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CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential environmental consequences of the construction and operation of the cooling water alternatives for C- and K-Reactors (once-through cooling towers, recirculating cooling towers, and no action) and the D-Area powerhouse (increased flow with mixing, direct discharge to the Savannah River, and no action).

This chapter also discusses the cumulative impacts of the construction and operation of these cooling water alternatives in relation to other Savannah River Plant (SRP) facilities and to major facilities near the Plant, and unavoidable and irreversible impacts of these alternatives.

4.1 ALTERNATIVES FOR C-REACTOR

4.1.1 ONCE-THROUGH COOLING TOWER

As discussed in Section 2.2.1.1, the U.S. Department of Energy (DOE) is performing design evaluations and studies to optimize system performance and achieve cost savings in the construction and operation of once-through cooling towers without introducing major changes in the nature or magnitude of environmental impacts. The discussion of the potential environmental consequences of constructing and operating a once-through cooling tower for C-Reactor includes discussion of the major system features being evaluated and studied (i.e., gravity-feed versus pumped-feed towers, natural-draft versus mechanical-draft towers, and holding ponds versus a chemical injection system for control of chlorine biocide).

4.1.1.1 Construction Impacts

The following sections describe the environmental impacts expected to occur with the construction of a once-through mechanical-draft cooling tower (gravity or pumped feed) for C-Reactor. Impacts associated with the construction of a once-through natural-draft tower would not differ measurably from those described.

Socioeconomics

The construction of the once-through cooling tower for C-Reactor would be accomplished in approximately 18 months, after a 9-month lead design period, assuming the procurement for the C-Reactor tower is completed before that for K-Reactor. Construction would involve a combined workforce for the towers in both C- and K-Areas. Two groups of workers would be involved in constructing both towers.

The first group of workers, which would include the architect and building crew, would initially number about 60; this would increase to about 100 when work on the second cooling tower began because construction of the first tower would be continuing. The second group of workers would perform related construction activities, such as installing electrical facilities and piping, and would involve an estimated peak workforce of 330 workers. These two groups would each peak at a different time during the construction of the towers. The maximum total construction workforce during these combined activities would not exceed 400; therefore, the estimated peak construction workforce for C-Reactor alone is 200 persons.

For planning purposes, average annual construction workforce estimates have been prepared for the next several years for the Savannah River Plant and for Georgia Power Company's Vogtle Electric Generating Plant (Plant Vogtle), which is under construction in nearby Burke County, Georgia. Table 4-1 lists the projected total construction workforce levels at both plants from 1986 through 1989. The SRP construction workforce estimates include an approximation of the number of workers required to build the cooling towers.

Table 4-1. Projected Total Construction Workforces at Savannah River Plant and Plant Vogtle[a]

	Construction workforce			
Location of Construction	FY 1986	FY 1987	FY 1988	FY 1989
Savannah River Plant[b]	5900	7300[c]	6600	4500
Vogtle Nuclear Power Plant	7050	3575	30	0

[a]Sources: Du Pont, 1985a; Castrichini, 1985.
[b]The size of the SRP construction workforce is subject to change, contingent on changes in DOE authorized programs.
[c]This figure is high because it includes the peak construction workforce for the Defense Waste Processing Facility at the SRP.

A comparison of the estimates in Table 4-1 shows that the construction workforce at the Savannah River Plant will increase above the 1986 level of employment at the same time the construction workforce at Plant Vogtle will decrease. Because the Plant Vogtle construction workers who will be available represent many of the crafts necessary for cooling-tower construction and because these workers already reside in the SRP area, no impacts to local communities and services due to inmigrating workers are expected.

Historic and Archaeological Resources

The most recent archaeological and historic resources survey of the Four Mile Creek watershed area was conducted from May through August 1984, as described in Appendix E; this survey located 25 sites in the watershed. The implementation of the once-through cooling-tower alternative (with gravity or pumped feed) would disturb only one site (38BR548) in the Four Mile Creek area. Site 38BR548 is a small prehistoric lithic and ceramic scatter located on a terrace edge adjacent to the bank of the northern branch of Four Mile Creek. No impact mitigation has been recommended for this site, because the potential yield of additional research information is negligible.

Water Quality

The principal impact to water quality in Four Mile Creek during construction of the once-through cooling tower would be temporary increases in suspended solids due to runoff and erosion. Temporary measures such as berms, drainage ditches, drains, sedimentation basins, grassing, and mulching would control runoff until permanent drainage and erosion control facilities could be completed. Turbidity screens would prevent downstream movement of suspended material where construction activities would occur near Four Mile Creek.

Ecology

For the once-through cooling tower with pumped feed, approximately 90 acres of uplands would be disturbed by construction. This would include about 14 acres for relocating utility lines, 46 acres for holding pond construction, 2 acres for the cooling tower, and the remainder for relocation of various other facilities and construction of service roads and parking areas. Construction activities are not expected to affect vegetation outside the immediate construction area. At least 46 acres of immature slash pine would be lost in the construction of the holding pond. An additional 40 acres of reforested upland pine/hardwood would be lost due to other construction activities.

The construction of a once-through cooling tower with gravity feed would affect approximately 45 acres of uplands and bottomland hardwoods (16 acres for the gravity-feed canal, 3 acres for the cooling tower, and the remaining 26 acres for the relocation of various facilities and for construction of service roads and parking areas). No effects are expected on vegetation outside the immediate construction area. The construction of the discharge canal would require the removal of 10 acres of immature slash pine poletimber and 6 acres of regenerated loblolly pine. The effluent canal from the cooling tower to Indian Grave Branch would require the removal of about 0.5 acre of bottomland hardwoods consisting mainly of sweet gum and yellow poplar.

Construction activities could temporarily affect certain wildlife species, such as birds and turtles at the construction site. Most of the wildlife would leave the immediate area of construction when activities increase; however, some should return when construction is complete. The clearing of areas for construction would result in the loss of some small mammals, such as shrews and mice; however, significant impacts to the populations are unlikely.

When construction has been completed, areas that are no longer needed would be replanted with appropriate grasses, shrubs, or trees and thus made available for use by wildlife.

The expected impacts from sediment loading on fish and macroinvertebrates caused by construction would be minimal because the upper reaches of Four Mile Creek near the proposed construction are sparsely inhabited at present due to high temperature conditions (Appendix C).

Radiological Releases

During the construction of the once-through cooling tower, there would be no changes in the atmospheric and liquid releases of radionuclides. Reactor operation and the flow rate in Four Mile Creek would remain the same. There would be no changes in reactor releases or remobilization of radionuclides from the creek bed and, consequently, radiation doses to the offsite population would not change.

Because the proposed location for the cooling tower is within and part of the Savannah River Plant, construction personnel for the tower would experience slightly elevated background levels of radiation resulting from the operation of Plant facilities. From measurements made at the construction site of the Defense Waste Processing Facility (DOE, 1982), the annual dose increment from airborne emissions to a construction worker who spends 2000 hours (40 hours per week for 50 weeks per year) in the cooling-tower construction area is estimated to be approximately 20 millirem. This dose is below the standard of 25 millirem per year established by the U.S. Department of Energy for uncontrolled areas.

