5.1.2.6 Occupational dose

The operation of L-Reactor support facilities is expected to cause an incremental dose increase of about 291 person-rem in the total onsite occupational dose. The total expected occupational dose from operation of L-Reactor and its support facilities is 360 person-rem (i.e., 69 person-rem for L-Reactor and 291 person-rem from support facilities).

5.1.2.7 Summary - offsite dose commitment from operation of L-Reactor and its support facilities

Table 5-14 summarizes the maximum individual and population dose from release of radioactive materials from L-Reactor (reference case) and its support facilities. The doses listed as totals for both individuals and populations are conservative maximums, as explained in Section 5.1.2.4.

The composite maximum individual dose of 3.6 millirem in the first year of operations is about 26 times less than the average dose of 93 millirem per year received by an individual living near SRP from natural radiation. The total-body dose to both the 80-kilometer and downstream river-water-consuming populations of 36 person-rem (tenth year) is less than 0.03 percent of the approximately 109,000 person-rem received by the 80-kilometer and the downstream river-water-consuming population from natural background radiation sources.

In 1982, radiation exposure rates from 0.14 to 1.09 milliroentgen per day were measured in the uninhabited, privately owned Creek Plantation Swamp to the southeast of the SRP boundary (Du Pont, 1983a). These exposure rates are the result of radiocesium deposition in the swamp, principally during the 1960s. The current inventory of radiocesium in Creek Plantation Swamp is estimated to be about 21 curies. Approximately 6 years after resumed L-Reactor operation, the inventory will reach a maximum of about 23 curies (Appendix D). In the extremely unlikely event that a person should stay in Creek Plantation Swamp for an entire year, he would receive, on the average, an additional total-body dose of approximately 106 ± 22 millirem based on the distribution of radiocesium in the swamp (Hayes, 1982). This situation is not considered credible.

The population doses described above are received by the regional population. Certain radionuclides, primarily tritium, carbon-14, krypton-85, and iodine-129, can be transported through the atmosphere for long distances and can result in doses to the rest of the U.S. population. Most radionuclides in particulate form are deposited in the regional area.

The 100-year environmental dose commitment to the U.S. population beyond 80 kilometers of SRP from the four main radionuclides identified above is summarized in Appendix B. The sum of the doses to the total body from first- and tenth-year operation is about 25 and 48 person-rem, respectively; an additional 1.7 person-rem to the thyroid will result from iodine-129 releases during first or tenth-year operation.

The radiation-induced health effects that might be caused in the U.S. population by the operation of L-Reactor and its support facilities have been

Table 5-14. Summary of maximum individual and regional population total-body dose from the operation of L-Reactor and SRP support facilities for the reference case

Source of exposure	First year	Tenth year
MAXIMUM INDIVIDUAL ADULT DOSE (millirem per year)		
Atmospheric releases	0.10	0.23
Liquid releases	0.029	0.14
Radiocesium transport	3.5	0.31
Total	3.6	0.68

	Dose within 80 kilometers of SRP		Port Wentworth and Beaufort-Jasper doses	
Source of exposure	First year	10th year	First year	10th year
REGIONAL POPULATION DOSE (person-rem per year)				
Atmospheric releases	5.8	16.3	-	-
Liquid releases	0.053	0.066	1.7	18.5
Radiocesium transport	9.0	0.80	0.80	0.067
Total	14.9	17.2	2.5	18.6

analyzed by the methods described in the BEIR III Report (NAS, 1980). The estimated health effects due to the first year of L-Reactor and support facilities operations would be about 0.003 premature cancer death and 0.006 genetic disorder; releases during the tenth year of operation would eventually cause about 0.006 premature cancer death and 0.01 genetic disorder.

5.1.2.8 Waste-management operations

Currently, 50 of the 51 large subsurface tanks (Tank 16 is being decommissioned) are used to store the high-level radioactive wastes generated by the SRP chemical separations facilities (F- and H-Areas). Four types of waste tanks are being used to store high-level waste (HLW) (ERDA, 1977). All freshly generated HLW will be processed and stored in Type III tanks, which consist of a tank within a tank; the space between the inner and outer walls is monitored to detect any leaks in the inner wall so corrective action can be taken. The safety and potential environmental risk of constructing and operating the SRP Type IV tanks are discussed in the environmental impact statement prepared for the use of double-wall storage tanks (DOE, 1980). BH-6

Incremental processing by the chemical separations facilities as a result of L-Reactor operation will generate 1150 to 2300 cubic meters of liquid waste per year. This volume of waste will be concentrated to 380 to 760 cubic meters per year. With this additional volume of waste, a maximum of three tanks per decade of L-Reactor operation would be required, two for fresh waste and one for concentrated waste. However, because the Defense Waste Processing Facility is expected to be immobilizing SRP high-level waste into borosilicate glass by 1989, no new high-level waste tanks are actually expected to be required for L-Reactor operation. The volume of high-level radioactive waste to be generated by chemical processing of L-Reactor material was considered in the Defense Waste Processing Facility EIS (DOE, 1982a).

Operation of the L-Reactor will result in the generation of about 570 cubic meters of low-level and transuranic radioactive solid waste annually from the reactor itself and about 5700 cubic meters, containing about 86,000 curies of radioactivity, from the fuel fabrication and fuel reprocessing areas.

The low-level solid waste from the reactor operations contains both fission products and induced activity. This waste is generated during maintenance work on pipes, valves, instruments, and other reactor components; by the accumulation of radionuclides on the filters for the cooling-water basin; and by the partial disassembly of fuel, target, and control-rod assemblies before they are transported to the fuel reprocessing areas. Solid waste from the reactor consists of stainless-steel end fittings on fuel and target components, aluminum housing tubes, and other miscellaneous reactor parts, including contaminated work clothing and plastic suits.

Work clothing, plastic suits, and other items of a similar nature are packaged in boxes and sealed before their disposal in the SRP Burial Ground. The highly radioactive stainless steel and aluminum parts are placed in shielded casks before transport. The Burial Ground is a 195-acre area near the center of SRP between the F- and H-Separations Areas. At present, about 17,000 cubic meters of solid waste containing 260,000 curies of activity is added to the Burial Ground each year. After L-Reactor restart, the expected input will increase gradually to about 22,650 cubic meters and 350,000 curies of radioactivity per year.

The offsite radiological effects of high-level liquid and solid wastes will be negligible. (Additional information on the SRP waste management operation, including the disposal of SRP high-level and low-level radioactive waste, is
BH-6 contained in the following references: DOE, 1980, 1982a; Du Pont, 1983c, Volume II; and ERDA, 1977.)

5.1.2.9 Accident risks in non-reactor facilities

AB-10, DA-34 The resumption of L-Reactor operation will increase the material throughput in both the chemical processing (200-Area) and the fuel fabrication (300-Area) reactor support facilities. Because these facilities were designed to support five production reactors, no changes in the nature of the operations or in their size are required to accommodate L-Reactor.

The consequences of accidents are defined by the inventory of radioactive material in process and available for release at any one time; because these quantities will not be changed appreciably by the resumption of L-Reactor operation, no change in accident types or consequences will result.

The frequency of accidents is related to the material throughput (i.e., increasing the number of hours these facilities operate at full capacity increases the likelihood of accidents occurring). The resumption of L-Reactor operation will increase those frequencies by no more than 33 percent (resulting from the increase in the number of operating reactors from three to four), with a corresponding maximum percentage increase in the present risk (consequence x frequency), exclusive of risks from tritium releases (because L-Reactor will produce only plutonium). AB-10, DA-34

The most probable incremental risks from accidents at the L-Reactor support facilities are very nearly equivalent to the incremental impacts from the normal operation of these facilities. The doses from the normal operation of L-Reactor support facilities are listed in Tables B-15 through B-17 (for atmospheric releases) and Tables B-30 through B-33 (for liquid releases). Based on these data, risk to an individual would total about 0.1 millirem per year to the total body and 0.5 millirem per year to the thyroid; population risks total about 8 person-rem per year to the total body and about 100 person-rem to the thyroid.

5.1.3 Preferred alternatives*

The preferred mitigation alternatives for the restart of L-Reactor, which are described in Sections 4.4 and 4.5, include the following:

- Safety systems -- operate L-Reactor with the present confinement system, which consists of a series of filters through which air is exhausted from the reactor building to a tall stack.

