesium-137 concentrations at Cypress Bridge
averaged about 3.7 ± 0.6 picocuries per liter during the April through August
1983 study period. Hayes contends that a reequilibration process between the
water and the cesium in the creekbed and floodplain sediments governs the
cesium-137 concentrations, because he could find no correlation during this
period between cesium concentration and creek flow rate, or such other variables
as suspended solid or tritium concentrations in Steel Creek water or rainfall in
the area. Hayes concluded that the creekbed and floodplain sediments could support cesium concentrations as high as about 11 picocuries per liter at equilibrium, and that the lower concentrations (3.7 picocuries per liter) were probably
due to insufficient time for the process to reach equilibrium between the water
and the cesium-laden sediments. The travel time for water from L-Area to
Cypress Bridge is less than 1 day.

D.2.3.2 Savannah River

The concentrations of cesium-137 in the Savannah River have been monitored since 1960. The highest concentrations were measured in the early 1960s as a result of SRP releases and nuclear weapons test fallout (Figure D-8). Since 1972, concentrations of cesium-137 in the Savannah River have been below the routine detection limit of about 1 picocurie per liter. Recently, special measurements made with high water volume sampling techniques and low level counters show that the 1979-1982 average concentration in the Savannah River was about 0.08 picocurie per liter below SRP and near the limit of detection above SRP (Section 3.7.2). It is estimated that the cobalt-60 concentration in river water during the 1979 to 1982 period averaged about 0.002 picocurie per liter (based on measurements in Steel Creek performed by Hayes and Watts, 1983).

Radiocesium and radiocobalt concentrations will be diluted as the flow of the Savannah River increases downstream from SRP, and as these radionuclides are deposited in the river channel and floodplain. Based on river flow records for 1960 to 1969, an increase in flow of 11 percent can be expected between the U.S. Highway 301 bridge (River Mile 118.7) near Millhaven, Georgia, and the Georgia Highway 119 bridge (River Mile 61.5) near Clyo, Georgia. Ratios of drainage areas suggest that river flow will increase by 18 percent between River Mile 118.7 and River Mile 39.2, the location of the intake structure for the Cherokee Hill water treatment plant. Using tritium as a tracer, Hayes (1983a) measured an average 1976-1981 increase in flow of about 20 percent between these two locations. An additional 28 percent reduction in the concentrations of cesium-137 and cobalt-60 can be expected to occur through deposition, sorption and reequilibration of the radionuclides with river channel and floodplain sediments (Hayes and Boni, 1983).

D.2.3.3 Water treatment plants

The North Augusta, South Carolina water treatment plant is about 20 river miles above the SRP. However, there are no known individuals who consume Savannah River water for a distance of about 120 river miles downstream of the SRP. At this distance (River Mile 39.2) and beyond (River Mile 29.0) are the Beaufort-Jasper and Cherokee Hill water treatment plants, respectively. The Beaufort-Jasper water treatment plant pumps water from the river through a 2.4 kilometer long inlet canal that connects to an open canal. This open unlined canal flows 29 kilometers to the water treatment plant (Du Pont, 1983a). The Cherokee Hill water treatment plant pumps from the Savannah River above the U.S. Interstate Highway 95 bridge, and the water is piped about 11 kilometers to the plant (Du Pont, 1983a).

Recent measurement (April through June, 1983) of finished (potable) water indicates that cesium-137 concentrations (from SRP, weapons test fallout, and upstream nuclear reactors) averaged 0.028 picocurie per liter at Beaufort-Jasper and 0.033 picocurie per liter at Cherokee Hill (Kantelo and Milham, 1983). During this monitoring period, the cesium-137 concentrations in the finished water were found to vary inversely with river flow (Kantelo and Milham, 1983). The concentrations of cesium-137 at Beaufort-Jasper are slightly less than those at Cherokee Hill (Hayes and Boni, 1983). The slightly lower concentrations at Beaufort-Jasper result from inflow of local fresh water and deposition, sorption, and reequilibration of cesium-137 with the sediments of the open canal leading to the treatment plant (Hayes and Boni, 1983).

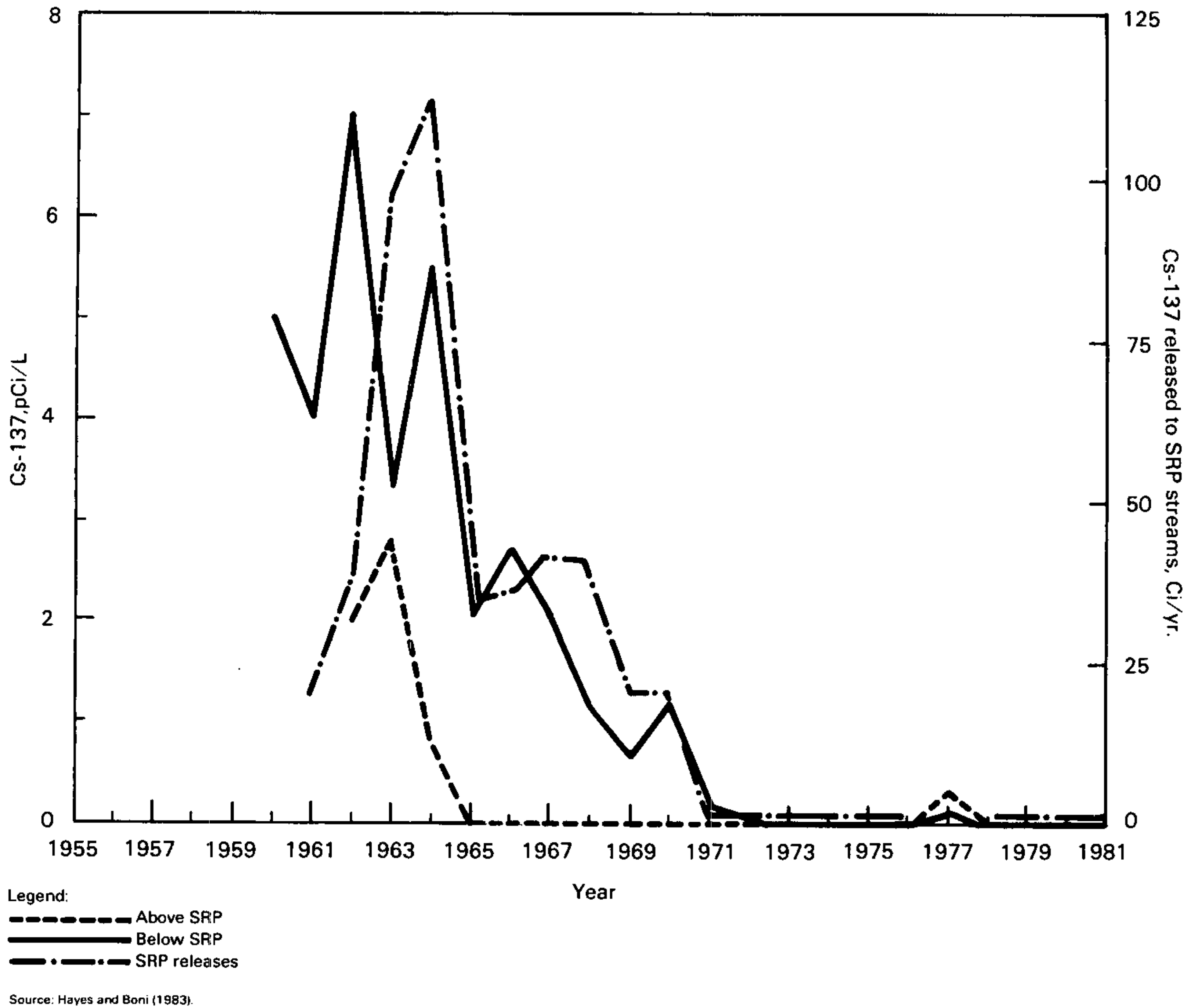


Figure D-8. Cesium-137 concentrations in the Savannah River, 1960-1980.

At North Augusta the concentration of cesium-137 in the finished water averaged 0.006 picocurie per liter, about 5 times less than comparable concentrations in Beaufort-Jasper and Cherokee Hill finished water. Upstream nuclear reactors and nuclear weapons test fallout account for the cesium-137 in the North Augusta finished water (Kantelo and Milham, 1983).

Studies of cobalt-60 in the finished water in these water treatment plants indicate that the concentrations are less than the detection limit of about 0.003 picocurie per liter (Kantelo and Milham, 1983).

Studies made in 1965, when the cesium-137 concentration in river water at the U.S. Highway 301 bridge was 1.47 picocuries per liter, suggest that a concentration reduction of about 48 percent by dilution and by association with river channel and floodplain sediments occurs by the time the water reaches the downstream water supply intakes. The Cherokee Hill water treatment plant removes another 32 percent. Dilution and association with sediments along the open canal and the treatment process at Beaufort-Jasper removes about 50 percent of the cesium-137 from the raw water. Thus, as summarized in Table D-16, the concentration of cesium-137 in the finished water from the water treatment plants is a small fraction of the concentration at the U.S. Highway 301 bridge (Hayes and Boni, 1983).

Table D-16. Cesium-137 concentrations and reduction ratio in the Savannah River and water treatment plants[a]

Location	Cs-137 (pCi/ℓ)	Reduction (percent)
North Augusta[b]	0.03	
Highway 301[c]	1.47	
Highway 17[c]	0.77	47.6
Cherokee Hill[b]	0.29	80.3
Beaufort-Jasper[b]	0.04	97.3[b]

TE

[a]Measurements made in 1965; adapted from Hayes and Boni (1983).

[b]Concentration in finished (potable) water.

[c]"Raw" Savannah River water. Approximate river flow rates of 200 cubic meters per second at Highway 301, and 225 cubic meters per second at Highway 17 at time of cesium-137 sampling.

[d]By the year 2000, the expected reduction factor for Beaufort-Jasper will be 79.3 percent because of planned changes in the intake canal.

D.3 RADIOCESIUM AND RADIOCOBALT INVENTORY IN STEEL CREEK AND SAVANNAH RIVER SWAMP

A number of different methods were used to calculate the inventory of cesium-137 and cobalt-60 in the Steel Creek system. These inventory estimates are discussed below.

D.3.1 Aerial radiological surveys

Aerial radiological surveys of the Savannah River Plant and the surrounding areas were performed in 1974 and 1979 to determine the surface terrestrial distribution of cesium-137 (Boyns, 1975; Boyns and Smith, 1981). A comparison of the position of the cesium-137 gamma exposure-rate isopleths from these surveys shows that the areas of activity are in the same general locations. Gamma exposure rates in 1979 were lower than those in 1974, which can be explained by the masking effect of higher creek and swamp water levels in 1979 and to a lesser extent by radioactive decay. When adjusted to a common water level, these surveys suggest little or no radiocesium transport (radiocesium associated with the streambed sediments) occurred during the 5-year interval.

Smith et al. (1982) used the 1974 aerial radiological survey data to estimate the mean cesium-137 gamma exposure rates in Steel Creek (Figure D-3). The aerially determined exposure rates were corrected to surface-level rates and to account for the cesium-137 distribution in the soil column. Based on the corrected data, the estimated cesium-137 inventory in Steel Creek (decay corrected to 1981) is 58.1 curies, which may be proportioned approximately as follows (Smith et al., 1981):

Location	Inventory (Ci)
Above Road A	18.4
Below Road A	39.7
Total	58.1

D.3.2 Ground radiological surveys

Smith et al. (1982) performed a ground radiological survey in Steel Creek (Figure D-3) using sodium iodide scintillation counters and stratified random sampling procedures. The cesium-137 gamma exposure rate data were corrected to account for the cesium-137 distribution in the soil column. Based on the corrected data, the estimated cesium-137 inventory (decay corrected to 1981) is

56.9 curies for the Steel Creek floodplain to a depth of 1.0 meter. The approximate portions of this inventory lying above and below Road A are listed below (extrapolated from Smith et al., 1981):

Location	Inventory (Ci)
Above Road A	18.0
Below Road A	38.9
Total	56.9

D.3.3 Soil surveys

Studies of cesium-137 in Steel Creek based on core samples up to 1 meter in length and categorized by soil type, sample depth interval, and creek section (Table D-3, Figure D-3), identified 67.1 curies decay corrected to 1981 between the area above L-Reactor and the delta (Smith et al., 1982). The approximate portions of this inventory lying above and below Road A are listed below:

Location	Inventory (Ci)
Above L-Reactor	9.2
L-Reactor to Road A	24.4
Total Above Road A	33.6

Location	Inventory (Ci)
Road A to Delta	10.4
Delta Area	23.1
Total Below Road A	33.5
Total Steel Creek	67.1

An estimated 8.9 curies is believed to lie onsite in the Savannah River swamp between the Steel Creek delta and the SRP boundary.