Other Construction Impacts

The construction of the once-through cooling tower for C-Reactor would result in the emission of small quantities of carbon monoxide and hydrocarbons from engine exhausts of construction equipment and truck traffic, and suspended particulates and dust from ground-surface disturbances. All applicable emissions standards would be met during construction.

Construction of the once-through cooling tower would also cause temporary increases in noise levels in the immediate area from construction equipment such as earth-moving equipment and cranes; however, no noise from these activities is expected to be detectable offsite.

Solid waste generated during construction (excluding clearing debris) would be placed in containers for disposal in an approved manner. Fueling and maintenance of construction equipment would be performed under controlled conditions to minimize spills.

4.1.1.2 Operational Impacts

The following sections present the expected environmental impacts associated with the operation of a once-through cooling tower for C-Reactor. These discussions include, as appropriate, the differences in environmental impacts attributable to the potential operation of either a pumped- or gravity-feed and either a mechanical- or natural-draft cooling tower.

Socioeconomics

The number of workers associated with the operation of a once-through cooling tower at C-Reactor would not result in any socioeconomic impacts, because only four additional mechanics would be required.

Historic and Archaeological Resources

The operation of a once-through cooling tower for C-Reactor would not impact any historic or archaeological resources. Anticipated flows in Four Mile Creek would be nearly the same as those at present, with little change in stream morphology. An archaeological and historic resources survey in the Four Mile Creek watershed area located no significant sites requiring impact mitigation (Appendix E).

Water Quality and Hydrology

The once-through cooling tower would primarily impact water quality in Four Mile Creek and the Savannah River swamp by lowering instream temperatures to meet the State of South Carolina's Class B water classification standard of 32.2°C. Water temperatures in the creek would be at a maximum of about 32°C under extreme 5-day average summer conditions, from the tower discharge to the stream delta. During an average summer, the water in this reach of the creek would be about 30°C, which compares to calculated ambient temperatures of 29°C. The final tower design would meet the requirements stipulated for Maximum Weekly Average Temperature (MWAT) for fish survival during a winter shutdown (EPA, 1977). Because expected instream temperatures during winter and spring average conditions would be raised more than 2.8°C due to the operation of the cooling-tower system, a Section 316(a) study would be performed after construction and submitted to the South Carolina Department of Health and Environmental Control; this study would demonstrate that effluent temperature conditions would ensure the protection and propagation of a balanced indigenous population of fish and wildlife in and on the waters affected by the discharge.

The reduction of the temperature in Four Mile Creek would cause a corresponding increase in dissolved oxygen concentrations. Studies show that water temperature controls oxygen content in the thermal portions of SRP streams (Du Pont, 1985b). Under current operating conditions, dissolved oxygen concentrations in Four Mile Creek are sometimes below South Carolina Class B stream standards during the summer months. Lower water temperatures would produce higher dissolved oxygen concentrations during the summer months, which would result in achieving compliance with water classification standards.

The operation of a once-through cooling-tower system would also reduce both the total suspended solids discharged to Four Mile Creek and sedimentation rates in the delta. There are two causes of these effects: First, the reduction of water temperatures would allow some vegetation to develop along the banks of the creek in areas where plants cannot grow now because of the heated discharge water, and thereby stabilize the stream banks and reduce erosion; and second, some of the suspended solids would be reduced by settlement in a holding pond (pumped feed) or cooling-tower basin (gravity feed).

Effluents discharged to Four Mile Creek as the result of the implementation of this alternative would be chemically similar to those associated with the present once-through system. There would also be a small increase in the concentration of nonvolatile constituents due to the evaporative losses from the cooling tower. Discharges would meet all NPDES permit limits. When C-Reactor is not operating, the concentrations of chemical pollutants in Four Mile Creek would not change appreciably because of the absence of the cooling water discharge; the stream would meet State Class B water classification standards (see Section 3.2.3 and Du Pont, 1985b).

The operation of a once-through cooling tower would result in small changes to the hydrology of Four Mile Creek and the swamp, compared to present conditions. By comparison, the operation of recirculating cooling towers would have a significant effect on the hydrology of the creek due to the reduction of the discharge flow from the present rate of 11.3 cubic meters to about 0.3 cubic meters per second. The loss of cooling water from the once-through tower due to evaporation would reduce the discharge flow into the creek from its current level of about 11.3 to about 10.4 cubic meters per second; this would produce no significant change in the hydrological conditions in the waterways below the outfall because the creek flow would be reduced from only 11.9 to about 11 cubic meters per second when the reactor is operating. When C-Reactor is not operating, the flow in Four Mile Creek would be reduced significantly.

The operation of the once-through cooling-tower system would not produce significant impacts on the subsurface hydrology in the area of C-Reactor. A water table mound would build up under the holding pond (pumped feed), but this mound would be localized to the pond area and the groundwater would not be contaminated. Present groundwater discharges from the Barnwell and McBean Formations would continue to discharge to Four Mile Creek. Seepage from the holding pond (pumped feed) would also discharge to the creek.

The major difference between the pumped- and gravity-feed cooling-tower systems would be the location of the discharge. The discharge point for the gravity-feed system would be about 1.5 kilometers farther down Castor Creek than that for the pumped-feed system. This 1.5-kilometer section of Castor Creek would revert to ambient-flow conditions if the gravity-feed system were implemented.

Air Quality

The operation of a once-through, mechanical-draft cooling tower at C-Reactor could result in the formation of ground-level fog, ice, elevated visible plumes, and total-solids (drift) deposition on the ground. As discussed in Appendix B, a computer model (Fisher, 1974) was used to predict the atmospheric effects of cooling-tower operation. Hourly meteorological data for the period January 1975 to October 1979 were used in the analyses; they were derived from the Savannah River Plant and the National Weather Service (NWS) station at Bush Field in Augusta, Georgia. Wind and atmospheric stability data collected at 61 meters elevation from the C-Reactor tower and temperature data obtained from the NWS station at Bush Field were the primary sources of meteorological input. For those periods when wind data from the C-Reactor tower were unavailable, data from the other SRP meteorological monitoring stations (described in Section 3.2) were used. If SRP data were not available, wind and atmospheric stability data based on the Pasquill-Turner approach were used, based on data from the Bush Field NWS station.

The effects of an evaporative-heat-dissipation system on the formation of fog and ice were determined by the quantity and location of added moisture and by the existing ambient air conditions. The significant factors in determining the increase of fogging and icing are the characteristics and quantity of the effluent air, the height of the effluent plume, and the downwind dispersion of the plume. The fogging calculations were based on the international definition of fog (i.e., the reduction of visibility to less than or equal to 1 kilometer) (Pettersen, 1956).

For the once-through mechanical-draft cooling tower with pumped feed, the calculated maximum annual-mean frequency of reduced ground-level visibility to less than 1000 meters would be approximately 5 hours per year occurring at 8.5 kilometers to the west-northwest through north-northwest of the cooling tower. Major roads affected would be SRP Roads A, C, F, and 2 and U.S. Highway 278. Within 2 kilometers of the cooling tower, the calculated maximum frequency would be less than 1 hour per year. The calculated annual-mean frequencies of reduced ground-level visibility to less than 1000 meters would be less than 2 hours per year for all directions within 3 kilometers of the tower.