- Cooling water -- The preferred cooling-water alternative of the Department of Energy is to construct a 1000-acre lake before L-Reactor resumes operation, to redesign the reactor outfall, and to operate L-Reactor in a way that assures a balanced biological community in the lake as specified in an NPDES permit to be issued by the State of South Carolina. The lake will require an anticipated minimum period of 3 to 5 years to establish and develop a balanced biological community. Initially, L-Reactor will be operated to maintain 32.2°C or less in about 50 percent of the lake. Studies will be conducted to confirm the biological characteristics and the cooling effectiveness of the lake. Following the results of these studies, L-Reactor operations will be adjusted as necessary to assure the continued maintenance of a balanced biological community.

- Disassembly-basin water disposal -- purge disassembly-basin water to the existing L-Reactor seepage basin after deionization and filtration;

*Because this section is new, vertical change bars are not necessary.

continue to study the detritiation of reactor moderator for all SRP reactors.

- 186-Basin sludge removal -- flush the 186-basin sludge (batch discharge) to the process sewer and eventually to Steel Creek after L-Reactor has been shut down and the basin drained; monitor the discharge from the process sewer for total suspended particulates during the flushing in accordance with the NPDES permit; report the findings to SCDHEC after 1 year of resumed operation.

The preferred alternatives will not cause any incremental impacts other than those described in Section 5.1. These impacts are summarized below. Where appropriate, the summaries have been modified to reflect changes resulting from interactions between L-Reactor and incremental impacts.

The preferred cooling-water alternative will cause only minor impacts to other facilities on SRP. These include the sale of timber, the relocation/abandonment of roads, and the relocation of two transmission lines (see Section 4.4.2). The sale, cutting, and removal of marketable timber in the area of the cooling pond on Steel Creek will be administered by the U.S. Forest Service. This will increase revenues from timber sales, but the cooling lake will prevent the reforesting of about 775 acres of uplands. The tie-in of the relocated 115-kilovolt power transmission line will require the shutdown of P-Reactor for a short period. However, the tie-in is expected during a scheduled reactor shutdown as part of routine operation; no special shutdown should be required.

5.1.3.1 Socioeconomics

Approximately 160 employees are expected to be hired by 1984 for existing SRP facilities in support of the resumption of L-Reactor operation. About half have already been hired. In addition, approximately 550 construction personnel will be required for the construction of the cooling lake. Because the number of additional employees to be hired is less than 4 percent of the SRP labor force, and because the inmoving population associated with the potential 330 additional employees is less than 0.1 percent of the indigenous population in the six-county area, no impacts on local communities or services is expected.

5.1.3.2 Nonradioactive effluent discharge

<u>Discharge to seepage basins</u>

Nonradioactive effluents generated in operations involving radioactive materials will be discharged to seepage basins in F-, H-, and M-Areas (Table 5-2). The present discharges to the F- and H-Area seepage basins are not hazardous (under RCRA) except for frequent periods of low pH and infrequent discharges of hazardous levels of mercury and chromium. The mercury levels are associated with the processing of onsite reactor products and radioactive waste management activities; the chromium levels are associated with the processing of offsite fuels, radioactive waste management, and the removal of oxide from onsite target elements. The incremental increases to the F- and H-Area seepage basins from the operation of L-Reactor are not expected to be hazardous except for low pH and occasional discharges of mercury (H-Area only). Effluent discharged to the M-Area seepage basin frequently meets the RCRA definition of hazardous waste because of pH. Typically, the waste stream contains 1,1,1-trichloroethane, but not at levels considered to be hazardous.

The projected L-Reactor incremental liquid releases to the Separations Areas will be 0.04 cubic meter per minute to the F-Area seepage basins and 0.09 cubic meter per minute to H-Area basins. The chemicals in these releases are expected to increase the concentrations of constituents in the contaminant plume by about 7 percent (Table 5-1). The water quality of Four Mile Creek will be degraded as the ground water flows into the creek through seepline springs in low-lying wetland areas. Concentrations of constituents in the creek water will be increased by about 7 percent. However, drinking-water standards will not be exceeded and the quality of the creek water is expected to be similar to that of the Savannah River below the outfall of C-Reactor.

The green clay has effectively protected the Congaree Formation from contaminants released to the seepage basins in the Separations Areas and is expected to continue to protect the Congaree when L-Reactor is restarted. The thick, low-permeability clay units of the lower Congaree and upper Ellenton Formations will remain effective confining units for the Tuscaloosa, and incremental releases to the Separations Area seepage basins are not expected to contaminate the ground water within this formation.

The L-Reactor incremental liquid releases projected for late 1984 to the Fuel and Target Fabrication Area seepage basin amount to 0.05 cubic meter per minute. By the time of the expected L-Reactor restart (early 1985), the I/R well system would have been operational for about 4 months. Additional fuel and target assemblies for L-Reactor are not expected to be produced until the wastewater-treatment facility is operational in April 1985. Thus, there might be no incremental releases to the seepage basin and Lost Lake. If fuel and targets are produced, the small incremental discharges will have only a minor and local effect on the contaminant levels in the Tertiary ground-water system beneath the seepage areas; the effects will be dissipated during the protracted period of seepage to the water table. The thick, low-permeability clay units of the lower Congaree and upper Ellenton Formations will remain effective confining units for the Tuscaloosa, and incremental releases to the M-Area basin are not likely to contaminate the ground water within this formation. However, the A- and M-Areas ground-water remedial action project is scheduled to be operating by August 1984. The I/R wells, which will have a capacity of at least 12.5 times the incremental release, are expected to intercept seepage from the basin and Lost Lake areas when it reaches the water table in about 10 to 17 years. The I/R system is expected to counter any tendency for increased downward migration of contaminants resulting from L-Reactor incremental pumping. Use of the M-Area seepage basin is scheduled to be discontinued by April 1985, when a wastewater-treatment facility will be in service.

<u>Ash basin</u>

Additional discharges of coal ash will be sluiced (mixed with water and discharged) to the K-Area ash basin for disposal as a result of the production of steam for L-Reactor operation. The additional burning of coal will produce approximately 815 metric tons of ash per year, which will increase the K-Area steam-plant discharge to the ash basin by about 15 percent. Leachate from the ash basin will enter the shallow ground-water system of the Barnwell Formation, from which it will migrate to Pen Branch; little impact is anticipated.

Effluent treatment processes

Alternatives to the discharge of process wastewaters to the seepage basins in the chemical separations and fuel and target fabrication areas are being investigated, with the intent that these seepage basins will be closed and decommissioned (see Section F.6).

Releases to surface streams

The operation of L-Reactor will cause an incremental increase of about one-third in the direct discharge of liquid effluent from the separations areas to surface streams. As listed in Table 5-5, F-Area will discharge an additional 890 liters per minute to Four Mile Creek; the increment to Four Mile Creek from H-Area will be about 1040 liters per minute (Du Pont, 1982b). Table 5-5 also lists the expected concentrations of pollutants in the liquid effluents to these streams and compares the concentrations to applicable drinking-water standards or water-quality criteria.

At the outfall, these releases are permitted under NPDES and, except for pH, are expected to meet SCDHEC water-quality standards for Class B streams.

5.1.3.3 Atmospheric releases

Incremental impacts of nonradiological atmospheric pollutants will occur because of the increased steam, electricity, and other processes that L-Reactor operation will require. However, these are not expected to cause any violations of regulations or air-quality standards.

Nitrogen oxide (NO_x) releases resulting from L-Reactor operation are higher than other air pollutant emission increases (Table 5-6). Overall, L-Reactor restart will increase future SRP NO_x emissions by about 5 percent. Air emissions permits for the F-, H-, and M-Area facilities have been revised to reflect process changes. Sulfur dioxide and total suspended particulate releases will add about 1 percent. Releases related to L-Reactor operation will contribute 1.1 micrograms per cubic meter NO_x to the ambient air at the SRP boundary. This compares to 15 to 23 micrograms per cubic meter NO_x estimated from all other SRP sources in 1985. Total sulfur dioxide and total suspended particulate releases from L-Reactor restart will add less than 1 gram per cubic meter each.

5.1.3.4 Water usage

Surface water

Only minor amounts of surface water will be consumed by SRP facilities to support L-Reactor operation, because ground water will be the principal source of process water at these facilities. The K-Reactor steam plant will require an estimated 0.005 cubic meter per second additional water from the Savannah River to produce steam for L-Reactor (Du Pont, 1981).