Results of soil samples collected in the swamp southeast of Steel Creek in 1974 (Figure D-6) estimated that the radiocesium inventory in the swamp was 25 curies (Marter, 1974); this could have decayed to 21 curies by 1981, assuming no net transport of cesium from the swamp.

D.3.4 Radiocesium inventory by a contaminated area method

Du Pont (1982a) also estimated the cesium-137 inventory in Steel Creek with a contaminated area method, which uses radiological measurements of concentrations in sediments and vegetation, which are integrated over the area and depth. The results of this method yield an inventory estimate of about 75 curies which would have decayed to about 61 curies by 1981. This estimate, detailed below, agrees with the estimates presented in Sections D.3.1, D.3.2, and D.3.3:

Location	Inventory (Ci)
Road A to SCL Bridge	18.0
SCL Bridge to delta	16.2
Delta	26.6
Total	60.8

D.3.5 Radiocesium inventory in vegetation

The cesium-137 inventory in the Steel Creek biotic community is very small. The inventory was made using floodplain areas integrated from USGS floodplain maps, estimates of the biomass inventory (304 grams per square meter; Martin et al., 1977), and analyses of cesium-137 concentrations in vegetation from various stream reaches. Approximately 0.4 curie of the cesium-137 is in the plant community (Du Pont, 1982a). The inventory in the animal community is insignificant (much lower biomass) compared to the plant community.

D.3.6 Radiocesium inventory in water

The amount of cesium-137 in the water of the Steel Creek system at any one time is small, less than 0.001 curie. This estimate is based on the assumption that the water stored in the system is equal to about 1 day's flow. The travel time of water from P-Area to the Cypress Bridge (Figure D-3) is about 0.5 day (Hayes, 1981) and the cesium-137 concentration averages about 4 pCi/l (Ashley and Zeigler, 1978b) (also see Section D.2.3.1).

D.3.7 Summary for cesium-137

Smith et al. (1982) estimated the cesium-137 inventory in Steel creek using gamma exposure rates obtained from aerial and ground surveys and cesium-137 concentrations obtained from soil core measurements. These results are in agreement with the inventory developed by the contaminated area method (Du Pont, 1982a). The inventory of about 67 curies determined from soil core measurements is considered the best estimate. As shown in Figure D-9, this cesium-137 inventory estimate for Steel Creek leaves about 55 curies unexplained.

This unaccounted for cesium-137 is within the error limits of the estimated inventory. The unexplained cesium-137 might be caused by:

Less radiocesium released than indicated in Table D-1.

A cesium-134-to-cesium-137 ratio greater than 1:20.

Cesium-137 deposited in the Savannah River between the mouth of Steel Creek and the U.S. Highway 301 bridge.

More cesium-137 from Steel Creek transported past the U.S. Highway 301 bridge than indicated by the measurements.

More cesium-137 below depths of 1 meter than indicated by Figure D-4.

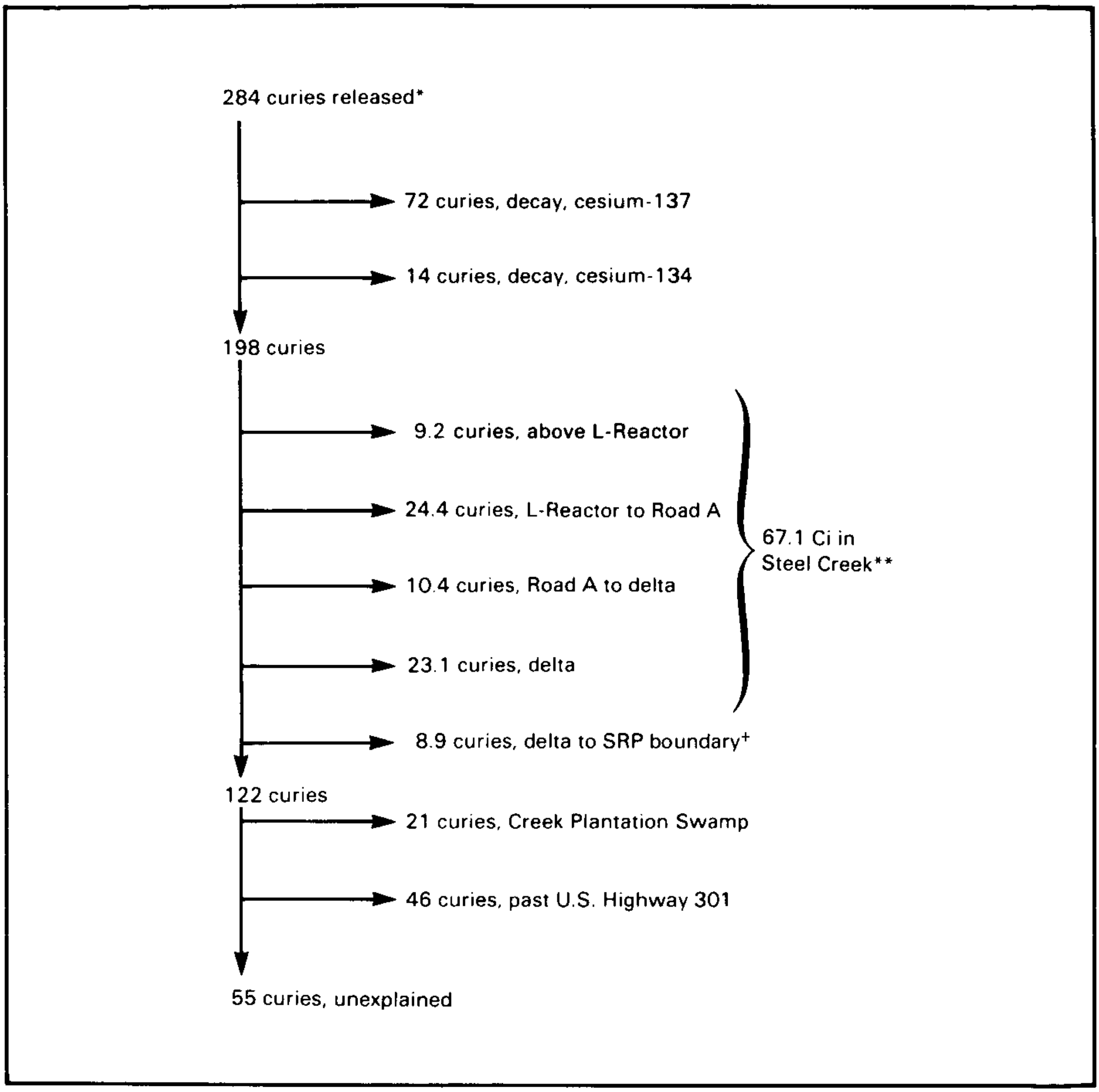
D.3.8 Radiocobalt inventory

The current radiocobalt inventory in Steel Creek has been bounded by two values, 2.1 and 4.6 curies, and calculated according to the following methods, respectively, (1) assuming no transport of cobalt from the creek system and decay correcting to 1981, and by (2) conservatively assuming that cobalt behaves in a manner similar to cesium such that the inventory is reduced by a factor of .068, the ratio of cobalt-60 to cesium-137 in the sediments of the Steel Creek system.

D.4 REMOBILIZATION OF RADIOCESIUM AND RADIOCOBALT

A portion of the cesium-137 and cobalt-60 inventory that is currently in the Steel Creek channel and floodplain (Figure D-9) will be remobilized and transported off the plant site when the direct discharge of thermal effluents to Steel Creek is resumed after the restart of L-Reactor at temperatures as high as 75°C near the outfall canal and at discharge rates of about 11 cubic meters per second (reference case). This remobilization of cesium-137 and cobalt-60 will augment the small amount that is currently being transported from the creek.

Using the reference case, the quantities of cesium-137 (and cobalt-60) transported from Steel Creek to the Savannah River and to offsite portions of the swamp (Creek Plantation Swamp) as the result of L-Reactor operations are reestimated below, using 1976 monitoring data, a new set of data for 1982 on radionuclide transport in Steel Creek, and the historic flooding record for the swamp (Du Pont, 1982a, 1983a; Langley and Marter, 1973). Section 4.4.2 contains estimates of cesium-137 remobilization and transport for each alternative cooling-water system (also see Section D.4.4). TC



*Released to Steel Creek during 1955-1980.

**Based on soil core measurements.

+Estimated

Figure D-9. Cesium-137 mass balance in Steel Creek in 1981 based on soil core and river measurements and decay.

The following field measurements in Steel Creek provided data that were used in the transport analyses:

- In June 1976, a study was performed to observe the effect of a month-long diversion from P-Reactor Area (to permit inspection of Par Pond dam) of about 2.5 cubic meters per second of hot water (about 70°C at the discharge point) on desorption of cesium-137 from the sediments. The cesium-137 transport near Road A peaked at about 3.2 mCi/day within 2 weeks and returned exponentially to normal levels in about 3 months (Du Pont, 1982a). These data were supplemented by laboratory hot water desorption experiments (Du Pont, 1982a).

- In the spring of 1982, a study was performed to observe the transport of cesium-137 and cobalt-60 during testing of the L-Reactor secondary cooling-water system using Savannah River water that was discharged at near-ambient temperatures and at flow rates up to about 6 cubic meters per second. Measurement of creek flow and concentration of cesium-137 in water samples during these tests were used to reestimate the sediment-water transport values presented in Du Pont (1982a). Similar measurements were used to predict the sediment-water transport of cobalt-60 that is likely to occur when L-Reactor cooling-water discharges are resumed (Hayes, 1983b; Hayes and Watts, 1983).

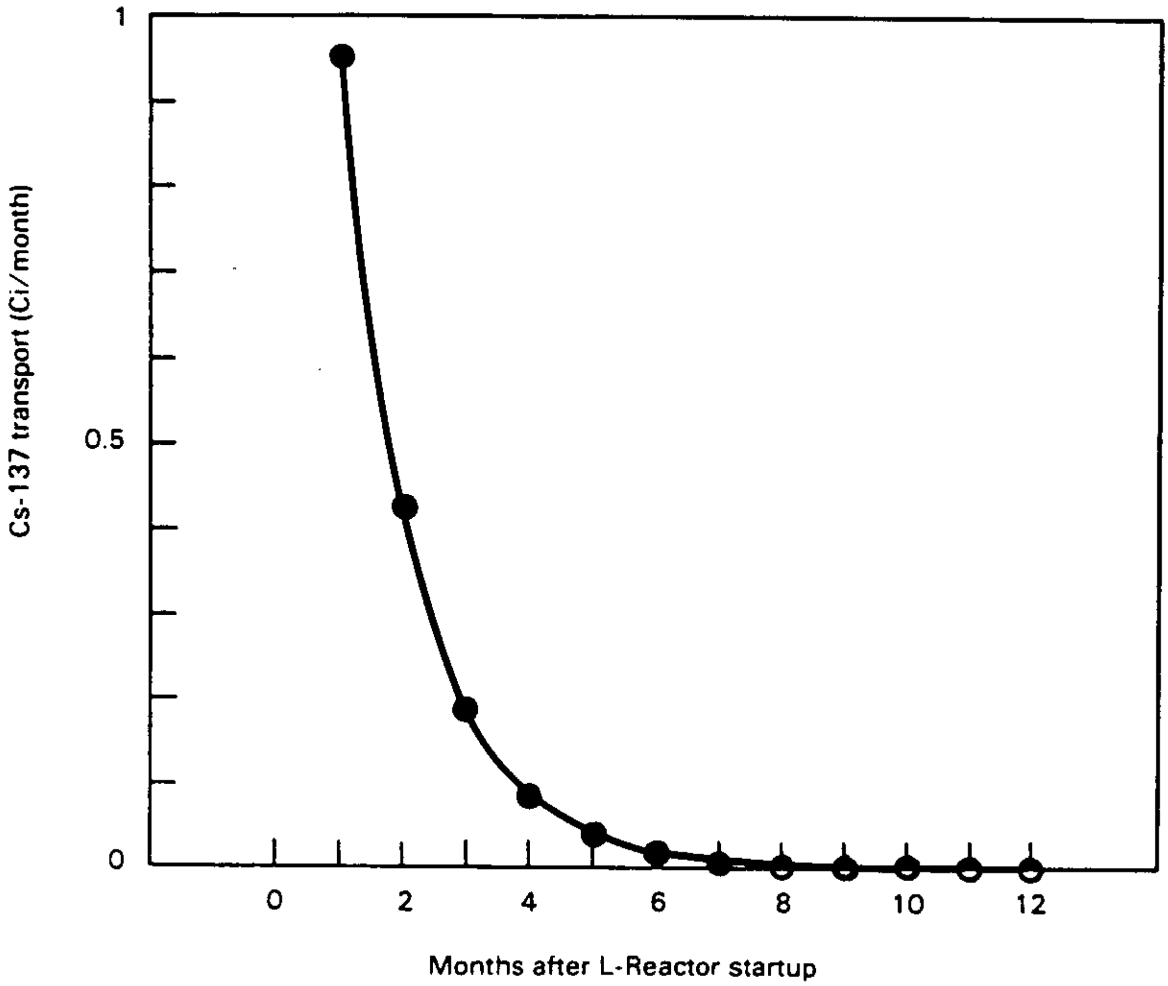
D.4.1 Desorptive transport

For the reference case, hot-water desorption of cesium-137 and cobalt-60 from the sediments in the Steel Creek system will occur following the resumption of L-Reactor operation. From early June 1976 until the end of that month, about 2.5 cubic meters per second of heated water, discharged at approximately 70°C, was diverted to Steel Creek from P-Reactor. The cesium-137 concentration at Cypress Bridge (Figure D-3) peaked within 2 weeks after the start of the diversion and decreased exponentially to a background level in about 3 months (Du Pont, 1982a). To estimate the heated water cesium-137 transport, the Cypress Bridge data (Figure D-10) were fitted with an exponential function and integrated to give monthly transport values.