The calculated maximum ice accumulation on horizontal surfaces would be no more than 1 millimeter beyond 0.8 kilometer in all directions from the cooling tower. The maximum predicted ice thickness would be 7 millimeters, occurring within 0.4 kilometer from the tower with a total frequency of 208 hours per winter season.

The calculated maximum occurrence of visible plumes aloft would be approximately 50 hours per year in the immediate vicinity (0.4 kilometer) of the cooling tower, primarily from SRP Road A-7. The calculated maximum occurrence would be 20 hours per year within 2.4 kilometers of the cooling tower, primarily from SRP Roads C, 3, and 5.

The calculated maximum annual total-solids deposition (defined as the total amount of solid material deposited as dry particles and in droplet form) would be about 1.0 kilogram (2.2 pounds) per acre per year within 2 kilometers of the tower in all directions.

The impacts of the once-through mechanical-draft cooling tower with gravity feed would be similar to those of the pumped-feed tower. Due to the location of the gravity-feed tower (southwest from C-Reactor), the impacted areas would be somewhat different, because the fogging, drift, and icing isopleths would shift toward the south and southwest of C-Reactor, without any change in the maximum release values near the tower.

Natural-draft cooling towers are much taller than mechanical-draft towers; consequently, the plumes are released at higher levels and remain aloft over greater distances, resulting in fewer ground-level impacts. Therefore, the environmental impacts, including ground-level fogging, icing, and salt deposition, would generally be smaller than those of mechanical-draft towers, with the exception of increased frequencies for visible plumes.

Noise

During the operation of a once-through mechanical-draft cooling tower with pumped feed for C-Reactor, increases in noise levels would occur due to the operation of the cooling tower and pumps. Cooling-tower noise would come from fans and waterfall. Beyond approximately 152 meters from the cooling tower, average sound levels would be below 70 decibels. (Continuous exposure to 70 decibels or less has been determined to cause no loss of hearing.) At the nearest offsite area, noise from C-Area activities would not be detectable.

Noise impacts of the operation of a once-through cooling tower with gravity feed would be less than those associated with a once-through tower with pump feed because there would not be any pumps operating that would contribute to increased noise levels. There would be no significant differences between a mechanical- or a natural-draft tower.

Ecology

Vegetation and Wetlands

Vegetation near the cooling tower would be subject to salt deposition attributable to drift from the tower. Cooling-tower drift can cause vegetation stress either directly by deposition of salts on the foliage or indirectly from excess accumulations of salts in the soil. Salt stress in plants, which can occur via various mechanisms, includes (1) increased osmotic potential of the soil solution affecting the availability of soil moisture to the plant; (2) alteration of the mineral nutrition balance in the salt tissues; and (3) toxic effects due to specific ion concentrations in the plants (Bernstein, 1975; Hanes, Zelazny, and Blaser, 1970; Allison, 1964; Levitt, 1980).

Tolerances and susceptibility to salt deposition are highly variable, depending on the plant species and on other conditions in the environment. Vegetative studies indicated that thresholds for development of visible salt stress symptoms on the most sensitive species were approximately 83 kilograms per acre per year of sodium chloride salt (INTERA, 1980). Studies indicate that at sodium chloride deposition rates of about 41 kilograms (90 pounds) per acre per year, agricultural productivity can be reduced (Mulchi and Armbruster, 1981).

The composition of the drift is equivalent to that of the circulating water. The concentration of substances in the circulating water for the once-through cooling tower is shown in Table 3-3. The substance of particular interest with regard to its potential for damage is the chloride ion. The other constituents listed in this table either are at such low concentrations as to be negligible or are potentially beneficial.

The operation of a once-through mechanical-draft cooling tower with pumped or gravity feed would result in an estimated total solids deposition of about 1.0 kilogram (2.2 pounds) per acre per year within 2 kilometers. The sodium chloride deposition rates from the cooling tower would be much less than the critical values, reported by Mulchi and Armbruster (1981) and INTERA (1980), that can cause reduced productivity of plant species. Therefore, no significant impacts on vegetation are expected. The operation of a once-through natural-draft cooling tower at either the pumped- or gravity-feed location would result in even smaller total-solids deposition.

The most significant impact on vegetation from the operation of a once-through cooling tower would be a reduction in the loss of wetland habitat due to thermal discharges; losses due to sedimentation would continue. However, sedimentation rates in the delta and the total suspended solids discharged to Four Mile Creek would both be reduced. Portions of the delta would revegetate once the water temperature was reduced. There would be limited reestablishment of upstream wetland communities along Four Mile Creek because the stream would still be subject to variable flows. From 1955 through 1984, about 1147 acres of wetlands were affected in the Four Mile Creek floodplain and swamp due to thermal discharges and flooding (Du Pont, 1985b; Appendix F), with an average loss of about 28 acres per year in the swamp. The operation of a once-through cooling tower would eliminate both additional losses in the stream corridor and thermal effects--one of the three major factors (the others are flooding from reactor operation and river flooding)--responsible for continuing swamp canopy loss (Du Pont, 1985b). The reduction in effluent temperatures would therefore, have a beneficial impact on wetland communities by significantly reducing wetland loss.

The effects on wetlands from the operation of a once-through gravity-feed cooling tower would be the same as those described for a pumped-feed tower. However, the operation of the gravity-feed tower would result in about 1.5 kilometers of Castor Creek upstream of the discharge reverting to natural stream conditions. This is because the gravity-feed tower discharge is located about 1.5 kilometers downstream from C-Reactor along Castor Creek.

To assist in ongoing consultations with the U.S. Fish and Wildlife Service (FWS), a Habitat Evaluation Procedure (HEP) analysis is being prepared. This analysis will identify the value of habitat to be gained or lost and will assess the need for further mitigation.

Aquatic Habitat

During the operation of the once-through cooling-tower system, discharge water temperatures in Four Mile Creek during the spring would be between 3° and 4°C above stream ambient temperatures at the swamp/delta area. These temperatures in the spring could produce some attraction of fish and possible early spawning. Earlier or continuous spawning could affect the biological community of Four Mile Creek and the Savannah River swamp to a limited degree due to the loss of progeny from a lack of an adequate food supply or changes in species composition caused by the overabundance of certain species that could migrate into the warmer water to spawn. Earlier reproduction in some macroinvertebrates could also occur as a result of the operation of a once-through cooling-tower system; this could result in some mortality. Although earlier spawning could occur to a limited degree, it is not considered detrimental to the establishment of a reproducing stream fishery. The operation of a once-through cooling-tower system would improve spawning conditions for fish in the creek and delta areas over present conditions. The present aquatic communities in the nonthermal headwaters of Four Mile Creek and other tributaries would expand and colonize downstream areas when the thermal stress is eliminated. These headwater areas would no longer be isolated from the Savannah River by a heated discharge. Species such as sunfish, minnows, and darters could spawn in sections of the creek that are currently too warm. Also, the spawn of those fishes that is now cast in the nonthermal headwaters of Four Mile Creek and subsequently carried downstream into the thermal areas would no longer be lost. In addition, migratory species (e.g., blueback herring) would be able to use the deep-water swamp areas near the delta for spawning.