Ground water

Incremental ground-water pumping from the Tuscaloosa Formation, required to support the resumption of L-Reactor operation, will occur in five areas on SRP; as identified in Table 5-7, these are K-Area (steam plant), the Central Shops, and F-, H-, and M-Areas. The 1985 projected ground-water consumption from the Tuscaloosa at SRP, including that from those areas in support of L-Reactor (0.94 at L-Area + 4.94 total incremental = 5.9 cubic meters per minute), is estimated to be 25.4 cubic meters per minute. This represents a 7-percent increase over the 1982 SRP withdrawal from the Tuscaloosa of 23.8 cubic meters per minute, but a 6-percent decrease from the 1983 withdrawal rate of 27.0 cubic meters per minute (Tables 5-7 and F-10). The withdrawal of Tuscaloosa ground water at the rate of 25.4 cubic meters per minute is expected to have little impact (less than 0.4 meter) on offsite water levels. Beneath the Central Shops and H-Area basins, the head differential between the Tuscaloosa and Congaree is expected to become downward; the differential in A- and M-Areas is expected to become increasingly downward. However, the green clay has a very low permeability and appears to be an effective barrier to the downward migration of pollutants wherever it is present on SRP. The lower Congaree and upper Ellenton clay units act as similar barriers for the Tuscaloosa Aquifer. A new equilibrium piezometric surface is expected to develop quickly in response to the decrease in pumping from 27.0 to 25.4 cubic meters per minute, and the decline in water levels measured in monitoring wells is expected to be arrested.

5.1.3.5 Radiological effects of support facilities

The resumption of L-Reactor operation will result in an increase of about 33 percent in radioactive discharges from the support facilities (i.e., central shops area, heavy-water area, fuel fabrication area, and the separations areas). Releases from support facilities associated with L-Reactor operation will build up gradually; during the first year of L-Reactor operation they will be less than 50 percent of the equilibrium values in succeeding years. However, for the purpose of the present analysis, it is assumed that first-year releases are equal to the expected equilibrium annual average releases.

None of the preferred alternatives will result in additional incremental radiological releases from any of the facilities supporting the operation of L-Reactor. Section 5.1.2 characterizes the radioactive releases from support facilities and presents the radiological impact of the releases on the maximally exposed individual and on population groups. Appendix B contains the methodology of the calculations and detailed dose results, including tables that provide the doses by age groups, organs, and pathways.

The total-body doses received by the maximum individual and regional population from L-Reactor radiologicial releases under the preferred alternatives are combined with the doses from incremental releases in Table 5-15 (compare with Table 5-14). The composite maximum individual dose of 3.6 millirem in the first year of resumed operation is about 26 times less than the average dose of

Table 5-15. Maximum individual and regional population total-body dose from the operation of L-Reactor and SRP support facilities (preferred alternative)

Source of exposure	1st-year dose	10th-year dose
MAXIMUM INDIVIDUAL ADULT DOSE (millirem per year)		
Atmospheric releases	0.10	0.24
Liquid releases	0.029	0.12
Radiocesium and cobalt transport	3.5	0.31
Total	3.6	0.67

Source of exposure	Dose within 80 kilometers of SRP		Port Wentworth and Beaufort-Jasper dose	
	1st year	10th year	1st year	10th year
REGIONAL POPULATION DOSE (person-rem per year)				
Atmospheric releases	5.8	16.7	--	--
Liquid releases	0.053	0.065	1.6	16.1
Radiocesium and cobalt transport	9.0	0.80	0.80	0.067
Total	14.9	17.6	2.4	16.2

93 millirem per year from natural background radiation received by an individual living near SRP. The total-body dose to both the 80-kilometer and downstream river-water-consuming populations of 33.8 person-rem (tenth year) is about 0.03 percent of the estimated 109,000 person-rem received by the 80-kilometer population and the Beaufort-Jasper and Port Wentworth drinking-water populations from natural sources. These effects are slightly less than those expected under the combination of reference case and incremental releases.

The 100-year environmental dose commitment to the U.S. population beyond 80 kilometers from SRP from tritium, carbon-14, krypton-85, and iodine-129 was calculated as described for the direct discharge of cooling water to Steel Creek. The sum of the doses to the total body from first- and tenth-year operation is about 25 and 49 person-rem, respectively; an additional 1.7 person-rem to the thyroid will result from iodine-129 releases during first- or tenth-year operation.

The radiation-induced health effects that might be caused in the U.S. population by the first-year operation of L-Reactor and its support facilities are estimated to be about 0.003 premature cancer death and 0.006 genetic disorder; during the tenth year of operation, the induced health effects would be about 0.006 premature cancer death and 0.01 genetic disorder.

5.2 CUMULATIVE IMPACTS

This section describes the cumulative impacts of L-Reactor operation when taken in conjunction with the effects from its other SRP facilities and from major facilities near the Savannah River Plant. The major SRP facilities include the operating facilities, the Fuel Materials Facility, and the Defense Waste Processing Facility. Major facilities near the Savannah River Plant include the Vogtle Nuclear Power Plant in Burke County, Georgia, the Urquhart Steam Station at Beech Island, South Carolina, and the Chem-Nuclear Systems, Inc., plant near the site boundary.

5.2.1 Socioeconomics

Given the small number of potential inmigrating workers associated with the resumption of L-Reactor operation, potential cumulative socioeconomic impacts depend heavily on the workforce requirements and the schedules of other projects at and near the Savannah River Plant. These projects include the Georgia Power Company's Alvin W. Vogtle Nuclear Power Plant in Burke County, Georgia; capital improvements projects at the Savannah River Plant; the Fuel Materials Facility (FMF) at the Savannah River Plant, which will convert enriched uranium into naval nuclear propulsion fuel form; and the Defense Waste Processing Facility (DWPF), which will immobilize SRP high-level wastes.

The craft construction workforce at the Vogtle Nuclear Power Plant currently is about 6700 and is expected to decline in 1984, coinciding with the buildup of the construction workforce for the FMF. After 1983, the SRP construction labor force is expected to increase due to capital improvements and FMF and DWPF construction. Based on the latest forecast of construction activities, the SRP labor force is expected to increase by 2800 persons by the end of the third quarter of 1984.

Assuming that modeling results of a DWPF scenario--reference immobilization alternative, with the Vogtle project having a peak workforce in 1985 (DOE, 1982a)--are applicable to the cumulative construction worker increase at the Savannah River Plant, about 735 total workers (including overhead personnel) are expected to relocate in the six-county area.

In addition to these 735 construction-related personnel, about 80 L-Reactor support personnel (L-Reactor plus incremental) are expected to relocate in the six-county area by the end of 1984. Thus, the cumulative workforce that might relocate into the six-county area is 815. Table 5-16 lists the projected distribution pattern of the cumulative labor force increase at the Savannah River Plant and summarizes potential socioeconomic impacts.

The cumulative SRP construction and operational workforce increase by the end of 1984 is not expected to have major impacts in the six-county area. The potential relocating workforce and its associated population is expected to account for less than 1 percent of the projected 1984 population of the area. Minor impacts on housing, schools, and other public services and facilities might occur where existing or projected 1984 demands exceed current service capabilities; however, the demands placed on these services by the potential relocating workers and their families will be relatively small in relation to the total indigenous demand.

The greatest effects associated with the multiple projects at the Savannah River Plant will be on the economy of the region. As listed in Table 5-17 these projects are anticipated to provide a total of about 4750 direct and indirect job opportunities and $40 million in additional direct and indirect annual income based on an estimated $235 million in direct payroll and overhead expenditures. These benefits, however, will be offset partially by local and state government expenditures to serve the relocating construction and operational workers.

Table 5-17. Cumulative SRP economic impact analysis, end of third quarter 1986

Categories of cost and employment	1986
Employment	
Direct employment	2880
Indirect employment	1875
Income and expenditures	
Additional direct income (current $ millions)	21
Indirect income (current $ millions)	19
Local expenditures on materials and services (current $ million)	57

5.2.2 Surface-water usage

At the Savannah River Plant, the Savannah River supplies water for cooling two production reactors, makeup water for Par Pond (the source of cooling water for P-Reactor), and for use in the coal-fired power plants. For the 3-year period from 1974 to 1976, the withdrawal of water from the river by the Savannah River Plant averaged 20.5 cubic meters per second. This withdrawal represented about 7 percent of the river flow past the Savannah River Plant. The maximum usage during the 3-year period was about 26 cubic meters per second. Essentially all water withdrawn from the river is returned to the river (Du Pont, 1981). Based on Neill and Babcock (1971), the estimated consumptive water use will be 0.85 cubic meter per second each for C-, K-, and L-Reactors and about 1.25 cubic meters per second on the average for P-Reactor. EL-2

When L-Reactor operation is resumed (reference case) water withdrawal from the river will be increased by about 11 cubic meters per second and the total withdrawal rate for the Savannah River Plant will be about 37 cubic meters per second. Under 7-day, 10-year, low-flow conditions (159 cubic meters per second; Section 3.4.1), the Savannah River Plant will withdraw about 23 percent of the river flow; under average flow conditions, the Savannah River Plant would withdraw about 13 percent for all its operations.