A correlation coefficient of 0.94 was calculated using an exponential representation of the data. A laboratory experiment (Du Pont, 1982a) with sediments from Steel Creek confirmed that higher water temperatures extract more cesium-137 than water at ambient temperatures.

These analyses indicate that the transport in the first year for the reference case would be about 1.7 curies due to cesium-137 being desorbed from the sediments.

Hot water desorption experiments conducted in the laboratory to determine the desorption of cesium-137 from sediments also showed the desorption of small amounts of cobalt-60 (Table D-17) (Du Pont, 1982a; Hayes and Watts, 1983). The cobalt-60 to cesium-137 ratio of desorbed activity averaged 0.056. An estimate of the amount of cobalt-60 that will be desorbed during the first year of L-Reactor operation for the reference case was made by multiplying the 1.7



Source: Du Pont (1982a).

Figure D-10. Transport of cesium-137 from hot-water desorption of cesium-137 from Steel Creek sediments.

curies of cesium-137 that is expected to be desorbed by the laboratory-determined cobalt-60/cesium-137 ratio, 0.056. This calculation indicates that about 95.2 mCi/yr or 0.26 mCi/day of the cobalt-60 is expected to be desorbed from the sediments in the first year. No additional desorption is expected the second year.

Table D-17. Cs-137 and Co-60 desorption from sediments during a laboratory experiment[a]

Water Temperature (°C)	Activity Desorbed (pCi/ℓ) Co-60	Cs-137	Co-60/Cs-137
72	20.4	458	0.045
52	25.4	288	0.088
42	14.2	384	0.037
22	16.5	314	0.053
	Average ratio = 0.056 ± 0.023		

[a]Adapted from Du Pont, 1982a, Appendix I.

D.4.2 Transport in biota

SRP routinely monitors vegetation in the Steel Creek corridor for radionuclides. Even though cesium-137 is routinely detected in the vegetation, cobalt-60 is not. The limit of detection for cobalt-60 is about 5 pCi/g.

About 0.4 ± 0.2 curie of cesium-137 is tied up in the biota on the Steel Creek floodplain. The reference-case discharge, principally the result of high flow rates and fluctuating water levels (related to reactor operation about 65 percent of the year), would be expected to kill this biota in the first year of L-Reactor operation and to transport the isotope off the site. TC

D.4.3 Sediment-water transport

D.4.3.1 Cesium-137

The initial (1981) estimates of the expected cesium-137 transport in Steel Creek following L-Reactor restart using the direct discharge of cooling water to Steel Creek (reference case) are presented in Du Pont (1982a). The cesium-137 transport process was divided into three elements: coupled suspended sediment-water (7.7 ± 4.4 curies first year, 7.2 curies second year), hot water desorption (1.7 ± 0.2 curies; Section D.4.1, above), and biota loss (0.4 ± 0.2 curies; Section D.4.2, above). In this manner, total cesium-137 transport was estimated at 9.8 curies for the first year and 7.2 curies for the second year, with a 20-percent-per-year decrease thereafter. To improve these estimates of cesium-137 remobilization in the Steel Creek system, cesium-137 transport studies were made during secondary cooling-water system tests using ambient river water from February to April 1982. These tests included flows as high as about 6 cubic meters per second, about one-half of full reactor cooling-water flow (Hayes, 1983b; Du Pont, 1983a).

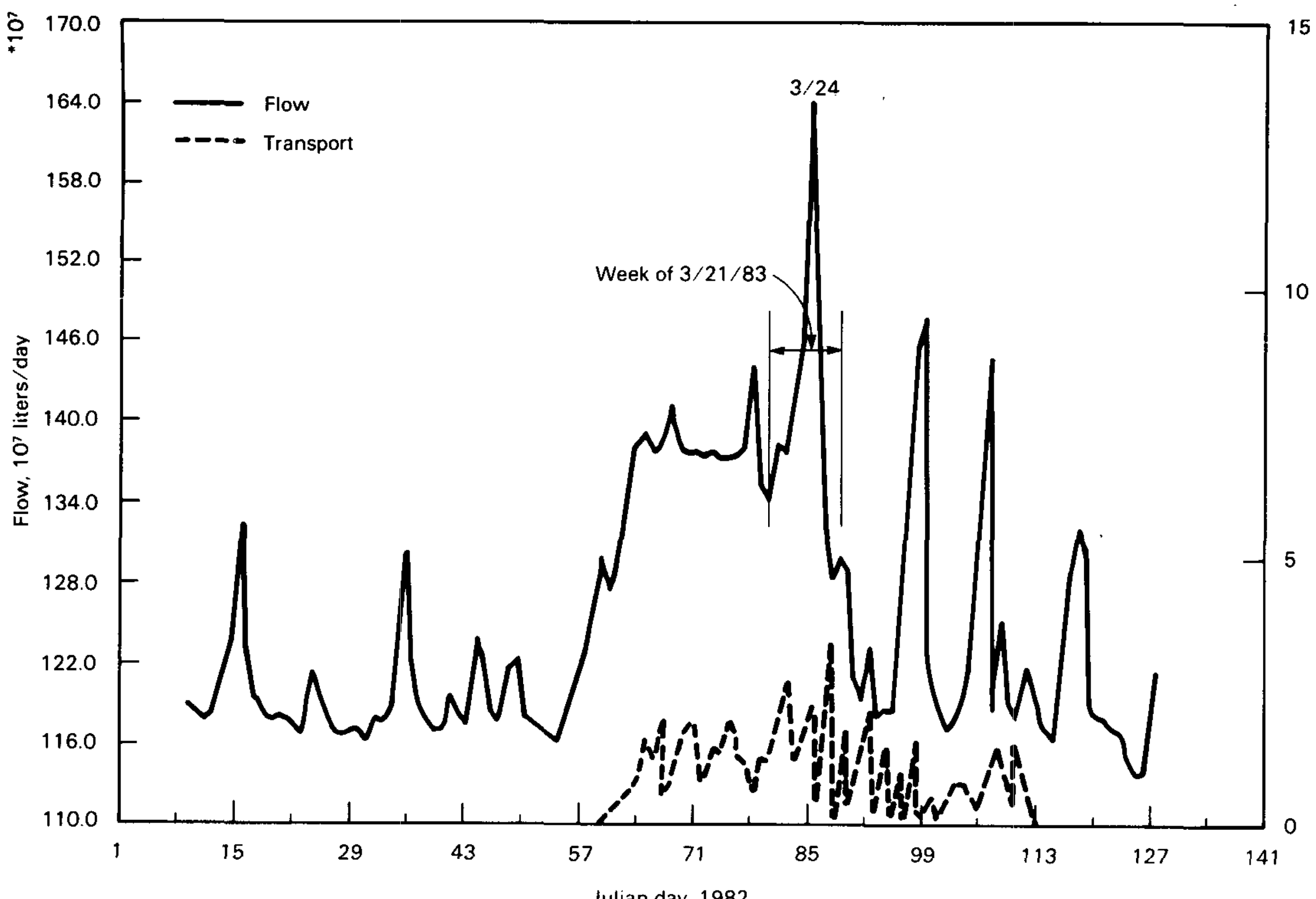
Average flow rates required to estimate total cesium-137 transport (flow rate times concentration) were obtained by calculating noon-to-noon average flow using data sampled every 15 minutes from the U.S. Geologic Survey-maintained gaging station at the Cypress Bridge upstream of the creek mouth (Figure D-3). Composite water samples were also obtained on a noon-to-noon schedule; however, they were collected at the mouth of Steel Creek. Because Pen Branch combines with Steel Creek in the swamp before discharging to the Savannah River, the creek flow values measured at Cypress Bridge were increased by 12.7 cubic meters per second to obtain the correct flow at the mouth of Steel Creek. Flow rates in Steel Creek varied during the test period, depending on the specific test of the secondary cooling water system being conducted (see Figure D-11).

As shown in Figure D-11 and Table D-18, the test period most similar to the reference case conditions expected during resumed L-Reactor operation occurred during the week of March 21, 1982 (Julian day 80). During this week (on March 24, 1982), the average daily flow reached 6.2 cubic meters per second and averaged 3.5 cubic meters per second for the week. This average weekly flow exceeded any previous weekly discharge of cooling water flow since L-Reactor was shut down in 1968, although flows of this magnitude have occurred as the result of heavy rainstorms (see Section 3.4.1).

Increases in total cesium-137 concentrations (with suspended solids and in solution) at the mouth of Steel Creek lagged the increase in pump test flow (Table D-18). The highest cesium-137 concentration, 2.7 pCi/l, occurred on March 28, 1982, about 3 days after the flow decreased to about 2.1 cubic meters per second from the peak flow of 6.2 cubic meters per second. This concentration is probably the result of water draining off the back areas of the floodplain and into the creek. Water in the back areas would have longer residence times and the sediments have higher concentrations of cesium-137 (Figure D-5); thus, the water draining from these areas could accumulate higher cesium-137 concentrations.

The average daily cesium-137 transport during the period of highest flow, March 21-28, 1982, was 1.96 ± 1.53 mCi and at an average flow of 3.5 cubic meters per second (flow measured at Cypress Bridge). Hayes (1983b) used this data to reestimate the transport of cesium-137 from the mouth of Steel Creek. His new estimate for the sediment-water transport during the first and second years of resumed reactor operation is 2.3 ± 1.8 curies per year (1.96×10^{-3} curies per day x [11 cms/3.5 cms] x 365.25 days/year = 2.3 Ci/yr).

EV-47 This transport estimate is supported by more recent measurements (Hayes, 1983e). Hayes believes that the concentrations of cesium-137 in Steel Creek water are governed by a reequilibration process between the water and the cesium in the creekbed and floodplain sediments (see Section D.2.3.1). During the April through August 1983 study period, the cesium-137 concentration at Cypress Bridge averaged 3.7 picocuries per liter on a weekly basis. From this value and a cooling-water discharge from the heat exchangers of about 11 cubic meters per second, the estimated sediment-water transport during the first and second years



Note: See Table D-16 for data listing.

Source: Hayes (1983b).

Figure D-11. Daily average discharge and cesium-137 transport at Steel Creek mouth from January 8 to May 6, 1982.