The once-through cooling-tower system for C-Reactor would be designed to meet the Maximum Weekly Average Discharge Temperature (MWAT) criteria (EPA, 1977) to minimize the effects of cold shock on fish that would occur in Four Mile Creek during a winter shutdown. During periods of reactor shutdown, flows in Four Mile Creek would continue to be reduced from 11.3 to about 0.3 cubic meters per second. This variable flow regime would continue to affect the macroinvertebrate and fish populations of the creek; benthic organisms could be stranded on the mud flats and lost due to the reduced water level, while fish would be concentrated or forced to migrate to downstream areas. These impacts would be most severe during long shutdowns that coincide with the warmest time of the year (summer).

To identify the value of habitat gained or lost and to assess the need for further mitigation, a Habitat Evaluation Procedure (HEP) analysis is being prepared, to assist in ongoing consultations with the U.S. Fish and Wildlife Service.

Entrainment and Impingement

The operation of a once-through cooling-tower system would not require changes to the intake structures or the receiving water flow rates. Accordingly, the entrainment and impingement rates associated with this system would be similar to those resulting from present operations.

Projections of current entrainment losses, based on ichthyoplankton studies at the site (Paller et al., 1984; Paller, O'Hara, and Osteen, 1985), indicate that operation of C-Reactor presently results in the loss of between about 8.2 $\times 10^6$ and 13.1 $\times 10^6$ fish larvae and between 2.6 $\times 10^6$ and 8.5 $\times 10^6$ fish eggs each year. These totals represent about half the ichthyoplankton entrained by the 1G and 3G pumphouses combined before the operation of L-Reactor. The principal taxa entrained as larvae, in decreasing order of abundance, are Clupeidae (shad, herring, etc.), Centrarchidae (crappies, sunfish, etc.), and Cyprinidae (carp, minnows, etc.). The eggs of the American shad and the striped bass were entrained most often and generally accounted for 70 percent of all eggs entrained. About 25 percent of the eggs entrained each year could not be identified.

The current rates of impingement at the 1G and 3G intake screens would not be expected to change with a once-through cooling-tower system. During 1984, 1840 fish were collected from both intake screens (824 from 1G and 1016 from 3G) during 107 sampling dates. The weight of these impinged fish was about 64.6 kilograms (Paller and Osteen, 1985). The average impingement rate was about 17 fish per day, about half of which could be attributed each to both C- and K-Reactors. The average number of fish impinged during 1984 is approximately 40 percent less than the 24 fish impinged during 1983 (Paller et al., 1984), but similar to the average of about 15 fish impinged daily during 1982 (ECS, 1983). Therefore, based on these 3 years of data, the implementation of this alternative would result in the loss of between about 15 and 24 fish per day (5438 to 8760 fish per year), about half of which could be attributed to C-Reactor. The principal species affected during these 3 years were blue-spotted sunfish and threadfin shad; redbreast sunfish, gizzard shad, and spottail shiners were also frequently impinged (ECS, 1983; Paller et al., 1984, Paller and Osteen, 1985).

Endangered Species

The operation of the once-through cooling-tower system would not impact the habitat of the endangered red-cockaded woodpecker (Picoides borealis). No active or inactive red-cockaded woodpecker colony has been located in the Four Mile Creek area.

The endangered American alligator (Alligator mississippiensis) occurs on the SRP site in both flowing waters and lake environments. Mildly thermal water appears to attract alligators, particularly during the winter. Under current operating conditions, the temperature in the thermal region of Four Mile Creek in the summer is higher than 70°C, which greatly exceeds the critical thermal maximum (38°C) for American alligators (Sires, 1984). Thus, alligators are not present during periods of reactor operation. The operation of a once-through cooling-tower system would lower the temperature in the reaches of Four Mile Creek well below the alligator's critical thermal maximum temperature; thus, the operation of this system is expected to result in the establishment of additional habitat for this species.

Although shortnose sturgeon (Acipenser brevirostrum) larvae and adults have been collected from the Savannah River and the intake canals, no shortnose sturgeon have been collected from any SRP creeks, nor do these areas provide spawning habitat. Current SRP operations have been determined to have no adverse impact on the endangered shortnose sturgeon population in the Savannah River (Oravetz, 1983).

Endangered wood storks (Mycteria americana) from the Birdsville colony (40 kilometers southwest of the Savannah River Plant, near Millen, Georgia) forage in the SRP swamps. On seven occasions during the summers of 1983 and 1984, wood storks were observed soaring over the Four Mile Creek swamp area (Meyers, 1984). Coulter (1986) observed wood storks in the Four Mile Creek area, but did not document the use of the area as a foraging site. However, low fish densities, high water temperatures, and increased water depths from reactor flows generally limit the value of the creek and the adjacent swamp for wood stork foraging. The implementation of a once-through cooling-tower system would reduce the flow of Four Mile Creek from about 11.9 to about 11.0 cubic meters per second during reactor operation, and would reduce effluent temperatures, thereby attracting more fish and other vertebrates to these areas. The operation of this system would not result in the destruction of any wood stork foraging habitat and could enhance potential habitat and improve food source availability.

Consultations with the U.S. Fish and Wildlife Service (FWS) on the American alligator, red-cockaded woodpecker, and wood stork are in progress. The need for the preparation of a biological assessment for each of these species will be determined through this formal consultation process. The National Marine Fisheries Service (NMFS) has previously concurred in DOE's determination that the population of shortnose sturgeon in the Savannah River would not be affected adversely by SRP operations (Oravetz, 1983).

Radiological Releases

The radiological releases associated with the discharge of cooling water from C-Reactor are those resulting from either the remobilization of radionuclides contained in the Four Mile Creek streambeds and floodplain, or those resulting from small process-water leaks into the cooling water.

The operation of the once-through cooling tower (either mechanical draft or natural draft) would not result in any significant changes in the remobilization of radionuclides contained in the Four Mile Creek streambed since the flow rate of cooling water discharged to the creek would remain essentially unchanged. The operation of the once-through cooling tower, however, would decrease the amount of tritium discharged to Four Mile Creek and correspondingly increase the amount of tritium released to the atmosphere because of the evaporation from cooling-tower operation. The following sections present a discussion of changes in the doses to the maximally exposed individual at the site boundary and to offsite population groups (based on Year 2000 projections) that are attributable to the change in atmospheric and liquid releases of tritium resulting from operation of the once-through cooling tower.

A once-through mechanical-draft cooling tower with gravity feed would have essentially the same doses as those discussed in the following sections for a once-through mechanical-draft tower with pumped feed. The gravity-feed tower would cause a slightly higher dose to the maximally exposed individual at the site boundary because it is closer to the boundary; however, the change in dose is negligible. A natural-draft tower would also result in atmospheric doses to the maximally exposed individual that would be slightly higher than those caused by a mechanical-draft tower, because of its higher release height. This difference in doses is also negligible.

Appendix G contains details of the dose assessment methodology and parameters; it also contains tables that list specific organ doses by pathway and age group.