Two neighboring facilities will also use Savannah River water for cooling. The South Carolina Electric and Gas Company's Urquhart Steam Station, located above the SRP, uses about 7.4 cubic meters per second as once-through cooling water. The Vogtle Nuclear Power Plant, near Hancock Landing, Georgia, is now under construction. When completed, it will use a few cubic meters of river water per second as make-up water for its cooling towers.

5.2.3 Ground-water usage

Two new facilities are under construction at SRP, the Defense Waste Processing Facility (DWPF) and the Naval Reactor Fuel Materials Facility (FMF). The DWPF site, adjoining H-Area to the north, has been cleared and preliminary earthwork completed. Actual construction of the FMF, located in F-Area, has begun.

Current (December 1983) projections of the ground-water requirements for the DWPF and FMF are less than 0.75 cubic meter per minute for the DWPF and 0.2 cubic meter per minute for the FMF. The FMF probably would draw its water from the existing F-Area well field. As many as two wells producing from the Tuscaloosa Formation are currently planned for the DWPF, each well with a capacity of about 3.78 cubic meters per minute. The expected drawdown from these planned wells (about 2 to 3 meters near the center of the cone of depression) would increase the drawdown in F-, H-, and M-Areas. Beneath the seepage basins in these areas, the incremental drawdowns from withdrawal for the DWPF and FMF are calculated to be 0.5, 0.7, and 0.2 meters, respectively. The resultant upward head differential between the Tuscaloosa and the Congaree Formations will decrease accordingly beneath the F-Area basins and will become increasingly downward beneath the other basins in H- and M-Areas (see Table 5-7).

AW-1, BT-7, DA-8, EN-24

The cumulative ground-water consumption from the Tuscaloosa is estimated to be 0.95 cubic meter per minute. Thus, the total SRP consumption will be about 26.4 cubic meters per minute, including all L-Reactor-related and cumulative usage. This projected usage represents an 11-percent increase over the 1982 SRP withdrawal from the Tuscaloosa of 23.8 cubic meters per minute, but a slight decrease from the 1983 withdrawal rate of 27.0 cubic meters per minute (see Table F-10). Computer modeling (Marine and Routt, 1975) indicates that the ground-water flux in the aquifer is about 110 cubic meters per minute throughout a study area including SRP and nearby users (Figures F-25 and F-31). The current ground-water flux through this study area is estimated conservatively to be 51 cubic meters per minute, which is the lower bound estimate. This flux estimate compares with a current, incremental, and cumulative withdrawal rate of about 37.9 cubic meters per minute within the study area (11.5 for offsite users + 26.4 for SRP, including L-Area use, support facility incremental use, and cumulative use; see Section 5.1.1.4 for a discussion of incremental ground-water withdrawal). The total SRP projected pumpage rate from the Tuscaloosa Aquifer of about 26.4 cubic meters per minute compares with 37.8 cubic meters per minute, which Siple (1967) concluded could be pumped at the SRP with no adverse effects on the pumping capabilities of existing 1960 wells, particularly additional wells if spaced to minimize interference between wells. In 1960, SRP pumpage from the Tuscaloosa was about 18.9 cubic meters per minute. Cumulative impacts on offsite water levels are expected to be small (Table 5-8), about 0.4 meter at Jackson and at the site boundary opposite the A-Area. As shown in Table 5-8, the cumulative drawdowns resulting from pumping at SRP are not expected to increase in relation to the incremental drawdowns. This is because the additional pumping for the FMF and the DWPF will be from locations that are large distances from the nearest site boundary relative to the pumping rate (Siple, 1967). AW-1, BT-7, DA-8, EN-24

The withdrawal of ground water from the Tuscaloosa Aquifer in support of current and projected SRP operation is not expected to affect either the quality of water or the offsite water levels in the aquifer.

At the recommendation of the U.S. Army Corps of Engineers, a foundation grouting operation was conducted at the Savannah River Plant to improve subsurface conditions (COE, 1952a,b). Operating experience at SRP over the past 30 years has demonstrated that subsidence is not a problem. Available leveling data in the vicinity of SRP do not indicate subsidence (DOE, 1982b). Based on anticipated needs over the next few years, subsidence from withdrawal of ground water from the Tuscaloosa Formation is not expected to affect operations at SRP.

5.2.4 Thermal discharge

5.2.4.1 Wetlands

Between 1950 and 1970, palustrine vegetated wetlands experienced a net loss of 11 million acres in the conterminous United States (Frayer et al., 1983). The overall net loss was due primarily to agriculture, and consisted of 6 million acres (55 percent) of forested wetland, 4.7 million acres (43 percent) of emergent wetland, and 220 thousand acres (2 percent) of scrub/shrub wetland. Approximately 11.4 percent and 10.1 percent of the total land area of the States of South Carolina and Georgia, respectively, contain bottomland hardwood forests (Clark and Benforado, 1981). The Savannah River watershed includes some 258,000 acres of wetlands dominated by bottomland hardwood forests; of this total, South Carolina contains 138,000 acres and Georgia has 120,000 acres. Between 1960 and 1975, South Carolina lost about 30,000 acres and Georgia lost 141,000 acres of bottomland hardwood forests. AY-4

The Savannah River Plant contains approximately 37,000 acres of wetlands that include Carolina bays, old farm ponds, impoundments, canals, and riparian habitats associated with creeks and the Savannah River. Cumulative impacts to these wetlands from the Savannah River operations have occurred primarily along streams and in the Savannah River swamp.

Streams that flow through SRP are bordered by 24,607 acres of bottomland hardwood forest (Figure 5-2). Five major streams drain the site and flow to the Savannah River (Table 5-18). Upper Three Runs Creek, which has the largest watershed, is the only major stream on the SRP that has not received reactor cooling-water discharges; it contains 9165 acres of bottomland hardwood wetlands onsite.

Table 5-18. Distribution (acres) of forested wetlands for the principal streams of the SRP[a]

Stream	Currently thermally impacted	Currently nonthermally impacted	Total
Upper Three Runs Creek	0	9,165	9,165
Four Mile Creek	772	1,176	1,948
Pen Branch	626	1,885	2,511
Steel Creek	0	3,073[b]	3,073
Lower Three Runs Creek	0	5,574[c]	5,574
Other[d]	0	2,336	2,336
Total	1,398	23,209	24,607

[a]Adapted from Du Pont, 1983b.
[b]Includes the formerly thermal area between L- and P-Reactors.
[c]Includes the formerly thermal area just below Par Pond dam.
[d]Other bottomland hardwood wetland areas include areas north of Par Pond (part of the former Lower Three Runs system), interior swamp areas adjacent to the SRP river swamp, wetland SSW of A-Area, part of the Salkahatchie watershed, parts of Boggy Gut Creek watershed, etc.

Currently, about 1400 acres (7 percent) of wetlands associated with the five principal stream corridors are thermally impacted due to SRP operations (Table 5-18). Restart of the L-Reactor (reference case) will impact an additional 420 to 580 acres of wetlands along the Steel Creek corridor and 310 to 420 acres of wetlands in the delta and swamp. The cumulative total acreage of wetlands affected by all SRP operations is approximately 2135 to 2415 acres. TC

Four Mile Creek and Pen Branch currently receive thermal effluents from C- and K-Reactors, respectively. About 772 acres of thermally impacted bottomland hardwood border Four Mile Creek from C-Reactor to the Savannah River swamp (Figure 5-1). The Four Mile Creek system contains 1948 acres of bottomland hardwood, 40 percent of which occurs along the thermal portion of the stream. Pen Branch has less bottomland hardwood acreage affected by thermal effluents (626 acres) and more total wetlands (2511 acres). Most of the nonthermal Pen Branch system wetlands (75 percent) occur above the confluence with Indian Grave Branch.

Steel Creek and its main tributary, Meyers Branch, have more wetlands acres (3073) and a more varied thermal discharge history than Pen Branch or Four Mile Creek (Figure 5-2). Steel Creek received a wide range of thermal effluent quantities from both P- and L-Reactors from 1954 to 1968. The bottomland hardwood wetlands formerly impacted by L- and P-Reactors have now partially recovered. About 792 acres of bottomland hardwood exist along the Steel Creek corridor from L-Reactor to the swamp. Most of this area (16 percent of the Steel Creek system) was also previously affected by reactor discharges and has partially recovered to a diverse ecological state. The planned restart of L-Reactor will again impact most of this floodplain corridor.