Table D-18. Daily Cs-137 concentrations, transport and creek flow at mouth of Steel Creek[a]

Calendar date	Julian date	Cs-137 (pCi/ℓ)	Cs-137 (mCi/day)	Flow (m^3/day)
03/01/82	60	0.1	0.129	1,293,600
03/05/82	64	0.6	0.826	1,376,900
03/06/82	65	1.2	1.661	1,384,250
03/07/82	66	0.9	1.270	1,411,200
03/08/82	67	1.4	1.935	1,381,800
03/09/82	68	0.6	0.826	1,376,900
03/10/82	69	1.1	1.517	1,379,350
03/11/82	70	1.4	1.924	1,374,450
03/12/82	71	1.4	1.931	1,379,350
03/13/82	72	0.6	0.825	1,374,450
03/14/82	73	1.1	1.512	1,374,450
03/15/82	74	1.0	1.377	1,376,900
03/16/82	75	1.4	1.931	1,379,350
03/17/82	76	1.2	1.729	1,440,600
03/18/82	77	0.9	1.217	1,352,400
03/19/82	78	0.5	0.671	1,342,600
03/20/82	79	1.0	1.384	1,384,250
03/21/82	80	0.9	1.249	1,376,900
03/22/82	81	1.5	2.124	1,416,100
03/23/82	82	1.9	2.774	1,460,200
03/24/82	83	0.9	1.473	1,636,600
03/25/82	84	1.0	1.428	1,428,350
03/26/82	85	1.6	2.120	1,325,450
03/27/82	86	0.8	1.027	1,283,800
03/28/28	87	2.7	3.513	1,300,950
03/29/82	88	0.3	0.387	1,291,150
03/30/82	89	1.4	1.701	1,215,200
03/31/82	90	0.4	0.477	1,193,150
04/01/82	91	1.1	1.358	1,234,800
04/02/82	92	1.8	2.130	1,183,350
04/03/82	93	0.6	0.712	1,188,250
04/04/82	94	1.1	1.304	1,185,800
04/05/82	95	0.4	0.517	1,293,600
04/06/82	96	0.8	1.162	1,452,850
04/08/82	98	1.1	1.350	1,227,450
04/09/82	99	0.1	0.120	1,195,600
04/10/82	100	0.5	0.589	1,178,450
04/11/82	101	0.1	0.117	1,173,550
04/13/82	103	0.7	0.852	1,217,650
04/14/82	104	0.6	0.808	1,347,500
04/16/82	106	0.4	0.476	1,190,700
04/18/82	108	1.2	1.438	1,198,050
04/20/82	110	1.3	1.586	1,220,100
04/22/82	112	0.2	0.236	1,178,450

[a]Adapted from Hayes, 1983b. Cesium-137 values are the sum of the suspended solid fraction and the dissolved fraction. See Figure D-11.

of resumed reactor operation (under the reference case) is 1.3 curies per year (11 cubic meters per second x 1000 liters per cubic meter x 86,400 seconds per day x 365.25 days per year x 3.7 x 10^{-12} curies per liter = 1.3 curies per year. If the upper equilibrium limit of 11 picocuries per liter (Hayes, 1983e) is used, the transport estimate becomes 3.8 curies per year, which is within the estimate of 2.3 ± 1.8 curies per year (Hayes, 1983b) described in the preceding paragraph. The travel time from the L-Reactor outfall to the Steel Creek delta, about 1 day, is apparently too short to develop the upper concentration equilibrium limit. EV-47

D.4.3.2 Cobalt-60

Radiocobalt was detected in only four of the suspended sediment samples obtained during the flow tests of the secondary cooling-water system. In contrast, cesium-137 was detected in nearly all of the 250 samples. Because of the limited number of positive samples from the flow test, the expected cobalt-60 sediment-water transport was conservatively estimated by assuming that the cobalt-60 in the sediments would be transported in a manner similar to cesium-137. The ratio of cobalt-60 to cesium-137 in the sediments of the Steel Creek system is about 0.068 (Table D-6).

On the basis of the flow test data, a weekly maximum of about 0.56 mCi/day-m^3/sec of cesium-137 was remobilized from Steel Creek. Thus, the expected cobalt-60 transport from sediment sources in Steel Creek, as determined by Hayes and Watts (1983) is 0.43 mCi/day or 0.16 curie per year (0.56 x 10^{-3} Ci/day-m^3/sec x 0.068 x 11 cms x 365.25 days/year = 0.16 Ci/yr).

D.4.4 Summary of remobilization estimates

For the reference case, the total amount of cesium-137 estimated to be remobilized and transported from Steel Creek during the first year of resumed L-Reactor operation is 4.4 ± 2.2 curies. This value is the sum of three transport estimates: 1.7 ± 0.2 by desorptive transport, 0.4 ± 0.2 curie transport in biota, and 2.3 ± 1.8 curies suspended sediment-water transport. In the second year it is anticipated that this value will be reduced to 2.3 ± 1.8 curies. Thereafter, a 20 percent reduction in transport per year is assumed. Thus, after 10 years of resumed operation, approximately 14.4 curies of cesium-137 will have been transported to the Savannah River swamp system (Hayes, 1983b).

The 2.1 curie decrease from the first to the second year is based on the assumption that the hot cooling water will no longer desorb cesium-137 from the creekbed and floodplain sediments and that there is no more vegetation to contribute cesium-137. It is also noted that the sediment-water transport estimate presented here is substantially less than initially estimated (Du Pont, 1982a); however, the original estimates of transport resulting from hot water desorption and from cesium-137 in the vegetation remain unchanged (see Section D.4.3.1).

The amount of cesium-137 remobilized and transported to the Savannah River on an annual basis was estimated for each alternative cooling-water systems involving flowing streams (see Section 4.4.2) by applying the following equation:

$$Cs_{out} = 2.3F + 0.4F + 1.7(T/75°C), \text{ in curies per year}$$

where F is the cooling-water flow normalized to the flow from the reference case, and T is the temperature (°C) of the water discharged from the cooling-
TC water system to Steel Creek during periods of severe summer meteorological conditions. This equation accounts for the three major aspects of cesium-137 remobilization and transport--the first term accounts for sediment-water transport, the second term is for biota (principally vegetation), and the third term is for hot-water desorption. For the reference case, F = 1 and T = 75°C, and CS_{out} = 4.4 curies per year. This equation is believed to provide conservative results because, when the summer ambient conditions (0.62 cubic meter per second creek flow at L-Reactor with a water temperature of 28°C) are used as input parameters, the calculated cesium-137 transport is 0.65 curie per year, about three times the measured value.

The total amount of cobalt-60 estimated to be remobilized and transported from Steel Creek during the first year of resumed L-Reactor operation is estimated to be at most 0.25 ± 0.13 curie. This total is composed of a 0.16 curie per year fraction associated with sediment-water transport and a 0.09 curie per year fraction associated with desorptive transport. During the second year, up to 0.14 ± 0.10 curie will be transported in association with the suspended sediments (0.16 Ci/yr x 0.876 decay factor = 0.14 Ci/yr; Hayes and Watts, 1983). Approximately 0.6 curie of cobalt-60 will be transported to the Savannah River swamp system during the first 10 years of resumed L-Reactor operation.

Tables D-19 and D-20 compare the current cesium-137 and cobalt-60 transport values with the estimated values for the first, second, and tenth years after resumption of L-Reactor operation. Maximum concentrations of cesium-137 and cobalt-60 1.5 river miles below Steel Creek, the point of complete mixing of Steel Creek and river water, are predicted to be 1/425 and 1/3300 of the EPA drinking-water standard, respectively. Concentrations in finished water from the Beaufort-Jasper and Cherokee Hill water treatment plants are predicted to be very small fractions of these drinking-water standards.

D.4.5 Accumulation of cesium-137 in Creek Plantation Swamp

The flooding of the SRP and Creek Plantation swamps at river stages above 27.7 meters above mean sea level (about 440 cubic meters per second) will cause the flow from Steel Creek to be diverted from the Savannah River into the swamp paralleling the river. In the past, this diversion has caused cesium-137 to be deposited in Creek Plantation Swamp (Figure D-6) and other areas. Radiological surveys showed that the cesium-137 was in a relatively narrow band on the bankside edge of the Creek Plantation floodplain. Using sediment measurements, about 21 curies of cesium-137 are currently estimated to be present in the Creek Plantation Swamp.

Table D-19. Estimated cesium-137 remobilization from Steel Creek compared with current transport values[a]

Location	River Mile	Inventory transported (Ci/yr): Current values	Inventory transported (Ci/yr): After restart 1st year	2nd year	10th year	Concentration in water (pCi/ℓ): Current values	Concentration in water (pCi/ℓ): After restart 1st year	2nd year	10th year
Steel Creek mouth	141.6	0.25	4.4	2.3	0.4	5.3	11.15	5.80	1.01
Savannah River at 1.5 river miles below Steel Creek	140.1	0.41[b]	4.4	2.3	0.4	0.04[b]	0.47	0.25	0.04
Hwy 301 bridge	118.7	0.39[b]	4.3	2.2	0.4	0.04[b]	0.44	0.23	0.04
Hwy 17 bridge	21.4	0.20[b]	2.7	1.4	0.2	0.02[b]	0.23	0.12	0.02
		WATER TREATMENT PLANTS							
Finished water									
Beaufort-Jasper	39.2	--	--	--	--	0.028	0.01	<0.01	<<0.01
Cherokee Hill	29.0	--	--	--	--	0.033	0.09	0.05	<0.01
EPA interim primary drinking water standard	--	--	--	--	--	200	200	200	200

[a]Based on mean transportation estimates made by Hayes (1983b) and Hayes and Watts (1983), and data presented in Table D-16, and average flow rates in the Savannah River at locations indicated. Estimates of concentration and transport for 1st, 2nd and 10th year only represent the contribution resulting from the remobilization of cesium-137 in Steel Creek by resumed operation of L-Reactor (reference case). No alterations of existing water treatment plant systems were assumed.

[b]1979-1982 average concentration measured at the Hwy. 301 bridge was 0.04 picocurie per liter; other values derived using appropriate flow rates and reduction factors.

Table D-20. Estimated cobalt-60 remobilization from Steel Creek compared with current transport values[a]

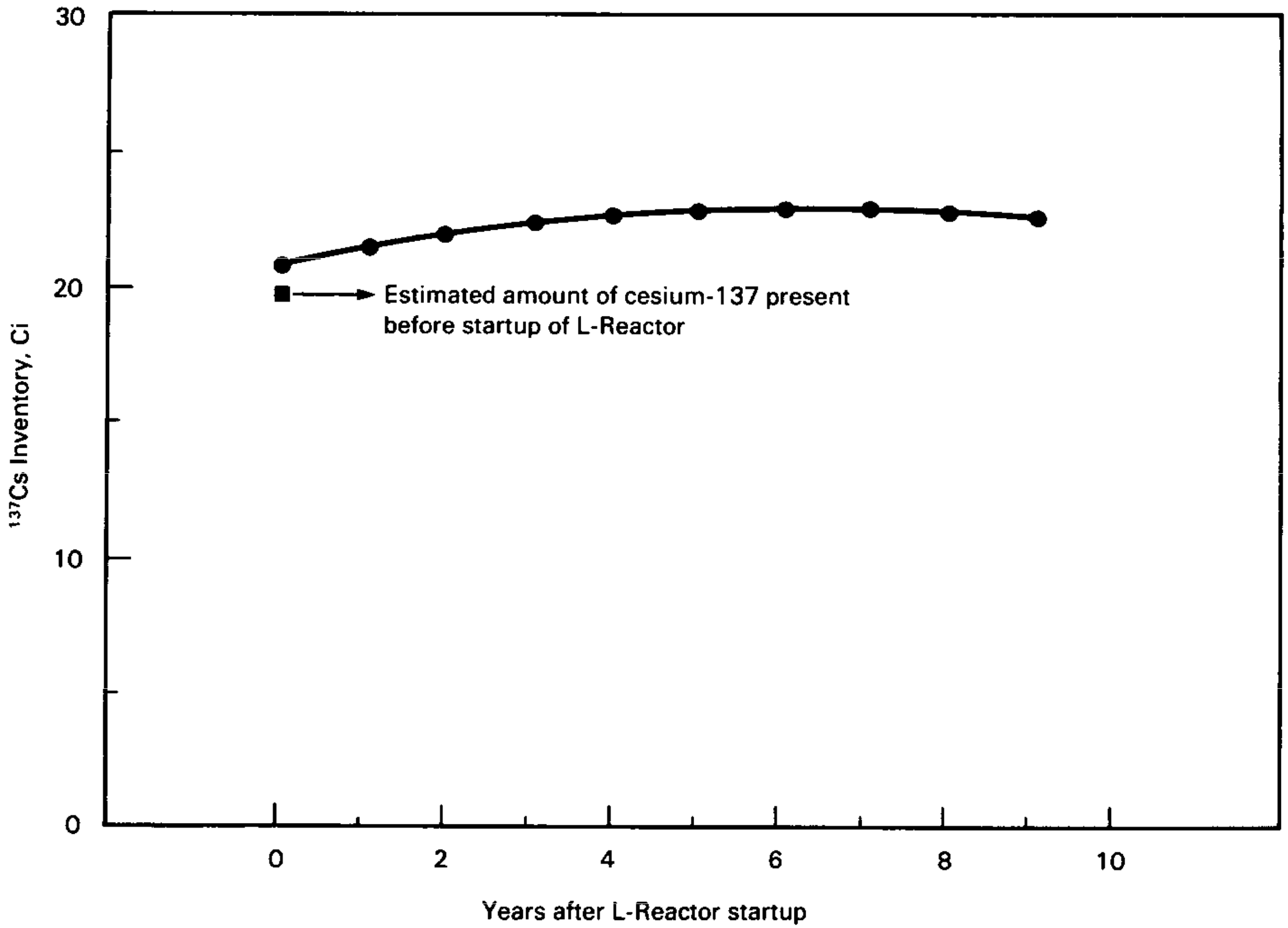
Location	River Mile	Inventory transported (Ci/yr)				Concentration in water (pCi/ℓ)			
			After restart				After restart		
		Current values	1st year	2nd year	10th year	Current values	1st year	2nd year	10th year
Steel Creek mouth	141.6	0.02[b]	0.25	0.14	<0.01	0.3[b]	0.63	0.35	0.02
Savannah River at 1.5 river miles below Steel Creek	140.1	0.02[b]	0.25	0.14	<0.01	<<0.01[b]	0.03	0.02	<<0.01
Hwy 301 bridge	118.7	0.02[b]	0.24	0.14	<0.01	<<0.01[b]	0.03	0.02	<<0.01
Hwy 17 bridge	21.4	0.01[b]	0.15	0.09	<<0.01	<<0.01[b]	0.02	<0.02	<<0.01
		WATER TREATMENT PLANTS							
Finished water									
Beaufort-Jasper	39.2	--	--	--	--	<0.003[c]	0.02	<0.02	<<0.001
Cherokee Hill	29.0	--	--	--	--	<0.003[c]	0.02	<0.02	<<0.001
EPA interim primary drinking water standard	--	--	--	--	--	100	100	100	100