Atmospheric Releases

The amount of tritium released annually to the atmosphere is expected to increase by 50 curies per year (about 0.012 percent of total SRP releases of tritium to the atmosphere) as a result of evaporation producing the cooling effect. This release would increase the atmospheric dose commitments of the regional population and the maximally exposed individual. Changes in dose commitments resulting from the increased release of atmospheric tritium are summarized below.

Maximum Individual Dose - The hypothetical individual who would receive the highest effective whole-body dose from atmospheric releases associated with this cooling alternative is assumed to reside continuously at the SRP boundary about 9.3 kilometers southwest of C-Reactor. The selection of this location was based on distance to the plant boundary and meteorological dispersion characteristics. This individual is assumed to receive doses by inhalation and by the ingestion of meat, vegetation, and cow's milk.

The annual increase in soft-tissue and effective whole-body doses to the maximally exposed individual due to the atmospheric release of tritium is summarized in Table 4-2.

Population Dose - Collective doses resulting from atmospheric releases associated with this cooling alternative are calculated for the population within 80 kilometers downstream of the Plant. The annual effective whole-body dose to this population would increase by 4.97×10^{-3} person-rem as a result of the increase in tritium released to the atmosphere.

Liquid Releases

The operation of the once-through cooling tower would reduce the amount of tritium released to Four Mile Creek. The release of tritium would decrease by 50 curies per year (about 0.12 percent of total releases of tritium to streams) as a result of evaporation experienced during cooling. Doses associated with the change in liquid releases are discussed below for both the population and the maximally exposed individual.

Table 4-2. Increase in Annual Doses to Maximally Exposed Individual Resulting from Atmospheric Releases of Tritium from C-Reactor Once-Through Cooling Tower (Pumped Feed)

Age group	Incremental dose increase (mrem/yr)	
	Effective whole body	All soft tissue[a]
Adult	1.08×10^{-4}	1.27×10^{-4}
Teen	1.17×10^{-4}	1.37×10^{-4}
Child	8.09×10^{-5}	9.51×10^{-5}
Infant	2.40×10^{-5}	2.82×10^{-5}

[a]Tritium imparts an equal dose to all soft tissues (i.e., all organs except bone) that is about 18 percent higher than the effective whole-body dose.

Maximum Individual Dose - The hypothetical individual who would experience the greatest change in dose from liquid effluents is assumed to live near the Savannah River downstream from the Savannah River Plant. The individual is assumed to use river water regularly for drinking, to consume fish from the river, and to experience external exposures from shoreline activities. The individual is also assumed to drink more water and eat more fish than an average person.

The annual decrease in soft-tissue and effective whole-body doses received by the maximally exposed individual due to a decrease in the liquid release of tritium is summarized in Table 4-3.

Population Dose - Savannah River water is not used for drinking within 80 kilometers downstream of the Savannah River Plant; therefore, the dose to the population in this area would come from fish and shellfish consumption, and shoreline activities.

The decrease in the collective dose to the population within 80 kilometers of the Savannah River Plant from liquid releases of tritium associated with this cooling alternative would be 2.46×10^{-5} person-rem (Table 4-4).

The Beaufort-Jasper and Port Wentworth population groups use the Savannah River as a source of potable water. While these groups are more than 80 kilometers from the Savannah River Plant (about 100 river miles downstream), their drinking-water doses have been calculated. The decrease in the collective dose delivered to these populations (about 317,000 people are expected to consume water from the Beaufort-Jasper and Port Wentworth water-treatment plants by the year 2000) from tritium in drinking water is presented in Table 4-4.

Table 4-3. Decrease in Annual Doses to Maximally Exposed Individual Resulting from a Decrease in Liquid Releases of Tritium from C-Reactor Once-Through Cooling Tower (Pumped Feed)

Age group	Incremental dose reduction (mrem/yr) Effective whole body	All soft tissue[a]
Adult	2.19×10^{-4}	2.58×10^{-4}
Teen	1.54×10^{-4}	1.81×10^{-4}
Child	1.50×10^{-4}	1.76×10^{-4}
Infant	9.52×10^{-5}	1.12×10^{-4}

[a]Tritium imparts an equal dose to all soft tissues (i.e., all organs except bone) that is about 18 percent higher than the effective whole-body dose.

Table 4-4 Decrease in Effective Whole-Body Collective Dose Resulting from Liquid Releases of Tritium from C-Reactor Once-Through Cooling Tower (Pumped Feed)

Population group	Incremental collective dose reduction (person-rem/yr)
80-kilometer radius	2.46×10^{-5}
Beaufort-Jasper	1.13×10^{-2}
Port Wentworth	2.13×10^{-2}
Total	3.26×10^{-2}

Overall Changes in Offsite Doses

Changes in the effective whole-body dose received by the maximally exposed individual resulting from the operation of this cooling alternative are summarized in Table 4-5. Changes in the collective dose are indicated in Table 4-6.

Table 4-5. Effective Whole-Body Dose Increments Received by Maximally Exposed Individual Resulting from Operation of C-Reactor Once-Through Cooling Tower (Pumped Feed) (millirem per year)[a]

Source of exposure	Adult	Teen	Child	Infant
Atmospheric tritium releases	1.08×10^{-4}	1.17×10^{-4}	8.09×10^{-5}	2.40×10^{-5}
Liquid tritium releases	-2.19×10^{-4}[(b)]	-1.54×10^{-4}	-1.50×10^{-4}	-9.52×10^{-5}
Net dose change	-1.11×10^{-4}	-3.70×10^{-5}	-6.91×10^{-5}	-7.12×10^{-5}

[a]Tritium imparts an equal dose to all soft tissues that is about 18 percent higher than the effective whole-body dose.
[b]Negative sign denotes a decrease in dose.

The average background total-body dose to an individual living in the vicinity of the Savannah River Plant is 93 millirem per year. By extrapolation, the collective dose to the 80-kilometer population is 79,200 person-rem; to the Port Wentworth water users, 18,600 person-rem; and to the Beaufort-Jasper water users, 10,900 person-rem.

This cooling alternative would reduce the annual dose to the effective whole body of the maximally exposed adult and the collective dose to Port Wentworth and Beaufort-Jasper water users by 1.11×10^{-4} millirem, 2.13×10^{-2} person-rem, and 1.13×10^{-2} person-rem, respectively, and increase the collective dose to the 80-kilometer population by 4.95×10^{-3} person-rem. These dose changes are very small compared with the normal variations in natural background radiation.

Present SRP operations result in an effective whole-body dose increment of 5.92×10^{-2} millirem per year to the maximally exposed adult from tritium releases to the Savannah River from Four Mile Creek. This alternative would reduce the liquid tritium dose by 2.19×10^{-4} millirem per year and increase the atmospheric dose by 1.08×10^{-4} millirem per year, resulting in an overall reduction of 1.11×10^{-4} millirem per year.

Health Effects

Risk estimators used to project health effects are 120 fatal cancers and 257 genetic effects per 1 million person-rem of collective dose; the risk estimators, by organ, are presented in Appendix G. According to these estimators and the organ doses, the population within 80 kilometers of the Savannah River

Table 4-6. Effective Whole-Body Collective Dose Increments Resulting from Operation of C-Reactor Once-Through Cooling Tower (Pumped Feed) (Person-rem per Year)

Source of Exposure	80-kilometer population	Beaufort-Jasper	Port Wentworth	Total
Atmospheric tritium releases	4.97×10^{-3}	--	--	4.97×10^{-3}
Liquid tritium releases[a]	-2.46×10^{-5}	-1.13×10^{-2}	-2.13×10^{-2}	-3.26×10^{-2}
Net dose change	4.95×10^{-3}	-1.13×10^{-2}	-2.13×10^{-2}	-2.77×10^{-2}

[a]Negative sign denotes a decrease in dose.