Lower Three Runs Creek has the second largest watershed. In 1958, the headwaters of this stream were impounded to form Par Pond, a cooling reservoir for R- and P-Reactors. From 1954 to 1958, thermal effluents from R-Reactor were released to Lower Three Runs Creek. Most of the wetland impact areas have now recovered or were inundated by Par Pond. Lower Three Runs Creek contains 5574 acres of bottomland and hardwood forest below the Par Pond dam and swamp forest along the Savannah River.

The historic growth of the Steel Creek delta, as measured by computer digitized aerial photographs taken from 1943 to 1982, show that thermal discharges first affected the canopy between 1955 and 1956; this was more than 1 year after both P- and L-Reactors began releasing hot water to Steel Creek. Rapid vegetation kill and canopy loss occurred at a rate of 50 acres per year from 1956 to 1961 when both reactors discharged to Steel Creek. Delta growth slowed to about 3 acres per year from 1961 to 1966, probably because P-Reactor thermal effluents were diverted to Par Pond in 1963. In 1966, the impact area was nearly maximum at 314 acres (Table 5-19). When L-Reactor discontinued operations in 1968, the swamp canopy began to recover. From 1968 to 1982, about 40 acres of impact zone recovered and new canopy cover was established. Partial canopy recovery occurred in an additional 67 acres of former tree kill.

Table 5-19. Steel Creek delta impacts (acres)[a]

Year	Moderate effect[b]	Intense effect[c]
1951	0	0
1955	0	0
1956	180	0
1961	303	214
1966	307	235
1974	299	210
1982	280	184

[a]Adapted from Du Pont (1983b).
[b]Includes partial to total tree canopy losses.
[c]Includes primarily the sedimentation delta and total canopy removal.

Savannah River swamp

The Savannah River floodplain between Augusta, Georgia (River Mile 195), and Ebenezer Landing, Georgia (River Mile 45), contains approximately 130,000 acres of wetlands. The Savannah River swamp provides approximately 10,400 acres of palustrine wetland habitat. It is seasonally separated from the waters of the Savannah River by a 3-meter-high natural levee (Smith et al., 1981) and receives the waters of several SRP streams. In 1951, prior to the discharge of thermal effluents, a closed canopy of second-growth forest extended over the 10,369-acre swamp (Sharitz et al., 1974). Following the release of heated effluents into the swamp via tributary streams, some trees died in about two-thirds of the area (Figure 5-2).

Between 310 and 420 acres of the Savannah River swamp will be impacted due to the direct discharge of thermal effluent by the L-Reactor (reference case).

This range includes the total area of swamp that was impacted by discharges into Steel Creek during previous operations (Table 5-20). Cumulative thermal impact to the swamp following the resumption of L-Reactor operations should affect about half of the total swamp wetlands.

Table 5-20. Areal extent (acres) of reactor-effluent effects on the Savannah River swamp forest bordering the Savannah River Plant[a]

Delta region	Intense effect	Moderate effect	Slight effect	Total area affected
Beaver Dam Creek	110	60		170
Four Mile Creek	70	45		115
Pen Branch	55	50		105
Steel Creek	245	130		375
Total	480	285		765
Total swamp	560	650	3450	4660

[a]Adapted from Sharitz et al. (1974).

5.2.4.2 Savannah River

Both the Urquhart Steam Station at Beech Island and operations at the Savannah River Plant discharge cooling-water effluent to the Savannah River from South Carolina. In addition, the Alvin W. Vogtle Nuclear Power Plant, near Hancock Landing, Georgia, will discharge its cooling-tower blowdown to the river. These thermal discharges will be permitted by Georgia under the National Pollutant Discharge Elimination System (NPDES).

As the result of water storage in Clarks Hill Reservoir above Augusta, Georgia, and its mode of discharge, the temperature of the Savannah River is as much as 8°C below the temperature that would occur in the summertime if the reservoir did not exist (Neill and Babcock, 1971). The temperature of the river water generally increases naturally as the water flows from Clarks Hill Reservoir past the Savannah River Plant. The South Carolina Electric and Gas Company's Urquhart Steam Station, located above the Savannah River Plant, discharges about 7.4 cubic meters per second of cooling-water effluent at temperatures as high as 6°C above ambient river temperature. The thermal effluent raises the temperature of the river by about 0.3°C on the average and by as much as 0.5°C in the summer (Boswell, 1972).

At present, once-through cooling-water effluent is discharged from the Savannah River Plant via three streams--Beaver Dam Creek, Four Mile Creek, and Pen Branch/Steel Creek--to the Savannah River. Beaver Dam Creek has the smallest SRP thermal effluent, which originates about equally in D- and C-Areas. In the future, SRP will also discharge thermal blowdown from the small cooling towers servicing the Fuel Materials Facility and the Defense Waste Processing Facility will be small and will not impact the Savannah River.

The temperature at the mouth of Beaver Dam Creek typically ranges from 5.5°C to 11.1°C above the temperatures of the Savannah River during the warmer
TE months (Du Pont, 1982a).

Four Mile Creek receives once-through cooling-water discharges from C-Reactor. The temperatures of thermal effluent discharged from Four Mile Creek ranges from 16.7° to 19.4°C above Savannah River water temperatures during the
TE late spring and summer months (Du Pont, 1982a).

Pen Branch receives once-through cooling-water effluent from K-Reactor. This effluent is discharged to the Savannah River through the mouth of Steel Creek. The temperature of the water released at about 15.6 cubic meters per second from the mouth of Steel Creek typically is less than 5.6°C above the water temperature of the river during spring and summer. When both K-Reactor and L-Reactor (direct discharge) discharged via the mouth of Steel Creek, the creek-to-river delta-T averaged about 7.2°C during warmer months and ranged to a maximum of 14.7°C and the flow rate to the river averaged about 27.4 cubic meters per second (DOE, 1982a).

The thermal plumes in the Savannah River from Beaver Dam Creek, Four Mile Creek, and Steel Creek will not interact with each other. Analyses of upstream and downstream water temperature data for the 11-year period since L-Reactor was placed on standby (1968 to 1978) suggest that, once in 10 years, a maximum increase of 1.6°C will occur in the Savannah River (fully mixed) water temperature resulting from SRP operations. With the addition of L-Reactor thermal effluent (reference case), once in 10 years the maximum increase is projected to be about 2.3° to 2.4°C; it will probably occur in June, July, or August during periods of low river flow. This increase was exceeded three times (3.2°C) from 1959 to 1963, when four SRP reactors discharged to the river, and once in 1966 (2.7°C) when three reactors discharged to the river. In winter, the maximum increase in river water temperature from the operation of three reactors will be about 0.7° to 1.3°C, depending on flow conditions (Du Pont, 1982a).

The Vogtle Nuclear Power Plant will use natural draft cooling towers to dissipate the heat generated by the two reactor units. The heated cooling-tower blowdown will be discharged to the Savannah River at temperatures below 33°C
FF-12 (Georgia Power Company, 1973). Because the blowdown will be from a single-point discharge pipe at River Mile 150.7 at a rate of only a few cubic meters per second, it is expected that the contribution of heat to the river by the Vogtle Plant will be very small compared to the contribution from C-Reactor via the mouth of Four Mile Creek. No thermal blockage of the Savannah River by the interaction of the Vogtle Plant and Four Mile Creek plumes is anticipated. The plume from Vogtle Plant operations will dissipate quickly. Calculations show

that a plume-river delta-T of 1°C will extend only about 100 meters downriver from the diffuser and the 2.8°C plume-river delta-T will extend less than 20 meters downriver and approximately 30 meters across the 105-meter-wide river (Georgia Power Company, 1973). Thus, the Vogtle plume will have dissipated before reaching the plume from Four Mile Creek at River Mile 150.4.

In conclusion, a zone of passage for anadromous fish and other aquatic organisms will exist in the Savannah River from Steel Creek to Beech Island. Thermal blockage will not occur.

5.2.5 Fisheries

5.2.5.1 Thermal effects

The direct discharge of heated effluent from L-Reactor (reference case) will eliminate most fish from the Steel Creek corridor and from much of the Steel Creek delta. Access to the flood-plain swamp for fish via the mouth of the creek will be blocked. Accordingly, spawning in Steel Creek by anadromous species will be eliminated. In addition, because access to the wetland areas near Boggy Gut Creek will be restricted at times by the thermal plume, spawning in these areas also might be affected.