[a]Based on mean transportation estimates made by Hayes (1983b) and Hayes and Watts (1983), and average flow rates in the Savannah River at locations indicated. Estimates of concentration and transport for 1st, 2nd and 10th year only represent the contribution resulting from the remobilization of cobalt-60 in Steel Creek by resumed operation of L-Reactor (reference case). No credit is taken for removal of cobalt-60 by the water treatment process.

[b]Estimated on the basis of 0.06 times the value for cesium-137.

[c]Based on Kantelo and Milham (1983).

Cesium-137 is expected to be deposited again in Creek Plantation Swamp during the first 10 years of operation of L-Reactor (reference case) as a result of river flooding and the transport of cesium-137 from Steel Creek. The maximum inventory estimate, corrected for radioactive decay, will be about 23 curies about 6 years after resumed L-Reactor operation (Figure D-12).



Adapted from Du Pont (1982a).

Figure D-12. Increase in cesium-137 on the Creek Plantation Swamp.

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APPENDIX E

ARCHEOLOGICAL AND HISTORIC RESOURCES

In accordance with the National Environmental Policy Act of 1969, Executive Order 11593, the National Historic Preservation Act of 1966, as amended in 1980, and the Archeological and Historic Preservation Act of 1974, archeological and historic surveys were conducted for the resumption of L-Reactor operation. Because no major earthwork is to be undertaken at the L-Reactor site, the surveys were focused on the Steel Creek terrace and floodplain system into which L-Reactor cooling water is planned to be discharged.

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This appendix describes the results of the survey performed on the Steel Creek terrace and floodplain system for the L-Reactor operation reference case (direct discharge). In addition, this appendix contains tables that list sites contained in the National Register of Historic Places in the six-county area (Figure 3-4) near Savannah River Plant (SRP). Additional surveys and mitigation have been performed or are in progress; these are described in Appendix L.

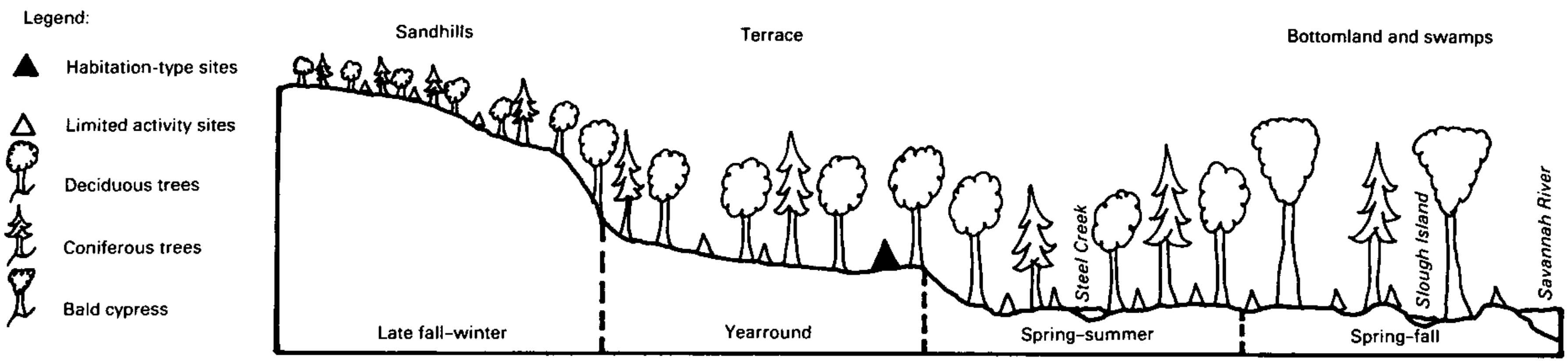
E.1 STEEL CREEK ARCHEOLOGICAL AND HISTORIC RESOURCES

The archeological and historic survey of the Steel Creek terrace and floodplain system below the L-Reactor area was conducted during January and February of 1981 (Hanson et al., 1981). The purpose of the survey was to identify all archeological and historic resources in the potentially affected area, and to determine if identified sites would be affected by increased flow in Steel Creek. The following subsections describe a subsistence model for the prehistoric occupation of the Steel Creek area, a summary of historical activities of the general area, the survey that was performed, and the results of the survey.

E.1.1 Settlement-subsistence model

The variability in the topography, hydrology, elevation, soils, and biota of the Steel Creek watershed was used to construct a settlement-subsistence model for prehistoric times (Figure E-1). The watershed has been divided into four zones, each having characteristic resources for prehistoric man. Two zones--the Savannah River swamp (Zone IV) and the tributary/bottomlands (Zone III)--would have been inhospitable for long-term settlement due to their excessive moisture and poorly drained soils. However, due to the extremely high productivity of these zones, they are expected to have been seasonally exploited for their aquatic resources. Thus, sites located in these zones would represent limited activities, and more permanent residential sites would be elsewhere.

The zone with the greatest probability for providing more permanent base-camp and habitation sites is the mesic terrace (Zone II), just above the tributary/bottomland zone. The mesic terrace is highly productive in flora and fauna during the spring, summer, and fall. Its soils and topography provide dry



	Zone I Upland Sandhills	Zone II Mesic Terraces	Zone III Tributaries and Bottomland	Zone IV Savannah River and Swamps
Key resources	Red oak acorns, deer, small terrestrial mammals, seeds, and hickory nuts	White and red oak acorns, deer, small terrestrial mammals, seeds, greens, turkey, berries, and fruits	Fish, aquatic fauna, water-fowl, deer, small mammals, red and white oak acorns, greens, fruits, berries, and seeds	Fish, aquatic fauna, fresh-water mussels, small mammals, deer, greens, seeds, some acorns, and hickory
Season(s) of major utilization	Late fall and winter	Spring, summer, fall, and winter	Spring, summer, and fall	Spring and summer with minor use in fall
Activities	Acorn and hickory gathering, deer hunting and processing, small game hunting, seed collecting, general foraging, and short-term camping	Acorn and nut gathering, small mammal hunting, deer hunting and processing, vegetal food foraging, food processing and storage, and habitation	Fish procurement with spears and weirs, deer hunting, waterfowl hunting, acorn collecting, vegetal food foraging, and possible short-term camping	Fish procurement with spears, nets, weirs, and traps, mussel collecting, some deer hunting, and general vegetal foraging
Archaeological correlates	Small lithic and/or ceramic scatters, debitage indicative of tool maintenance, broken hunting and meat-processing tools, sites dispersed throughout the zone, and overall low lithic assemblage diversity	Large base-camp and habitation sites near either Zone III or Zone IV, high lithic assemblage diversity, seed and nut processing tools, storage containers, debitage reflecting tool manufacture and maintenance, and some small low tool diversity sites	Stream-edge fishing stations, fish traps and weirs, scattered meat-processing sites with low tool diversity, broken hunting and meat processing tools, and a dispersed pattern of nonfishing sites	Levee and slough edge fishing/mussel collecting stations, hunting and meat-processing sites on islands, overall low tool diversity in all of these small sites, and possible large base camps on islands

Figure E-1. General settlement-subsistence model for Steel Creek watershed.

and protected areas for dwellings. All areas in this zone are within 1 kilometer of permanent water sources.

For the most part, resources in the upland zone (Zone I) are available in their highest densities during the late fall and winter. The limiting factor in this zone is water, which occurs only in small springs and intermittent streams. Sites in this zone would be expected to represent limited activity, the primary activities being hunting and meat processing. Contributions to the archeological record would be limited to broken or exhausted tools related to these activities.

E.1.2 Prehistoric time periods

Early Archaic (9500 to 7500 B.C.) and Middle Archaic (7500 to 3000 B.C.) components found at three sites indicate a substantial early occupation in the Steel Creek watershed. The data collected indicate a subsistence strategy relying on the seasonal use of a great variety of resources scattered over a number of the settlement-subsistence zones, including an intensive use of the upland area of Savannah River Plant. This environmental diversification is accompanied by a gradual diversification of tool assemblage needed to accomplish various procurement tasks.

The predominant era of occupation, however, occurred during the Late Archaic (3000 to 1000 B.C.) and Early Woodland (1000 B.C. to A.D. 1), as evidenced by data collected at 10 sites. The data indicate subsistence strategy, but with an increased emphasis on riverine resources. Artifactual assemblages were much more diverse than those from previous periods, including for the first time a large number of ground stone tools, grinding tools, and both ceramic and steatite vessels. Toward the Early Woodland period there was a gradual lessening of reliance on floodplain resources. Sites on Savannah River Plant seem to be evenly distributed between riverine and upland areas but reflect an increased use of uplands during this era.

Following the Early Woodland period, the occupation in the watershed appears to be reduced, suggested by a smaller number of Middle and Late Woodland components. These sites were restricted to the upland zone.

Finally, the survey established only one Mississippian (A.D. 1000 to A.D. 1700) component in the watershed, in the upland zone, which suggests a largely reduced use of the area during the most recent prehistoric period. The data collected indicated an even greater reliance on the upland zone for resources.

E.1.3 Steel Creek watershed survey

The archeological and historical survey study area consisted of the Steel Creek 100-year floodplain. Two teams of archeologists traversed a stretch of Steel Creek approximately 13 kilometers long and 300 meters wide, inspecting 4-square-meter plots of the ground surface every 5 meters along the creek. The study area was inspected by raking the ground surface in a systematic manner.

When a site was located, random or systematic rake tests, as appropriate, determined the extent of the site. If a site was within 125 meters of Steel Creek, subsurface testing was performed to determine the nature of the site. Data and artifacts were recovered from 18 discrete locations in the study area (Figure E-2 and Table E-1).

E.1.4 Conclusions

The sites located during the survey were divided into three groups to evaluate their eligibility for nomination to the National Register (36 CFR 63.3). The following criteria were used: (1) those sites that are not significant; (2) those that have the potential for being significant; and (3) those that are significant. Sites characterized as significant have unique and sufficient content, integrity, and scientific importance to warrant their eligibility to the National Register; their content, integrity, and importance would suffer adverse effects from any man-caused activity that alters or destroys the immediate environment.

Ten of the sites located during the survey were not considered significant (Table E-2). These sites are prehistoric but are either lacking in integrity or limited in archeological content.