Plant could experience an annual increase of 5.82×10^{-7} excess cancer fatality and 1.50×10^{-6} additional genetic disorder from the operation of this alternative cooling water system. The populations at Beaufort-Jasper and Port Wentworth downstream from the Savannah River Plant could experience decreases of 3.84×10^{-6} fatal cancers and 9.87×10^{-6} genetic disorders per year. This information is summarized in Table 4-7.

Table 4-7. Changes in Annual Health Effects

Population group	Genetic disorders	Fatal cancers
80-kilometer radius	1.50×10^{-6}	5.82×10^{-7}
Beaufort-Jasper[a]	-3.42×10^{-6}	-1.33×10^{-6}
Port Wentworth	-6.45×10^{-6}	-2.51×10^{-6}
Total	-8.37×10^{-6}	-3.26×10^{-6}

[a]Negative sign denotes a decrease in health effects.

4.1.2 RECIRCULATING COOLING TOWERS

4.1.2.1 Construction Impacts

Socioeconomics

Construction of the recirculating cooling towers for C-Reactor would be accomplished in approximately 24 months, assuming the procurement for these towers is completed before that for K-Reactor. This construction would involve a combined workforce for the towers in C- and K-Areas. Two groups of workers would be involved in constructing the recirculating cooling towers. The first group, which would include the architect and building crew, would initially number about 90. This group would increase to about 150 when work on the cooling towers for K-Reactor began because construction of the towers for C-Reactor would be continuing. The second group of workers would perform related construction activities, such as installing electrical facilities and piping; this group would involve a peak workforce of 490 personnel. The two workforce groups would peak at different times during construction. The maximum total construction workforce during these combined activities would not exceed 600; therefore, the estimated peak construction workforce for C-Reactor alone is 300 persons.

As described in Section 4.1.1.1, construction workers from other local projects would be available for employment on the Savannah River Plant. Because these workers already reside in the SRP area, no impacts to local communities and services due to inmigrating workers would occur.

Historic and Archaeological Resources

The construction of recirculating cooling towers would disturb only one site (38BR548) in the Four Mile Creek area. Site 38BR548 is a small prehistoric lithic and ceramic scatter located on a terrace edge adjacent to the bank of the northern branch of Four Mile Creek. No impact mitigation has been recommended for this site, because the potential yield of additional research information is negligible.

Water Quality

The impacts on water quality in Four Mile Creek from the construction of recirculating cooling towers would be similar to those associated with the construction of the once-through cooling tower (see Section 4.1.1.1). The principal impact would be some temporary localized increases in the concentration of suspended material in the stream water due to runoff and erosion from construction areas. The application of standard erosion control practices described in Section 4.1.1.1 would minimize these temporary effects.

Ecology

The construction of recirculating cooling towers would result in approximately 50 acres of uplands being disturbed by construction (20 acres for the holding pond, 3 acres for the cooling towers, and the remainder for the relocation of various facilities and for construction of service roads and parking areas). No adverse effects are expected on vegetation outside the immediate construction areas. The construction of the holding pond would require the removal of 25 acres of immature slash pine pole timber. An additional 25 acres of reforested upland pine/hardwood and open fields would be disturbed due to other construction activities.

The impacts to fish and wildlife from the construction of the recirculating cooling towers would be similar to those described for the construction of the once-through cooling tower (see Section 4.1.1.1).

Radiological Releases

During the construction of recirculating cooling towers for C-Reactor, there would be no changes in the atmospheric and liquid releases of radionuclides. Reactor operation and the flow rate in Four Mile Creek would remain the same. There would be no changes in reactor releases or remobilization of radionuclides from the creek bed and, consequently, radiation doses to the offsite population would not change.

The only change would be in doses delivered to onsite construction personnel, as discussed in Section 4.1.1.1. This dose, estimated to be approximately 20 millirem per year, is below the standards established by DOE for uncontrolled areas of 25 millirem per year.

Other Construction Impacts

The construction of the recirculating cooling towers for C-Reactor would also result in air quality and noise impacts similar to those described for the once-through cooling tower (Section 4.1.1.1). All applicable atmospheric emission standards would be met during construction, and solid waste generated during construction would be disposed of in an approved manner. Fueling and maintenance of construction equipment would be performed under controlled conditions to minimize spills.

4.1.2.2 Operational Impacts

Socioeconomics

The number of workers associated with the operation of the recirculating cooling towers at C-Reactor would not result in any socioeconomic impacts, because only six additional mechanics would be required.

Historic and Archaeological Resources

The operation of the recirculating cooling towers for C-Reactor would not cause any impacts to any historic and archaeological resources. During the operation of the towers, cooling water effluent would be conveyed to Four Mile Creek; flows in the creek would be significantly reduced. An archaeological and historic resources survey in the Four Mile Creek watershed area located no significant sites requiring impact mitigation (Appendix E).

Water Quality and Hydrology

The operation of recirculating cooling towers would lower discharge temperatures such that the State of South Carolina's Class B water classification standards (i.e., a maximum instream temperature of 32.2°C) would be met throughout the year; the temperature of the water released to the creek under average winter conditions would be about 10°C, only 1°C above ambient temperature, which is within the Class B water classification standard of a maximum rise of 2.8°C above ambient stream temperature.

The operation of the recirculating cooling towers would result in discharges to Four Mile Creek, with concentrations of most chemical constituents about 3 times higher than corresponding values for Savannah River water drawn into the intakes, due to cycling through the recirculating tower. An important difference between the compositions of river water and ambient creek water is the higher concentration of phosphorus and nitrogen compounds (i.e., orthophosphate, total phosphorus, nitrates, and ammonia) in the river. Although the concentrations of chemical constituents (e.g., nutrients) would increase by about 3 times due to cycling in the recirculating tower, the total quantity of nutrients and other chemicals transported to the swamp river system would not increase because the intake flow of Savannah River water for this alternative is much less than either the present cooling water system or the once-through cooling-tower alternative. Concentrations of chemicals in the cooling-tower blowdown and the chemicals (e.g., hypochlorite) added to control fouling of the cooling water in the towers would be dissipated by the holding pond. All discharges would comply with NPDES permit requirements and State Class B water classification standards.

With the operation of the recirculating cooling towers, dissolved oxygen levels in Four Mile Creek would comply with Class B water classification standards throughout the year as a result of lower discharge water temperatures and aeration as the result of water passing through the cooling towers. Under present conditions, dissolved oxygen concentrations sometimes fall below Class B water classification standards (5 milligrams per liter average; 4 milligrams per liter minimum) during warmer summer periods. The lower flow in the stream would reduce erosion, and the lower water temperatures would allow vegetation to grow along the waterway, thereby stabilizing the shoreline areas. Thus, the expected levels of total suspended solids would be lower in Four Mile Creek and the Savannah River swamp.