Heated effluents from C- and K-Reactors and the D-Area powerhouse are discharged currently into Four Mile Creek, and Pen Branch, and Beaver Dam Creek, respectively, rendering these areas unsuitable for spawning by anadromous fishes under normal river flow conditions. Accordingly, direct discharge (reference case) will increase the area of streams and wetlands from which spawning will be eliminated. With the preferred alternative, fish access for spawning will be limited only in the Steel Creek corridor, not in the swamp. Studies in the area have shown that suitable spawning habitat exists in other streams along the Savannah River. In addition, the spawning of many anadromous species (e.g., American shad, striped bass) occurs primarily in the Savannah River itself should not be affected by the thermal discharge from L-Reactor.

Predictive mathematical models and prior experience with L-Reactor operation indicate that direct thermal discharges to the Savannah River from Steel Creek (reference case) will not block the movement of fish past the site in the river. Because there will be no interaction of the L-Reactor plume with that from C-Reactor or from Vogtle Nuclear Power Plant, the cumulative impact from these sources will be minor.

5.2.5.2 Entrainment

Based on ichthyoplankton investigations conducted at the site (see Appendix C), an estimated 17.9×10^6 fish larvae and 18.1×10^6 fish eggs were entrained by SRP cooling-water intakes during 1982. During 1983, these totals were 9.1×10^6 eggs and 28.1×10^6 larvae. This represents about 13 percent of the ichthyoplankton passing the intake canals in the river during 1982, and 7.7 percent in 1983. Under present operating conditions, the flow of cooling water withdrawn from the river is about 26 cubic meters per second. An additional flow of TC about 11 cubic meters per second will be required by the L-Reactor. Entrainment losses will increase proportionately. Table 4-1 summarizes projections of cumulative entrainment impacts based on studies conducted in 1977, 1982, and 1983.

The estimated cumulative percentage of fish eggs and larvae passing the Savannah River Plant in the river that will be lost to entrainment by the combined operation of C-, K-, and L-Reactors is about 19 percent.

5.2.5.3 Impingement

TC The results of the most recent impingement studies conducted at the 1G, 3G, and 5G pumphouses indicate that, under present operating conditions, an average of about 37 fish are impinged each day for an annual total of 13,505 individuals. The highest daily rates occur during periods of high river-water levels when as many as 540 fish have been impinged. The restart of L-Reactor will result in the impingement of an estimated 16 additional fish per day or 5840 per year. During periods of high water, the cumulative total impinged could reach about 104 fish per day, 31 of which would be due to L-Reactor operations.

Surveys of the recreational fishery in the freshwater portions of the Savannah River indicate that the species caught in greatest numbers by anglers are bream, catfish, and crappie. These species comprise about 37 percent of the total number of fish collected during the impingement studies. Using these data, estimates can be made of the numbers of these recreationally important fish that would be lost annually due to impingement. Table 5-21 summarizes these estimates.

Another important sport fish is the largemouth bass. It is the second-most sought-after freshwater species in the Savannah River. However, it is not often caught and, therefore, does not rank highly in the catch statistics. Largemouth bass are impinged at SRP only rarely, comprising 0.3 percent of the total fish collected (i.e., 2 individuals out of 684 total). The projection of annual losses under present operating conditions is 14 fish. The cumulative impingement loss once L-Reactor is operating would be about 21 individuals per year.

Table 5-21. Numbers of fish that would be lost annually due to impingement under average river flow conditions

Species	Percentage of total number of fish impinged	Loss under present operating conditions	Cumulative loss with L-Reactor operational
Bream	25.0	1204	1734
Catfish	4.8	231	333
Crappie	7.3	352	506

5.2.6 Radiological effects

Nuclear facilities within an 80-kilometer radius of the L-Reactor include other currently operating Savannah River Plant facilities, the Alvin W. Vogtle Nuclear Power Plant (under construction), the Barnwell Nuclear Fuel Plant (not now expected to operate), and the Chem-Nuclear Services, Inc. low-level radioactive disposal site. The existing and planned operations of these facilities were reviewed to determine the potential cumulative radiological effects of all the facilities operating together.

Facilities currently operating at the Savannah River Plant include three production reactors, two chemical separations areas, a fuel fabrication facility, waste management facilities, and other support facilities. Future projects include construction and operation of a Fuel Material Facility (FMF), to produce fuel forms for the naval reactor program, and the Defense Waste Processing Facility (DWPF), to be used to immobilize high-level radioactive wastes currently stored in tanks at the Savannah River Plant. The FMF and DWPF are not expected to become operational until the latter half of the 1980s and will have no radiological impact during initial startup of the L-Reactor.

The Alvin W. Vogtle Nuclear Power Plant is being constructed by the Georgia Power Company about 15 kilometers southwest from the L-Reactor. When completed, this plant will have two light-water-cooled power reactors. The Vogtle Power Plant is not expected to reach full operation until the latter part of the 1980s and also will have no radiological impact during the initial startup of L-Reactor. TC

The Barnwell Nuclear Fuel Plant is located approximately 19 kilometers northeast of L-Reactor. The owners of this facility, Allied-General Nuclear Services, have announced that they do not plan to operate this plant. The normal operation of the Chem-Nuclear Services, Inc. low-level radioactive disposal site does not entail discharges of low-level radioactive material to surface waters or the atmosphere.

The cumulative offsite radiation dose, therefore, is the sum of the doses from L-Reactor and its support facilities, current SRP operation with three reactors, the planned Fuel Materials Facility and Defense Waste Processing Facility at SRP, and the Vogtle Nuclear Power Plant. The total-body doses to the maximally exposed offsite individual and to the population are summarized in Table 5-22 for the reference-case operation of L-Reactor. (Refer to Section 4.1.2.5.) The maximum individual dose is conservative because the defined "composite" individual would have to be a permanent resident of several different locations to receive the dose. The doses shown are for the tenth year of L-Reactor operation when it is expected that all described facilities will be in operation and when radioactive releases from L-Reactor will have reached an equilibrium maximum.

Table 5-22. Cumulative total-body doses from L-Reactor operation and other nearby nuclear facilities[a] (reference case)

Source of exposure	Atmospheric releases	Liquid releases	Total
MAXIMUM INDIVIDUAL ADULT DOSE (millirem per year)			
Cs-137 and Co-60 redistribution from Steel Creek	--	0.31	0.31
L-Reactor and support facilities	0.23	0.14	0.37
Savannah River Plant - current operations	0.81	0.43	1.2
TE Fuel Materials Facility - SRP[b]	0.000063	--	0.000063
Defense Waste Processing Facility - SRP	0.0047	0.0077	0.012
Vogtle Nuclear Power Plant	0.0060	1.6	1.6
Total	1.1	2.5	3.5
DA-45 REGIONAL POPULATION DOSE[c] (person-rem per year)			
Cs-137 and Co-60 redistribution from Steel Creek	--	0.87	0.87
L-Reactor and support facilities	16	19	35
Savannah River Plant - current operations	80	40	120
Fuel Materials Facility - SRP[b]	0.0026	--	0.0026
Defense Waste Processing Facility - SRP	0.23	1.2	1.4
Vogtle Nuclear Power Plant	0.024	7.8	7.8
Total	96	69	165

[a]During tenth year of L-Reactor operation.
[b]Adopted from DOE, 1982b.
[c]Includes doses from water consumed at Beaufort-Jasper and Port Wentworth.

The composite maximum individual dose of 3.5 millirem for the reference case is 26 times less than the average dose of 93 millirem (Du Pont, 1982b) received by an individual living near the SRP site from natural radiation. The composite population dose of 165 person-rem is about 0.15 percent of the exposure of about 109,000 person-rem to the population living within 80 kilometers of the Savannah River Plant and the Beaufort-Jasper and Port Wentworth drinking-water populations from natural radiation sources. TC

Table 5-23 lists estimated concentrations of radionuclides in the air, milk, and drinking water resulting from routine releases from L-Reactor, total

SRP, and other planned nuclear facilities in the vicinity of SRP for the reference case.