Seven of the sites located during the survey were considered to be potentially significant (Table E-2). Three of these are prehistoric with well-preserved archeological content. Each has the potential to give valuable scientific information about Archaic and Woodland adaptations and possibly about the development of ceramic technology in the area. These three sites are situated well beyond the area of potential impact from the increased water flow down Steel Creek. These three prehistoric sites have been determined not to be eligible for nomination to the National Register. The four other sites are historic features, three mill dams and a roadway, all situated on Steel Creek. These features have been weathered and partially destroyed by pre-SRP activities. The actual wooden mill structures are no longer standing, but the dams are relatively intact and well preserved. The bridge portion of the roadway that spanned Steel Creek is in ruins, but the earthen approaches are intact. These four sites are indicative of the pre-Civil War era and have the potential to yield information regarding the economy and transportation systems of the area. They also have been subjected to high water flow conditions, similar to the conditions anticipated with L-Reactor operations; they show no sign of adverse effects as a result of those conditions. In July 1982, DOE requested the concurrence of the Keeper of the National Register regarding these sites' eligibility for nomination to the National Register. The Keeper of the National Register concurred in the eligibility of these four sites for inclusion in the National Register.

One prehistoric site, located at the confluence of Steel Creek and Meyers Branch, was considered significant in terms of the National Register criteria. Although other sites contain similar artifactual data, this site's rich and diverse archeological deposit has the potential to provide valuable knowledge regarding the changes in technology and culture of the uninterrupted occupation from the Early Archaic through the Mississippian periods. Therefore, this site is considered a significant prehistoric resource. Aerial photographic studies

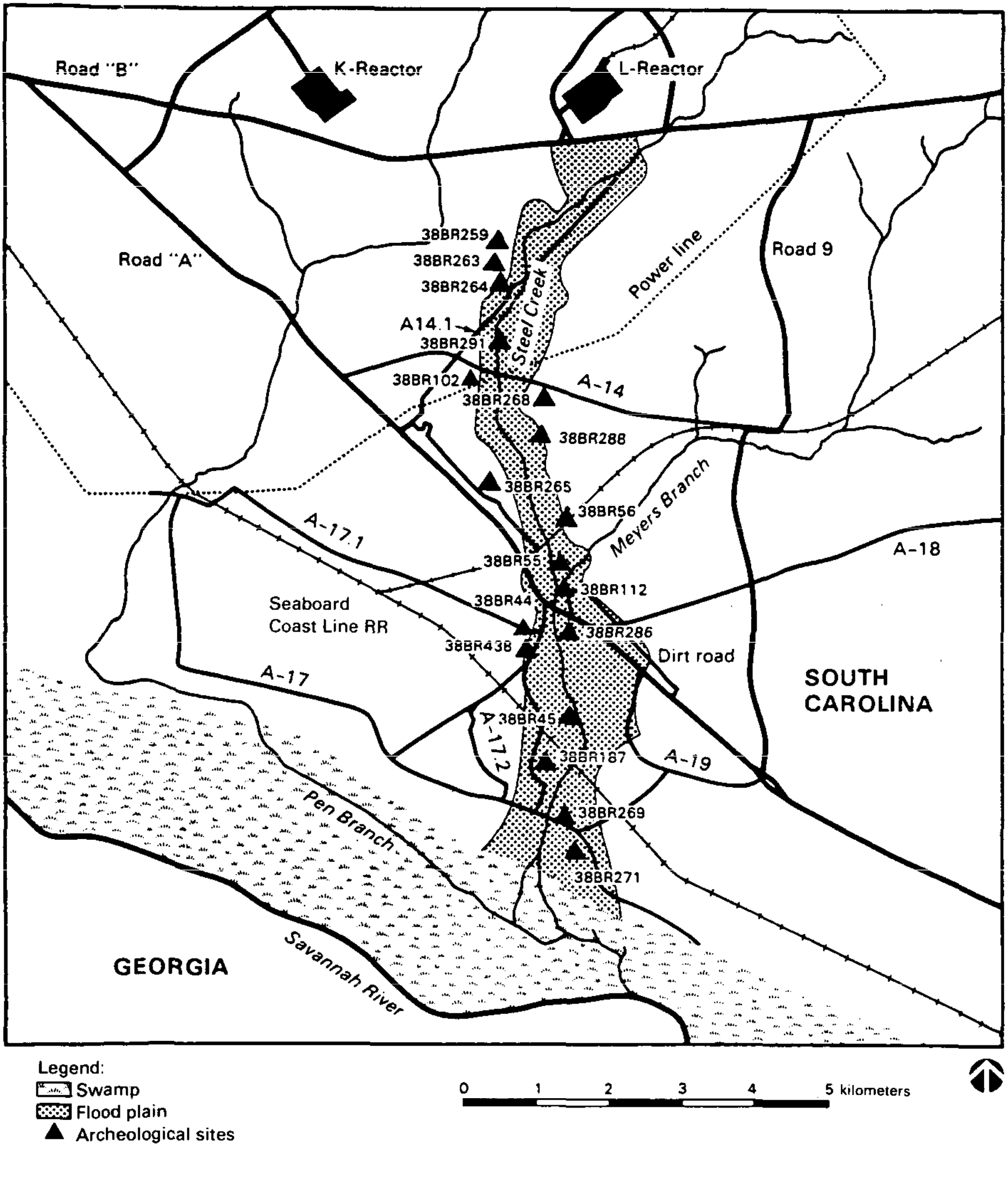


Figure E-2. General map of the survey area indicating site location.

Table E-1. Steel Creek archeological sites

Site number	Approximate location	Approximate size (m)	Prehistoric occupation[a]	Historic occupation	Remarks
38BR438	200 m west of floodplain; along Rd A-17 285 m south of Rd A-17.1	150 x 300	Middle and Late Archaic; Woodland	19th and 20th centuries	Repeated prehistoric occupation on a seasonal basis with habitation; no subsurface exploration; potentially significant.
38BR44	75 m west of floodplain; 100 m south of Rd A-17/A-17.1 junction	50 x 100	Early to Late Archaic	1780-1840 to 1930	No subsurface exploration except for material exposed in road cut to depth of 50 cm; site of preferred occupation.
38BR45	100 m west of floodplain on a ridgetop-terrace; 320 m northeast of Southern Railway line near junction with Rd A-17	300 x 700 (not well defined)	Early Woodland (?; ceramic prehistoric)	--	Possible reoccupations of short duration; no subsurface exploration.
38BR55	Confluence of Steel Creek and Meyers Branch; along terrace edges of both streams from 36.6 m to 4.27 m contours	100 x 600	Middle Archaic to Mississippian	--	Subsurface studies show cultural deposits about 1 m thick; approximate artifact density of 400/m^3; likely base camp or habitation site throughout most of prehistoric time since Middle Archaic; eligible for inclusion in the National Register.

Table E-1. Steel Creek archeological sites (continued)

Site number	Approximate location	Approximate size (m)	Prehistoric occupation[a]	Historic occupation	Remarks
38BR56	200 m east of floodplain along Seaboard Coast Line Railroad line; 625 m north of Steel Creek and Meyers Branch confluence	50 x 80	Lithic prehistoric	—	Most of site is distributed beyond recovery by construction of railroad during early 1980s; no subsurface exploration--exposed in railroad cut; lacks temporally diagnostic materials.
38BR102	125 m west of floodplain; along Rd B-5, about 180 m west of Rd B-5/A-14 junction	100 x 350	Late Archaic to Early Woodland	Pre-Civil War (1780-1830) to 1900	Site exposed during construction of transmission line; represents sandhill environmental zone and locus of limited activity.
38BR112	On and adjacent to Steel Creek about 200 m north of Rd A (125)	100 x 100	Lithic prehistoric	1814 to 1950	Historic mill and dam site across floodplain and prehistoric to the east of Steel Creek, which served as a limited-activity locus; absence of temporally diagnostic prehistoric artifacts; eligible for inclusion in the National Register.

Table E-1. Steel Creek archeological sites (continued)

Site number	Approximate location	Approximate size (m)	Prehistoric occupation[a]	Historic occupation	Remarks
38BR187	30+ m west of floodplain	250 x 1050	Early to Late Woodland	Post-1880 to 1940	Considered a single archeological scatter (composed of 38BR184, -185, -186, -187); some historic ruins near site; long occupation (with habitation) during Woodland; no subsurface exploration.
38BR259	100 m west of floodplain; 250 m west of Rd B-4 and 1690 m south of Rd B	50 x 120	Early Woodland	--	Artifacts found to a depth of about 80 cm; served as limited-activity locus and habitation; used for processing nuts and seeds.
38BR263	140 m west of floodplain; 100 m north of termination of Rd A-14.1 and 1780 m south of Rd B	50 x 50	Woodland (?, ceramic prehistoric)	--	No subsurface exploration; lacks temporally diagnostic materials; served as limited-activity locus.
38BR264	Along west side of floodplain; at terminus of Rd A-14.1.	50 x 50	Lithic prehistoric	--	Site disturbed by transmission line construction; lacks temporally diagnostic materials; served as limited-activity locus.

Table E-1. Steel Creek archeological sites (continued)

Site number	Approximate location	Approximate size (m)	Prehistoric occupation[a]	Historic occupation	Remarks
38BR265	100 m west of floodplain; 500 m north of Rd A-16	30 along north-south axis	Late Woodland (?)	—	No subsurface exploration; width of site is unknown; general lack of temporally diagnostic materials.
38BR268	150 m east of floodplain; 300 m from Rd A-14/B-5 junction	50 x 100	Early Woodland	—	Disturbed by earthwork for pre-1950 road maintenance; episodic limited-activity locus.
38BR269	On and beyond east side of floodplain; at termination of Rd A-17 on west and A-19 on east	Prehistoric site >40 x >80	Paleo-Indian-Early Archaic (?; Lithic prehistoric)	1788 (dam) site occupied through 1840	Historic mill dam site and associated prehistoric and historic artifact scatters; terrestrial portion of site is on the 30-m terrace of Savannah River; prehistoric artifact concentrations 160 and 210 m E of floodplain; artifacts to a depth of 45 cm; site of prehistoric habitation; eligible for inclusion in the National Register.
38BR271	300 m north of Savannah River swamp east of the delta; 1 km west of BM 131	40 x 60	Lithic prehistoric	—	No subsurface exploration early stage of lithic tool manufacture, but lacks temporally diagnostic materials.

Table E-1. Steel Creek archeological sites (continued)

Site number	Approximate location	Approximate size (m)	Prehistoric occupation[a]	Historic occupation	Remarks
38BR286	On east and west floodplain; 1786 path includes portions of Rds A-17.1 and A-18 west and east of Steel Creek, respectively	width = 7	--	1786-1940	Historic road and bridge approach; bridge known as Steel Creek Bridge; in 1966, when Steel Creek water level was maximum, water passed through the central area of the bridge pilings and approaches. No evidence of bridge piling found in 1981; eligible for inclusion in the National Register.
38BR288	On east side of floodplain; opposite Rd A-17.1/A-17.2 junction on west side of Steel Creek	5 x 3 at top	--	Before 1818-1840	Historic mill and dam site with several timbers remaining in water; eligible for inclusion in the National Register.
38BR291	125 m west of floodplain; 140 m south of Rd A-14.1 and 380 m north of Rd A-14	30 x 50	--	1770-1840	Historic artifact scatter site with no evidence of foundations or architectural features.

[a](?) = prehistoric lithic and/or ceramic debris--no specific time period.

Table E-2. Archeological resource summary for site recovery determined by Steel Creek survey

Site number	Period(s) of occupation[a]	Type of site	Eligibility for National Register	Adverse effects from increased water flow	Site preservation recommendations
38BR44	1, 2, 8 (1780-1930)	Limited activity	No	None	None
38BR45	4, (?)	Limited activity	No	None	None
38BR56	(?)	Limited activity	No	None	None
38BR102	3, 4, 8 (1780-1900)	Limited activity	No	None	None
38BR263	(?)	Limited activity	No	None	None
38BR264	(?)	Limited activity	No	None	None
38BR265	6	Limited activity	No	None	None
38BR268	4	Limited activity	No	None	None
38BR271	(?)	Limited activity	No	None	None
38BR291	8 (1760-1840)	Historic	No	None	None
38BR438	2, 3, 4	Habitation	No	None	None
38BR112	(?), 8 (1780-1940)	Limited activity, mill dam	Yes	Possible	Preserve vegetation cover and monitor
38BR187	4, 5, 6	Habitation	No	Possible	None
38BR259	4	Habitation	No	Possible	None
38BR269	(?), 8 (1780-1840)	Habitation, mill dam	Yes	Possible	Preserve vegetation cover and monitor
38BR286	8 (1780-1940)	Historic roadway	Yes	Possible	Preserve vegetation cover and monitor
38BR288	8 (1800-1870)	Mill dam	Yes	Possible	Preserve vegetation cover and monitor
38BR55	1, 2, 3, 4, 5, 6, 7	Habitation	Yes	Possible	Monitor erosion, provide erosion protection, data recovery

[a] 1 = Early Archaic Period (9500-7500 B.C.); 2 = Middle Archaic Period (7500-3000 B.C.); 3 = Late Archaic Period (3000-1000 B.C.); 4 = Early Woodland Period (1000 B.C.-A.D. 1); 5 = Middle Woodland Period (A.D. 1-700); 6 = Late Woodland Period (A.D. 700-1000); 7 = Mississippian Period (A.D. 1000-1700); 8 = Historic Period (A.D. 1700-present); and (?) = Prehistoric lithic and/or ceramic debris--no specific time period.