The operation of the recirculating cooling towers would have a significant effect on the hydrology of Four Mile Creek due to a reduction in discharge flow from the present level of about 11.3 cubic meters to about 0.6 cubic meter per second. The flow in the creek from areas upstream of C-Reactor is about 0.6 cubic meter per second; therefore, the combined flow through most of Four Mile Creek and its associated swamp area would be about twice the natural flow before C-Reactor began operations. Under these conditions, the morphology of the stream channel would be altered significantly; generally its depth and width would be reduced. Existing patterns and rates of erosion and deposition would change; one of the most important results could be a significant reduction in the rate of delta growth. The overall impact of the reduction in flow on the hydrology of the swamp would be small because the Savannah River is the principal factor influencing hydrological conditions in the swamp.

Impacts to subsurface hydrology would be similar to those discussed in Section 4.1.1.2 for the once-through cooling tower.

Air Quality

The air quality impacts from the operation of recirculating cooling towers at C-Reactor would be similar to those for the once-through cooling tower (Section 4.1.1.2).

The calculated maximum annual-mean frequency of reduced ground-level visibility to less than 1000 meters would be approximately 1 hour per year occurring about 4 kilometers southwest of the recirculating cooling towers. The maximum ice accumulation on horizontal surfaces would be no more than 1 millimeter beyond 0.8 kilometer in all directions from the towers. The maximum predicted ice thickness would be about 6 millimeters, occurring within 0.4 kilometer from the towers with a total frequency of 510 hours per winter season.

The maximum occurrence of visible plumes was calculated to be 50 hours per year within 2 kilometers of the cooling towers in all directions.

The maximum annual total-solids deposition would be about 23 kilograms (50.7 pounds) per acre per year within 0.2 kilometer of the cooling towers and approximately 10 kilograms (22.0 pounds) per acre per year within 0.8 kilometer from the cooling tower. At 2 kilometers, the predicted solids deposition is calculated to be about 6.0 kilograms (13.2 pounds) per acre per year.

Noise

During the operation of C-Reactor, increases in noise levels would occur due to the operation of the cooling towers and pumps. The impacts would be similar to those described for once-through cooling towers in Section 4.1.1.2.

Ecology

Vegetation and Wetlands

Vegetation near the recirculating cooling towers would not receive adverse impacts from drift from the towers. Operation of the towers would result in an estimated total solids deposition of about 6 kilograms per acre per year at 2 kilometers and about 10 kilograms per acre per year within 0.8 kilometer of the cooling towers. Because these rates are much less than the critical values reported (see Section 4.1.1.2), no significant impacts on vegetation are expected with this alternative.

The primary impact on vegetation would be a reduction in the loss of wetland habitat due to reductions in discharge temperature and flow. The operation of the recirculating cooling towers would reduce the rate of growth of the delta and allow the reestablishment of vegetation through the process of natural succession for an estimated area of 1000 acres of wetland habitat that are presently subject to thermal discharges and flooding.

Aquatic Habitat

The temperatures of water discharged to Four Mile Creek during the winter would be about 1°C above ambient creek temperatures. There would, therefore, be no potential for cold shock to fish that might be present during a wintertime shutdown.

The operation of the recirculating cooling towers would significantly improve spawning conditions for fish in the creek and delta areas over present conditions. The present isolated aquatic communities in the nonthermal headwaters of Four Mile Creek and other tributaries would expand and colonize the downstream areas; they would no longer be isolated from the Savannah River after the elimination of thermal stress. Although the decreased flows would reduce present aquatic habitat, a reproducing stream fishery is expected to become established; eventually it would be similar to other nonthermal SRP streams. In addition, migratory species (e.g., blueback herring) would have the opportunity to use deep-water swamp areas near the delta for spawning after the removal of the heated effluent.

The reduced discharge flows in Four Mile Creek would lower the flow regime variability from that when the reactor is operating to that during reactor shutdown. This lower differential would minimize changes in stream morphology, reduce stress in aquatic organisms, and provide a more stable aquatic habitat.

Entrainment and Impingement

The operation of the recirculating cooling towers would reduce the requirements for cooling water withdrawal from about 11.3 to about 1.7 cubic meters per second. The rates of entrainment of fish eggs and larvae into a cooling water system are directly proportional to the flow rate through that system. Because the flow requirements of recirculating towers would be about 15 percent of current levels, entrainment losses would be proportionally reduced. The estimated annual entrainment losses of fish larvae for the recirculating cooling towers would decline from a maximum of about 13.1×10^6 to about 2.0×10^6 individuals; losses of fish eggs would decline from about 8.5×10^6 to about 1.3×10^6 (based on Paller et al., 1984; Paller, O'Hara, and Osteen, 1985). The taxonomic groups benefiting from these reductions would be the clupeids (shad, herring, etc.), centrarchids (crappie, sunfish, etc.), and cyprinids (carp, etc.).

The rate at which fish are impinged on the SRP intake screens is related not only to intake flow rates, but also to such factors as river water level, water temperature, and the density of fish species in the intake canal (Du Pont, 1985b). Assuming that the rates of impingement are proportional to intake flow rates, the impingement loss would be about 15 percent of current levels. During the 1984 impingement investigations at the 1G and 3G intakes, 1840 fish were collected from the screens during 107 sampling dates (Paller and Osteen, 1985). However, during 1982 and 1983, 2300 and 179 fish were impinged on 98 and 12 sampling dates, respectively (ECS, 1983; Paller et al., 1984). The operation of the recirculating cooling towers would reduce the total annual impingement from between 5438 and 8760 to between 816 and 1314. This reduction would benefit the bluespotted sunfish, threadfin shad, redbreast sunfish, and gizzard shad, which are the species presently impinged in greatest numbers at the 1G and 3G intakes.

Endangered Species

Impacts of the recirculating cooling towers on endangered species would be similar to those described for the once-through cooling tower at C-Reactor (Section 4.1.1.2). The most significant difference would be in the reduced discharge flow from 11.3 to 0.6 cubic meter per second; this would allow the stream channel to revert approximately to its original width and would allow fish and invertebrates to inhabit the stream channel. It would also improve foraging habitat for the wood stork over present conditions.

Consultations with the U.S. Fish and Wildlife Service concerning endangered species are in progress.

Radiological Releases

Remobilization of Radionuclides

The operation of the recirculating cooling towers would reduce the flow rate of cooling water in Four Mile Creek and, therefore, decrease the amount of radionuclides being remobilized from the creek bed and transported to the Savannah River. The primary radionuclides contained in the Four Mile Creek bed are cesium-134 and cesium-137 (Appendix D). The reduced flow in Four Mile Creek would result in a decrease of about 0.24 curie of cesium-134 and 0.18 curie of cesium-137 released annually to the Savannah River.

Maximum Individual Dose - The individual who would experience the greatest change in dose from cesium remobilization is assumed to live near the Savannah River downstream from the Savannah River Plant. This individual is assumed to use river water regularly for drinking, to consume fish from the river, and to experience external exposures from shoreline activities. This individual is also assumed to drink more water and eat more fish than an average person.