5.2.7 Health effects

The potential radiation-induced health effect for the reference case calculated from the operation of L-Reactor and other nuclear facilities within an 80-kilometer radius (from atmospheric and liquid releases of radioactive materials and redistribution of cobalt-60 and cesium-137 from Steel Creek and downstream water consumption) were calculated by multiplying the regional population doses (from Table 5-23) by the following risk estimators: 120 cancers and 257 genetic effects per 1,000,000 person-rem exposure. The projected cumulative health effects that might eventually occur as a result of the operation of L-Reactor and other nearby nuclear facilities include a maximum of 0.02 excess cancer fatality and 0.04 genetic disorder in the tenth year of operations. CT-1

5.2.8 Preferred alternatives*

This section describes the cumulative impacts of L-Reactor operation with the preferred alternatives, taken in conjunction with the effects from other SRP facilities and from major facilities near SRP.

5.2.8.1 Socioeconomics

The SRP construction labor force is expected to increase by about 2800 persons after 1983 due to capital improvements and the construction of the Fuel Materials Facility (FMF) and the Defense Waste Processing Facility (DWPF). The DWPF site, adjoining H-Area to the north, has been cleared and preliminary earthwork has been completed. Actual construction of the FMF, located in F-Area, has begun. In addition, construction labor force requirements for the 1000-acre cooling lake are estimated to be about 550 persons. Approximately one-fourth of the total increase of the SRP construction labor force, or about 800 workers, are expected to relocate into the six-county area. In addition, about 80 L-Reactor support personnel are expected to relocate into the six-county area by the end of 1984.

The cumulative SRP construction and operational workforce increase by the end of 1984 is not expected to have major impacts in the six-county area and will be only slightly higher than cumulative impacts for the restart of L-Reactor with direct discharge (Section 5.2.1). Economic benefits will also be higher due to the temporary increase in construction employment for the cooling lake.

*Because this section is new, vertical change bars are not necessary.

5.2.8.2 Surface-water usage

At the Savannah River Plant, the Savannah River supplies water for cooling two production reactors, makeup water for Par Pond (the source of cooling water for P-Reactor), and for use in the coal-fired power plants. For the 3-year period from 1974 to 1976, the maximum withdrawal rate was 26 cubic meters per second. When L-Reactor operation resumes, water withdrawal from the river will increase by about 11 cubic meters per second; the total withdrawal rate for the Plant will be about 37 cubic meters per second. Under 7-day, 10-year, low-flow conditions (159 cubic meters per second; Section 3.4.1), the Savannah River Plant will withdraw about 23 percent of the river flow; under average flow conditions, the Plant will withdraw about 13 percent for all its operations.

Essentially all water withdrawn from the river is returned to the river. The estimated consumption of water will be about 1.25 cubic meters per second for L-Reactor (Neill and Babcock, 1971). This compares with a consumption of about 1.25 cubic meters per second for Par Pond; the consumption for C- and K-Reactors is about 0.85 cubic meter per second each.

Two neighboring facilities will also use Savannah River water for cooling. The South Carolina Electric and Gas Company's Urquhart Steam Station, located above the SRP, uses about 7.4 cubic meters per second as once-through cooling water. The Vogtle Nuclear Power Plant, near Hancock Landing, Georgia, is now under construction. When completed, it will use a few cubic meters of river water per second as makeup water for its cooling towers.

5.2.8.3 Ground-water use

Current projections of ground-water requirements are less than 0.75 cubic meter per minute for the DWPF and 0.2 cubic meter per minute for the FMF. The upward head differential between the Tuscaloosa and Congaree Formations will decrease beneath the F-Area basins and will become increasingly downward beneath the other basins in H- and M-Areas (see Table 5-7) as the result of this increased pumping.

The cumulative ground-water consumption from the Tuscaloosa as the result of SRP operations is estimated to be 0.95 cubic meter per minute. Thus, the total SRP consumption will be about 26.4 cubic meters per minute, including all L-Reactor-related and cumulative usage. This projected usage represents an 11-percent increase over the 1982 SRP withdrawal from the Tuscaloosa of 23.8 cubic meters per minute, but a slight decrease from the 1983 withdrawal rate of 27.0 cubic meters per minute (see Table F-10). Cumulative impacts on offsite water levels are expected to be small (Table 5-8), about 0.4 meter at Jackson and at the site boundary opposite the A-Area. As shown in Table 5-8, the cumulative drawdowns resulting from pumping at SRP are not expected to increase in relation to the incremental drawdowns. This is because the additional pumping for the FMF and the DWPF will be from locations that are long distances from the nearest site boundary relative to the pumping rate (Siple, 1967).

Operating experience at the SRP over the past 30 years has demonstrated that subsidence is not a problem. Available leveling data in the vicinity of

SRP do not indicate subsidence (DOE, 1982b). Based on anticipated needs over the next few years, subsidence from the withdrawal of ground water from the Tuscaloosa Formation is not expected to affect operations at SRP.

5.2.8.4 Thermal discharge

Wetlands

Steel Creek and its main tributary, Meyers Branch, have more wetlands acres (3073) and a more varied thermal discharge history than Pen Branch or Four Mile Creek. Steel Creek received a wide range of thermal effluent quantities from both P- and L-Reactors from 1954 to 1968. The bottomland hardwood wetlands that were affected during those years have partially recovered. About 790 acres of bottomland hardwood exist along the Steel Creek corridor from L-Reactor to the swamp. Most of this area (16 percent of the Steel Creek system) was also previously affected by reactor discharges and has partially recovered to a diverse ecological state. The planned restart of L-Reactor will produce renewed adverse impacts on most of this floodplain corridor.

Currently, about 1400 acres (7 percent) of wetlands associated with the five principal SRP stream corridors receive thermal impacts due to SRP operations (Table 5-18). The restart of L-Reactor will impact an additional 520 to 680 acres of wetlands and 775 acres of uplands. The cumulative total acreage of wetlands along streams affected by all SRP operations (including L-Reactor) is approximately 2135 to 2415 acres.

The Savannah River floodplain between Augusta, Georgia (River Mile 195), and Ebenezer Landing, Georgia (River Mile 45), contains approximately 130,000 acres of wetlands. The Savannah River swamp provides approximately 10,400 acres of palustrine wetland habitat; it is seasonally separated from the waters of the Savannah River by a 3-meter-high natural levee (Smith et al., 1981) and receives the waters of several SRP streams. In 1951, before the discharge of any thermal effluents, a closed canopy of second-growth forest extended over the 10,369-acre swamp (Sharitz et al., 1974). Following the release of heated effluents into the swamp via tributary streams, some trees died in about two-thirds of the area (Figure 5-2).

The historic growth of the Steel Creek delta in the Savannah River swamp, as measured by computer digitization of aerial photographs taken from 1943 to 1982, shows that thermal discharges first affected the canopy between 1955 and 1956; this was more than 1 year after both P- and L-Reactors began releasing hot water to Steel Creek. In 1966, the impact area was nearly maximum at 314 acres (Table 5-19). When L-Reactor discontinued operations in 1968, the swamp canopy began to recover. From 1968 to 1982, about 40 acres of impact zone recovered and new canopy cover was established. Partial canopy recovery occurred in an additional 67 acres of former tree kill.

With the preferred cooling-water alternative, between 215 and 335 acres of the Savannah River swamp at and adjacent to the Steel Creek delta, respectively, will be impacted by the flow caused by discharges from the cooling lake. Cumulative thermal impacts to the swamp following the resumption of L-Reactor operation should affect about 40 percent of the total swamp wetlands at SRP.

Savannah River

As the result of water storage in the Clarks Hill Reservoir above Augusta, Georgia, and its mode of discharge, the temperature of the Savannah River is as much as 8°C below the temperature that would occur in the summertime if the reservoir did not exist (Neill and Babcock, 1971). The temperature of the river water generally increases naturally as the water flows from Clarks Hill Reservoir past the Savannah River Plant. The Urquhart Steam Station above the Savannah River Plant discharges about 7.4 cubic meters per second of cooling-water effluent at temperatures as high as 6°C above ambient river temperature; this effluent raises the temperature of the river by about 0.3°C on the average and by as much as 0.5°C in the summer (Boswell, 1972).

At present, once-through cooling-water effluent is discharged from the Savannah River Plant via three streams--Beaver Dam Creek, Four Mile Creek, and Pen Branch/Steel Creek--to the Savannah River. Beaver Dam Creek receives the smallest amount of thermal effluent, which originates about equally in D- and C-Areas. In the future, SRP will also discharge thermal blowdown from the small cooling towers servicing the Fuel Materials Facility and the Defense Waste Processing Facility; this will not affect the Savannah River.