√

of Steel Creek during periods of high water flow experienced with past reactor operations and physical inspection of the site did not reveal any adverse effects during the increased water flow conditions. In July 1982, DOE requested the concurrence of the Keeper of the National Register regarding this site's eligibility for nomination to the National Register. The Keeper of the National Register concurred in this site's eligibility for inclusion in the National Register.

E.1.5 Mitigation plan for the sites eligible for inclusion in the National Register

Those sites eligible for inclusion in the National ~~Register (pre~~historic site 38BR55, three mill dams, and a roadway) will ~~be protected by a~~ mitigation plan designed to prevent possible destruction caused by the increased water flow down Steel Creek. A physical inspection of the four historic earthen features to determine the presence and extent of erosion due to increased water flow indicated no erosion. A major reason for the lack of erosion appears to be the stabilizing effect of the trees and vegetation cover. The preservation of these four sites will be ensured by allowing and encouraging ~~the continued~~ growth of trees and vegetation. The prehistoric site will be subjected initially to a monitoring program that ~~involves placing~~ and checking erosion control stakes on the ~~upstream~~ edge of the site along Steel Creek. If the stakes indicate any erosion of the site edge, erosion barriers will be built. If the erosion barrier is not sufficient to protect the site, data recovery will become necessary; the probability of this is low because previous high-water levels did not affect the site. If erosion is not evident after two years of monitoring, the site will be considered sufficiently protected.

E.2 REGIONAL ARCHEOLOGICAL AND HISTORICAL RESOURCES

In 1982, 62 sites in the six-county area near Savannah River Plant were listed in the National Register of Historic Places (Table E-3). Richmond County, Georgia, has the largest number of sites (26), most in and around the City of Augusta; Aiken County, South Carolina, has 15 sites. Fifteen of the 62 sites are within 15 kilometers of Savannah River Plant.

Table E-3. National Register sites in the six-county area near Savannah River Plant[a]

Name	Location
AIKEN COUNTY, SOUTH CAROLINA	
Chancellor James Carrol House	Aiken
Coker Springs	Aiken
Legare-Morgan House	Aiken
Phelps House	Aiken
Dawson-Vanderhorst House	Northeast of Aiken
Fort Moore-Savano Town site	Beech Island vicinity
Redcliffe	Northeast of Beech Island
Graniteville Historic District	Graniteville
Silver Bluff	West of Jackson
Charles Hammond House	North Augusta
Rosemary Hall	North Augusta
Joye Cottage	Aiken
Chinaberry (Williams-Converse House)	Aiken
St. Mary Help of Christian Church	Aiken
Willcox's	Aiken
ALLENDALE COUNTY, SOUTH CAROLINA	
Antioch Christian Church	Southwest of Allendale
Erwin House	Southwest of Allendale
Gravel Hill Plantation	Southwest of Allendale
Red Bluff Flint Quarries	Allendale vicinity
Roselawn	Southwest of Allendale
Smyrna Baptist Church	South of Allendale
Lawton Mounds	Johnsons Landing vicinity
Fennell Hill	Peeples vicinity
BAMBERG COUNTY, SOUTH CAROLINA	
General Francis Marion Bamberg House	Bamberg
Woodlands	SE of Bamberg
Rivers Bridge State Park	Ehrhardt vicinity
Voorhees College Historic District	Denmark vicinity
BARNWELL COUNTY, SOUTH CAROLINA	
Banksia Hall	Barnwell
Church of the Holy Apostles	Barnwell
Church of the Holy Apostles Rectory	Barnwell
Old Presbyterian Church	Barnwell
Bethlehem Baptist Church	Barnwell

Table E-3. National Register sites in the six-county area near Savannah River Plant[a] (continued)

Name	Location
COLUMBIA COUNTY, GEORGIA	
Kiokie Baptist Church	Appling
Stallings Island	Northwest of Augusta
Woodville	Winfield vicinity
Columbia County Courthouse	Appling
RICHMOND COUNTY, GEORGIA	
Academy of Richmond County	Augusta
Augusta Canal Industrial Historic District	Augusta
Augusta Cotton Exchange	Augusta
Stephen Vincent Benet Home	Augusta
Brake House	Augusta
Landmark Baptist Church of Augusta	Augusta
Fitzsimmons-Hampton House	Augusta
Gertrude Herbert Art Institute	Augusta
Harris-Pearson-Walker House	Augusta
Meadow Garden	Augusta
Old Medical College Building	Augusta
Old Richmond County Courthouse	Augusta
Sacred Heart Catholic Church	Augusta
St. Paul's Episcopal Church	Augusta
Augusta National Golf Club	Augusta
Gould-Weed House	Augusta
Lamar Building	Augusta
Reid-Jones-Carpenter House	Augusta
Woodrow Wilson Boyhood Home	Augusta
College Hill	Augusta vicinity
Broad Street Historic District	Augusta
Pinched Gut Historic District	Augusta
Summerville Historic District	Augusta
Greene Street Historic District	Augusta
Springfield Baptist Church	Augusta
Meadow Garden-George Walton House	Augusta

[a]Data from USDOI (1979, 1980, 1981, 1982, 1983).

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APPENDIX F

SUBSURFACE HYDROLOGY*

F.1 REGIONAL HYDROGEOLOGY

F.1.1 Regional geology and physiography

The Savannah River Plant (SRP) is located in the Upper Atlantic Coastal Plain, about 40 km southeast of the Fall Line, which separates the Piedmont and Coastal Plain provinces (Figure F-1). The coastal plain is underlain by a wedge of seaward-dipping unconsolidated and semiconsolidated sediments which increase in thickness from zero at the Fall Line to greater than 950 meters near the coast of South Carolina (Rankin, 1977) and continues to the seaward edge of the Continental Shelf. The topographic surface of the coastal plain slopes gently seaward as do the geologic units underlying this surface.

The Savannah River Plant lies on the Aiken Plateau as defined by Cooke (1936). The Aiken Plateau is bounded by the Savannah and Congaree Rivers (Figure F-1), and slopes from an elevation of 200 meters (above mean sea level) at the Fall Line to an elevation of about 76 meters. The surface of the Aiken Plateau is highly dissected and is characterized by broad interfluvial areas with narrow steep-sided valleys. Relief is locally as much as 90 meters (Siple, 1967). The Plateau is generally well drained although small poorly drained depressions occur. Drainage is poor in the low-lying river swamp areas.

The Savannah and Congaree Rivers are the largest in the region. The Savannah River forms the boundary between South Carolina and Georgia. The river has a flood plain 6 to 8 kilometers wide downstream from Augusta, Georgia, and a stream gradient of about 1.9×10^{-4} adjacent to the Savannah River Plant.

Between the Savannah and the Congaree Rivers are the North and South Forks of the Edisto River and the Salkehatchie River. Both of these rivers originate on the coastal plain and flow southeastward into the Atlantic Ocean. These rivers do not incise their valleys as deeply into the sediments as do the Savannah and Congaree Rivers. On the Aiken Plateau there are several southwest flowing tributaries to the Savannah River. From the Fall Line these are Horse Creek, Hollow Creek, Upper Three Runs Creek, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek (Figure F-2).

The sediments of the Atlantic Coastal Plain in South Carolina are stratified gravel, sand, clay, and limestone which dip gently seaward; there are local variations in dip and thickness due to locally variable depositional regimes. The base of the coastal plain sediments lies on the weathered surface of the crystalline metamorphic rock that dips at a gradient of about 6.8×10^{-3} from the Fall Line. Imbedded in the crystalline metamorphic rock is at least one sedimentary basin of Triassic age. The basin is comprised of sedimentary rocks that are buff to maroon in color and contain poorly sorted sands and clays. |TC

*This appendix is developed primarily from Du Pont (1983).

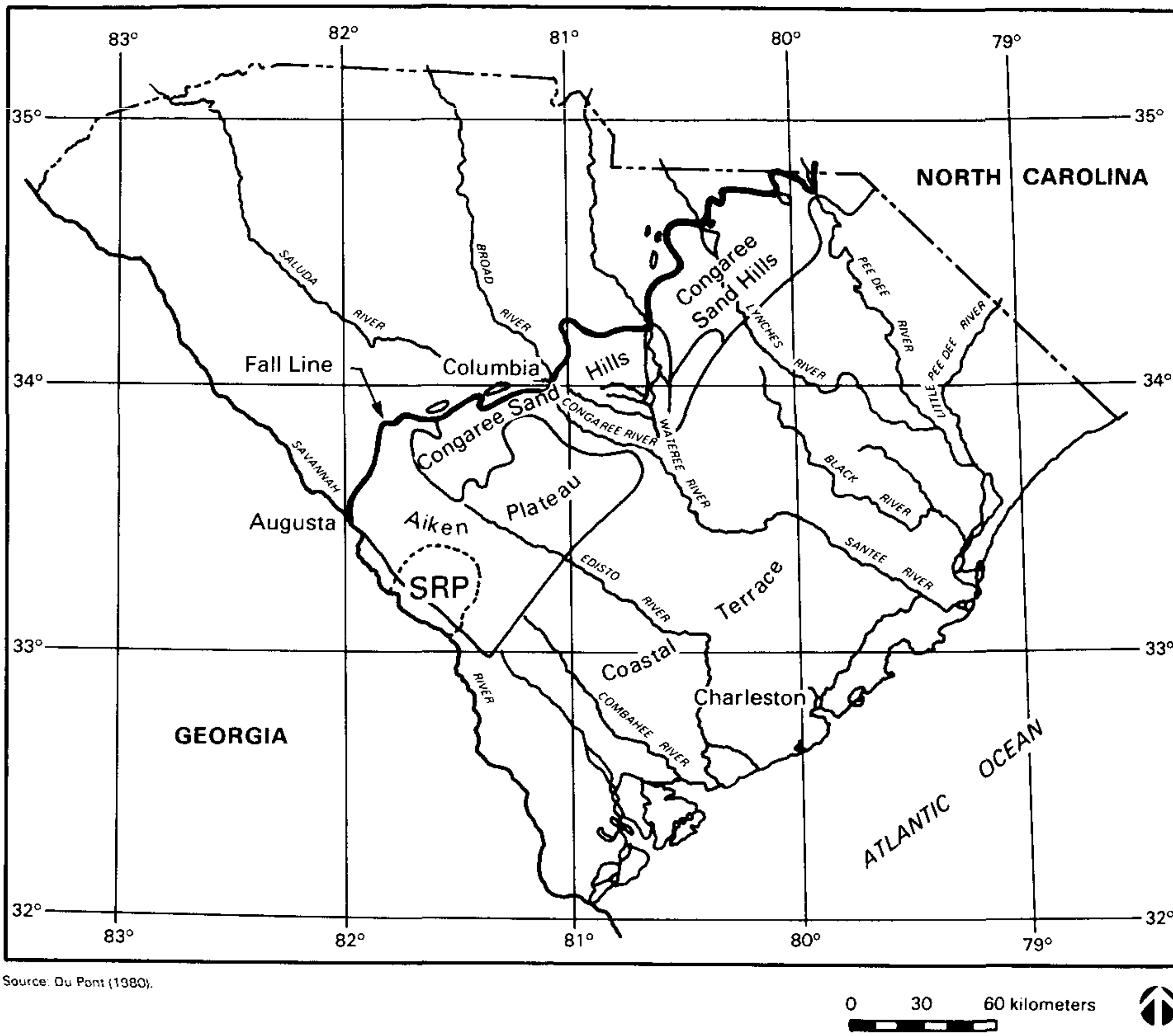
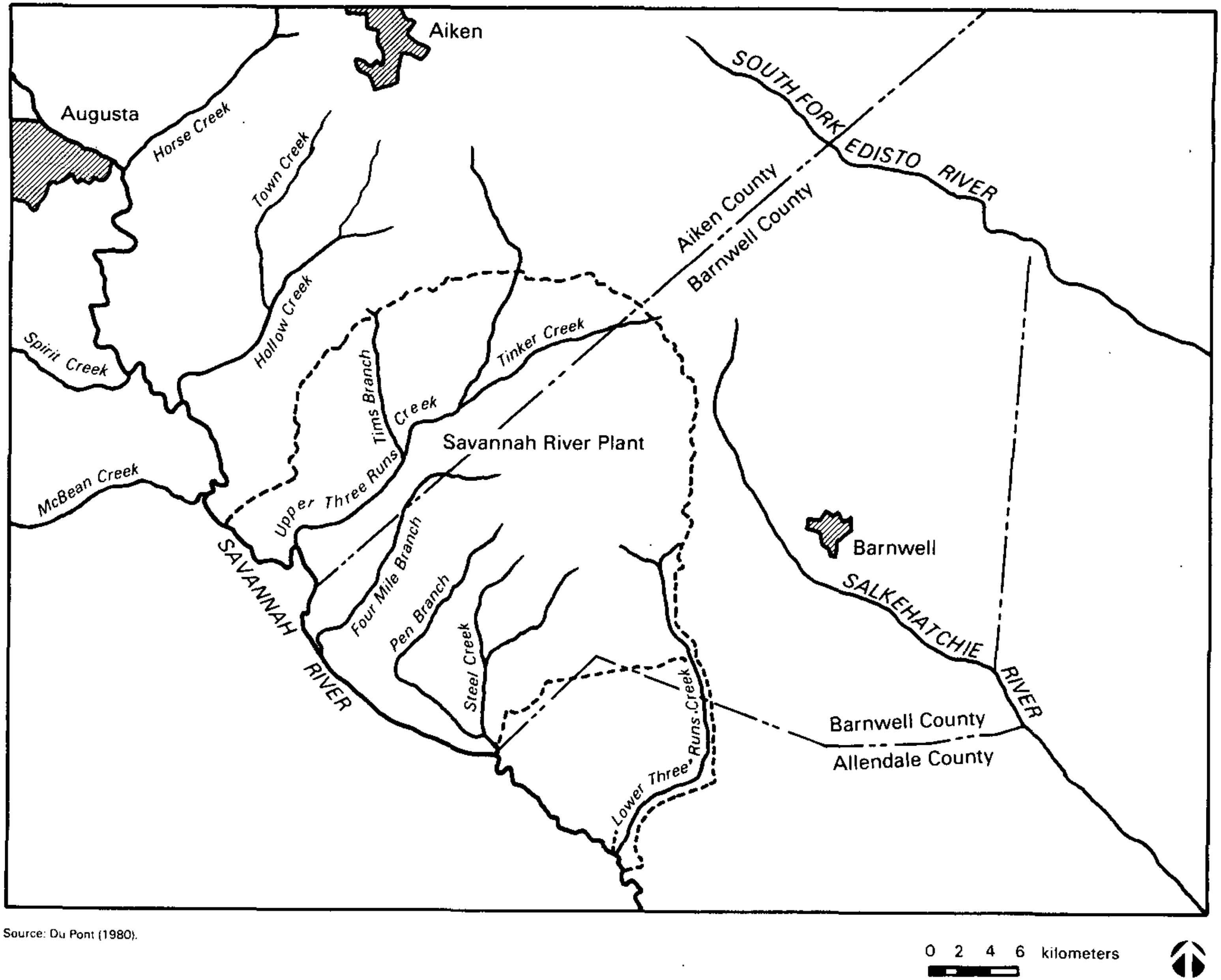


Figure F-1. Physiography of the Savannah River region.



Source: Du Pont (1980).

Figure F-2. Surface hydrologic features in the vicinity of the Savannah River Plant.

The erosional surface on the crystalline metamorphic rock is continuous across the Triassic basin and has a very low relief.

The structural setting of the Atlantic Coastal Plain is a monoclinal dip of gradient 1.7×10^{-3} to 6.8×10^{-3} to the southeast with some local variations. The Triassic basins beneath the coastal plain were created by tensional rifting and erosion from fault block mountains and deposition into fault block valleys, much as is occurring today in the basin and range province of Utah and Nevada.

F.1.2 Regional hydrology

Water moves through the ground from areas of high potential energy (the combined elevation and pressure heads) to areas of lower energy. In general, on the Atlantic Coastal Plain, this involves ground water moving seaward from the higher areas of the Aiken Plateau toward the Continental Shelf. Because most sedimentary units become finer grained and less transmissive toward the coast, this movement becomes exceedingly slow. Of major significance is the modification from this general southeastward movement caused by the incision of the Savannah and Congaree Rivers. Ground water in the regions of these rivers flows toward the hydraulic-energy low caused by discharge to the surface in these river valleys. Savannah River Plant is totally on the Savannah River side of the ground-water divide that occurs between these two rivers. Thus, the regional ground water of interest will have directions of flow determined by the relationship of the ground water to the Savannah River Valley.

The depth of dissection by the southwestward-flowing tributaries has a significant influence on the direction of flow in most hydrostratigraphic units. In general, the direction of flow in the shallow ground water is most affected by small tributaries, deeper ground water by major tributaries, and deepest ground water only by the Savannah River itself. It is not unusual to have the deepest ground water moving at right angles, or even in the opposite direction to the shallow ground water at a particular location because of differences in stream incision.

The depth to the water table (the beginning of the saturated zone, below which all pores are filled with water and above which pores are partially filled with air) ranges from zero to about 38 meters below the surface. The depth to the water table is dependent on the horizontal and vertical hydraulic conductivity, topographic drainage and local surface water conditions. In some places where interbedded clays are common, the vertical movement of water is impeded and shallow or locally perched water tables exist. In other places where these clays are not present, the water table may be very deep. The water table generally slopes in the same direction but more gently than the land surface. Thus, deeper water tables commonly exist near the cuesta face of the asymmetrical tributary creek valleys, that is, the southeast side of the valleys; whereas shallower water tables exist on the northwest side.

As used in this appendix, the SRP vicinity extends only to those distances that could have a cause-effect relationship to ground water at Savannah River Plant. This distance ranges from about 64 kilometers from the center of the plant in a northerly direction to about 32 kilometers in a southeasterly direction. Even though the geologic names used for some of the water-bearing units at SRP extend to great distances, the hydrologic relationships do not. Thus, the hydrologic region is much more restricted than the geologic region.

The coastal plain sediments constitute a multilayer hydrologic system in which there are both retarding and transmitting beds, so that parts of it may be somewhat hydrologically isolated from other parts. Hydraulic properties vary for each of the hydrostratigraphic units, depending on their lithology. Groundwater flow paths and flow velocities for each of these units are governed by the hydraulic properties, by the geometry of the particular unit, and by the distribution of recharge and discharge areas.

Because of the sandy nature of the sediments and the comparatively short residence time of ground water (centuries), the water in the coastal plain sediments is low in dissolved solids. Most of the waters have a low pH (about 5.5) and are generally corrosive to metal surfaces.

F.1.3 Formation terminology

In order to discuss the geology and hydrology of the region and of the Savannah River Plant specifically, it is convenient to designate parts of the geologic column with names. Historically, the criteria for designating geologic units with names is well established, but in practical application, this topic is sometimes confusing. Ideally, each geologic unit should have a set of physical and visually observable characteristics that distinguish it from other units in the area. When a geologic unit has such a set of characteristics and is thick enough and extensive enough to be shown on the usual scale of geologic mapping, it is called a "formation" and receives a formal name. These names are designated and accepted through publication in the open refereed literature according to certain rules.

The terminology for the hydrostratigraphic units used in this report (Table F-1) is modified from that used by Siple (1967). Table F-1 describes the lithology and water-bearing characteristics of these units. These terms, as modified, have been found very useful in numerous studies of ground water at the SRP. Figure F-3 is a cross section through SRP from the Fall Line showing the relationship of the units discussed in Table F-1. Figure F-4 shows a tentative correlation of these units to stratigraphic terminology being described in current publications. However, the thrust of much of this current literature is on biostratigraphy and regional correlation of mappable units and not on hydrostratigraphy. Thus, for purposes of this appendix, the older terminology is retained.

F.1.4 Water-level measurements

Water levels used to construct piezometric maps presented in this appendix were measured in monitoring wells (not in pumping wells) during normal plant operations, including the withdrawal of process and domestic water from groundwater sources. EL-24

Table F-1. Hydrostratigraphic units in the vicinity of SRP[a,b,c]

Formation	Recharge	Discharge	Confining layers	Other characteristics
BARNWELL (& HAWTHORN)				
Surficial unit Miocene-Eocene Epoch, Tertiary Period 30 m thick in Separations Area	Winter rainfall is 31.2 cm/year. Total recharge is about 38 cm/year.	Onsite streams. Leakage through tan clay to McBean.	Tan clay at base; absent in M-Area	Fine to coarse sand and sandy clay with numerous clastic dykes (ironstone margin with clay center). "Tan clay" - 4-m thick unit at base of formation composed of 2 clay zones separated by a sandy zone. Tan clay is absent in A/M-Areas. Water-table aquifer in the central portion of SRP, but not in A/M-Areas. Water yield limited but sufficient for domestic use. Water table maps--Figs. 3-10, F-21, and F-24. L-Area cross-section--Fig. F-22. K_L = 0.6 m/day (Fig. F-19; also see Fig. F-14 and Table F-7). j = 0.2 - 0.25. I = 0.0188 (L-Area seepage basin to Steel Creek with 2-m head in basin). K_V(tan clay) = 1.6×10^{-3} m/day. $V_L = 365IK_L/j$ = 20.6 m/year. V_L = (14.5) (% gradient) m/year.

AW-1, FE-2

Table F-1. Hydrostratigraphic units in the vicinity of SRP[a,b,c] (continued)

Formation	Recharge	Discharge	Confining layers	Other characteristics
BARNWELL (& HAWTHORN) (continued)				
				V_V = 2.1 m/year (unsaturated zone). Seepage rate from F-, H-, and M-Area seepage basins about 5.5 m/year because of constant discharges and low pH of waste streams.
MCBEAN				
Eocene Epoch, (Claiborne Group), Tertiary Period 24 m thick in Separations Area	From Barnwell (through tan clay in Central SRP). Offsite areas.	Upper Three Runs Creek and Four Mile Creek. Almost no leakage through the green clay to Congaree in central SRP; some leakage in A/M-Areas.	Tan clay at top; absent in A/M-Areas Green clay at base; discontinuous in A/M-Areas	Upper unit of clayey sands and sand; lower unit of calcareous clayey sand with void spaces that could result in rod drops or lost circulation during drilling operations. Calcareous zone with void spaces is not present in A/M-Areas. Corps of Engineers performed soil grouting of calcareous zone beneath major buildings. Green clay at base formation is 2 m thick in Separations Area, and supports head differences up to 24 m. Green clay is discontinuous in A/M-Areas, and thickens to 7 ml L-Area and to 18 m in the southeastern SRP. Water yields to wells moderate to large. Forms water-table aquifer in M-Area; elevations range from about 65 to 75 m.

AW-
FE-

Table F-1. Hydrostratigraphic units in the vicinity of SRP[a,b,c] (continued)

Formation	Recharge	Discharge	Confining layers	Other characteristics
MCBEAN (continued)				
				Water levels shown on Figs. 3-8, F-5, F-11, F-15, F-16, F-20, and F-33. Main body of contaminant plume in the A/M-Areas is moving at 7.6 m/year; this suggests K_L = 1.0 m/day. Outer fringe of plume is moving at about 76 m/year. Hydraulic conductivity of upper McBean is about twice that of lower McBean (0.13 versus 0.07 m/day; Table F-7). K_L = 0.9 m/day (Fig. F-19: also see Fig. F-14 and Table F-7). j = 0.20 - 0.25. I = 0.017. $V_L = 365 I K_L / j$ = 27.9 m/year.
CONGAREE				
Eocene Epoch, (Claiborne Group), Tertiary Period 37 m thick in Separations Area	Principally in offsite areas; some leakage from McBean in A/M-Areas.	Savannah River and wetlands along upper Three Runs Creeks.	Green clay at top; discontinuous in A/M-Areas Pisolitic clay at base	Sand with some interbedded clay layers (absent in A/M-Areas). Becomes clayey sand in A/M-Areas, and is similar in character to McBean. Pervasive pisolitic clay at base correlates with similar clays in Gulf Coast.

AW-1, FE-2