Pen Branch receives once-through cooling-water effluent from K-Reactor. This effluent is discharged to the Savannah River through the mouth of Steel Creek. The temperature of the water released at about 15.6 cubic meters per second from the mouth of Steel Creek typically is less than 5.6°C above the water temperature of the river during spring and summer. When both K-Reactor and L-Reactor (preferred alternative) discharge via the mouth of Steel Creek, the temperature will be about 4°C, but the flow rate to the river will average TC
about 27.4 cubic meters per second.

Analyses of upstream and downstream water temperature data for the 11-year period since L-Reactor was placed on standby (1968 to 1978) suggest that, once in 10 years, a maximum increase of 1.6°C resulting from SRP operations will occur in the (fully mixed) water temperature of the Savannah River. With the addition of L-Reactor thermal effluent, the once-in-10-year maximum increase is not projected to change. With the preferred cooling-water alternative, the temperature at the mouth of Steel Creek contributed by L-Reactor will only be within about 1°C of ambient in the summer.

The Vogtle Nuclear Power Plant will use natural-draft cooling towers to dissipate the heat generated by its two reactor units. The heated cooling-tower blowdown will be discharged to the Savannah River at temperatures below 33°C (Georgia Power Company, 1973). The contribution of heat to the river by the Vogtle Plant will be very small compared to the contribution from C-Reactor via the mouth of Four Mile Creek. No thermal blockage of the Savannah River by any interaction of the Vogtle Plant and Four Mile Creek plumes is anticipated.

In conclusion, a zone of passage for anadromous fish and other aquatic organisms will exist in the Savannah River from Steel Creek to Beech Island. Thermal blockage will not occur.

5.2.8.5 Fisheries

The preferred alternative (a 1000-acre lake) would not pose any adverse thermal impacts to fishes in the delta area or at the mouth of Steel Creek during spring or summer months, because the temperatures would be 1°C to 3°C above ambient. Warmer conditions during the winter months from Road A to the mouth of Steel Creek (7°C to 9°C above ambient) could concentrate fish near the mouth of the creek. This alternative would not adversely affect access and spawning of riverine and anadromous fishes in the Savannah River swamp below the Steel Creek delta.

Currently, heated effluents from C- and K-Reactors and the D-Area powerhouse are discharged into Four Mile Creek, Pen Branch, and Beaver Dam Creek, respectively, rendering these areas unsuitable for spawning by anadromous fishes under normal river flow conditions. With the preferred alternative, fish access for spawning will be limited only in the Steel Creek corridor, not in the swamp. Studies in the area have shown that suitable spawning habitat exists in other streams along the Savannah River. In addition, the spawning of many anadromous species (e.g., American shad, striped bass) occurs primarily in the Savannah River itself and will not be affected by the thermal discharge from L-Reactor. Thermal effluent from L-Reactor will not block the movement of fish past the Plant in the river.

Because there will be no interaction of the L-Reactor plume with that from C-Reactor or from Vogtle Nuclear Power Plant, the cumulative impact from these sources will be negligible.

5.2.8.6 Entrainment

Based on ichthyoplankton investigations conducted at the site (see Appendix C), an estimated 17.9×10^6 fish larvae and 18.1×10^6 fish eggs were entrained by SRP cooling-water intakes during 1982. During 1983, these totals were 9.1×10^6 eggs and 28.1×10^6 larvae. This represents about 13 percent of the ichthyoplankton passing the intake canals in the river during 1982, and 7.7 percent in 1983. Under present operating conditions, the flow of cooling water withdrawn from the river is about 26 cubic meters per second. An additional flow of about 11 cubic meters per second will be required by the L-Reactor. Entrainment losses will increase proportionately. Table 4-1 summarizes projections of cumulative entrainment impacts based on studies conducted in 1977, 1982, and 1983.

The estimated cumulative percentage of fish eggs and larvae passing the Savannah River Plant in the river that will be lost to entrainment by the combined operation of C-, K-, and L-Reactors is about 19 percent.

5.2.8.7 Impingement

The results of the most recent impingement studies conducted at the 1G, 3G, and 5G pumphouses indicate that, under present operating conditions, an average of about 37 fish are impinged each day for an annual total of 13,505 individuals. The highest daily rates occur during periods of high river-water levels when as many as 540 fish have been impinged. The restart of L-Reactor will result in the impingement of an estimated 16 additional fish per day or 5840 per year. During periods of high water, the cumulative total impinged could reach about 104 fish per day, 31 of which would be due to L-Reactor operations.

Surveys of the recreational fishery in the freshwater portions of the Savannah River indicate that the species caught in greatest numbers by anglers are bream, catfish, and crappie. These species comprise about 37 percent of the total number of fish collected during the impingement studies. Using these data, estimates can be made of the numbers of these recreationally important fish that would be lost annually due to impingement. Table 5-21 summarizes these estimates.

Another important sport fish is the largemouth bass. It is the second-most sought-after freshwater species in the Savannah River. However, it is not often caught and, therefore, does not rank highly in the catch statistics. Largemouth bass are impinged at SRP only rarely, comprising 0.3 percent of the total fish collected (i.e., 2 individuals out of 684 total). The projection of annual losses under present operating conditions is 14 fish. The cumulative impingement loss once L-Reactor is operating would be about 21 individuals per year.

5.2.8.8 Radiological effects

Nuclear facilities within an 80-kilometer radius of the L-Reactor include other currently operating Savannah River Plant facilities, the Alvin W. Vogtle Nuclear Power Plant (under construction), the Barnwell Nuclear Fuel Plant (not now expected to operate), and the Chem-Nuclear Services, Inc., low-level radioactive disposal site. The existing and planned operations of these facilities were reviewed to determine the potential cumulative radiological effects of all the facilities operating together.

Facilities currently operating at the Savannah River Plant include three production reactors, two chemical separations areas, a fuel fabrication facility, waste management facilities, and other support facilities. Future projects include the construction and operation of the FMF to produce fuel forms for the naval reactor program, and the DWPF to immobilize high-level radioactive wastes currently stored in tanks at the Plant. The FMF and DWPF are not expected to become operational until the latter half of the 1980s; they will have no radiological impact during the initial startup of L-Reactor.

The cumulative offsite radiation dose is the sum of the doses from L-Reactor (under the preferred alternatives) and its support facilities, current SRP operation with three reactors, the planned Fuel Materials Facility and Defense Waste Processing Facility, and the Vogtle Nuclear Power Plant. The total-body doses to the maximally exposed offsite individual and to the population are summarized in Table 5-24 (compare with Table 5-22) for the operation of L-Reactor with the preferred cooling-water and disassembly-basin purge water alternatives. The maximum individual dose is conservative because the defined "composite" individual would have to be a permanent resident of several different locations to receive the dose. The doses shown are for the tenth year of

L-Reactor operation, when all described facilities are expected to be in operation and when radioactive releases from L-Reactor will have reached an equilibrium maximum.

The composite maximum individual dose of 3.5 millirem for operation with the preferred alternatives is 27 times less than the average dose of 93 millirem (Du Pont, 1982b) received by an individual living near the site from natural radiation. The composite population dose of 163 person-rem is about 0.15 percent of the exposure of about 109,000 person-rem from natural radiation sources to the population living within 80 kilometers of the Savannah River Plant and the Beaufort-Jasper and Port Wentworth drinking-water populations.

The potential radiation-induced health effects calculated from the operation of L-Reactor and other nuclear facilities within an 80-kilometer radius (from atmospheric and liquid releases of radioactive materials and redistribution of cobalt-60 and cesium-137 from Steel Creek and downstream water consumption) were calculated by multiplying the regional population doses (from Table 5-24) by the following risk estimators: 120 cancers and 257 genetic effects per 1,000,000 person-rem exposure. The projected health effects for operation with the preferred alternatives are a maximum of 0.02 excess cancer fatality from tenth-year operations and 0.04 genetic disorder in the tenth year of L-Reactor operation.

5.3 INCREMENTAL IMPACTS OF THE NO-ACTION ALTERNATIVE

K-Area would supply steam to L-Area as it is being maintained in a standby mode. K-Area would burn about 10 percent more coal and, consequently, the discharge to the K-Area ash basin will increase by about 10 percent over the L-Reactor standby phase. Leachate from the ash basin will enter the shallow ground-water system of the Barnwell Formation and migrate to Pen Branch.

The K-Area steam plant will use an additional 0.005 cubic meter of water per second from the Savannah River and an additional 0.002 cubic meter of ground water per second from the Tuscaloosa Formation to supply L-Area with steam.

Maintaining L-Reactor in a standby mode will have little or no effect on the operation of the SRP facilities (fuel fabrication, chemical separations, waste management, etc.) that support the operating reactors.