The changes in effective-whole-body and most-affected-organ (small and lower large intestine) doses to the maximally exposed individual resulting from the decrease in cesium-137 released to the Savannah River are presented in Table 4-8. Appendix G contains additional tables providing detailed dose results by age group, organ, and exposure pathway.

Table 4-8. Decrease in Doses to Maximally Exposed Individual Resulting from Cesium Redistribution Associated with C-Reactor Recirculating Cooling Towers

	Incremental dose reduction (mrem/yr)	
Age group	Effective whole body	Small and lower large intestine[a]
Adult	3.03×10^{-1}	3.23×10^{-1}
Teen	2.32×10^{-1}	2.46×10^{-1}
Child	1.01×10^{-1}	1.08×10^{-1}
Infant	9.75×10^{-4}	1.04×10^{-3}

[a]Dose to small and lower large intestine is directly comparable to soft-tissue doses resulting from tritium, because tritium imparts an equal dose to all soft tissues (i.e., all organs except bone).

Population Dose - Savannah River water is not used for drinking within 80 kilometers downstream of the SRP; therefore, the dose to the population in this area would come from fish and shellfish consumption and shoreline activities.

The Beaufort-Jasper and Port Wentworth population groups use the Savannah River as a source of potable water. While these groups are more than 80 kilometers from the Savannah River Plant (about 100 river miles downstream), their drinking-water doses have been calculated.

According to projections, by the year 2000 some 852,000 people will reside within 80 kilometers of the Savannah River Plant, 117,000 will consume water from the Beaufort-Jasper water-treatment plant, and another 200,000 will consume water from the Port Wentworth water-treatment plant. The decreases in the collective doses delivered to these population groups are presented in Table 4-9. Appendix G contains additional tables providing details dose results by age group, organ, and exposure pathway.

Table 4-9. Decrease in Effective Whole-Body Collective Dose Resulting from Cesium Redistribution Associated with C-Reactor Recirculating Cooling Towers

Population group	Incremental collective dose reduction (person-rem/yr)
80-km population	8.36×10^{-1}
Beaufort-Jasper	2.28×10^{-2}
Port Wentworth	4.30×10^{-2}
Total	9.02×10^{-1}

Tritium Releases

The following sections present a discussion of changes in the doses to the maximally exposed individual at the site boundary and to offsite population groups (based on Year 2000 projections) that are attributable to the changes in atmospheric and liquid releases to Four Mile Creek of tritium resulting from the operation of the recirculating cooling towers. The operation of these towers would change the doses delivered to the maximally exposed individual at the site boundary and to offsite population groups.

Atmospheric Releases - The amount of tritium released annually to the atmosphere is expected to increase by 425 curies (about 0.1 percent of total SRP releases of tritium to the atmosphere) as a result of evaporation experienced during cooling. This would increase the atmospheric dose commitments of the regional population and the maximally exposed individual. Changes in dose commitments resulting from the increased release of atmospheric tritium are summarized below.

Maximum Individual Dose - The maximally exposed individual who would receive the highest effective whole-body dose from atmospheric releases associated with this cooling alternative is assumed to reside continuously at the SRP boundary about 9.3 kilometers southwest of C-Reactor. The selection of this location was based on distance to the Plant boundary (see Appendix D) and on meteorological dispersion characteristics. This individual is assumed to receive the doses by inhalation and by the ingestion of cow's milk, meat, and vegetation.

The annual increase in soft-tissue and effective whole-body doses received by the maximally exposed individual due to the atmospheric release of tritium is summarized in Table 4-10.

Table 4-10. Increase in Annual Dose to Maximally Exposed Individual Resulting from Atmospheric Releases of Tritium from C-Reactor Recirculating Cooling Towers[a]

Age group	Incremental dose increase (mrem/yr) Effective whole body	All soft tissues[a]
Adult	9.15×10^{-4}	1.08×10^{-3}
Teen	9.91×10^{-4}	1.17×10^{-3}
Child	6.87×10^{-4}	8.09×10^{-4}
Infant	2.03×10^{-4}	2.40×10^{-4}

[a]Tritium imparts an equal dose to all soft tissues (i.e., all organs except bone) that is 18 percent higher than the effective whole-body dose.

Population Dose - Collective doses resulting from atmospheric releases associated with this cooling alternative are calculated for the population within 80 kilometers of the Savannah River Plant. The annual collective dose to this population would increase by 4.22×10^{-2} person-rem as a result of the increase in tritium released to the atmosphere.

Liquid Releases - The operation of this cooling alternative would reduce the amount of radioactivity released to the stream. The release of tritium would decrease by 425 curies per year (about 1 percent of the total SRP releases of tritium to streams) as a result of evaporation experienced during cooling. Doses associated with the change in liquid releases are discussed below for both the population and the maximally exposed individual.

Maximum Individual Dose - The hypothetical individual who would experience the greatest change in dose from liquid effluents is assumed to live near the Savannah River downstream from the Savannah River Plant. This individual is assumed to use river water regularly for drinking, to consume fish from the river, and to experience external exposures from shoreline activities. The individual is also assumed to drink more water and eat more fish than an average person.

The annual decrease in soft-tissue and effective whole-body doses received by the maximally exposed individual due to a decrease in the liquid release of tritium is summarized in Table 4-11.

Table 4-11. Decrease in Annual Dose to Maximally Exposed Individual Resulting from a Decrease in Liquid Releases of Tritium from C-Reactor Recirculating Cooling Towers

Age group	Incremental dose reduction (mrem/yr) Effective whole-body	All soft tissues[a]
Adult	1.85×10^{-3}	2.18×10^{-3}
Teen	1.31×10^{-3}	1.53×10^{-3}
Child	1.27×10^{-3}	1.50×10^{-3}
Infant	8.09×10^{-4}	9.48×10^{-4}

[a]Tritium imparts an equal dose to all soft tissues (i.e., all organs except bone) that is 18 percent higher than the effective whole-body dose.

Population Dose - Savannah River water is not used for drinking within 80 kilometers downstream of the Plant; therefore, the dose to the population in this area would come from fish and shellfish consumption and shoreline activities.

The decrease in the effective whole-body dose to the population within 80 kilometers of the Savannah River Plant from liquid releases of tritium associated with this cooling alternative would be 2.09×10^{-4} person-rem (Table 4-12).

The Beaufort-Jasper and Port Wentworth population groups use the Savannah River as a source of potable water. While these groups are more than 80 kilometers from the Savannah River Plant (about 100 river miles downstream), their drinking-water doses have been calculated. The decrease in the effective whole-body dose delivered to these populations (about 317,000 people are expected to consume water from the Beaufort-Jasper and Port Wentworth water-treatment plants by the year 2000) from tritium in drinking water is presented in Table 4-12.

Table 4-12. Decrease in Effective Whole-Body Collective Dose Resulting from Liquid Releases of Tritium from C-Reactor Recirculating Cooling Towers

Population group	Incremental collective dose reduction (person-rem/yr)
80-km radius	2.09×10^{-4}
Beaufort-Jasper	9.56×10^{-2}
Port Wentworth	1.81×10^{-1}
Total	2.78×10^{-1}

Overall Changes in Offsite Doses

Changes in the effective-whole-body and the most-affected-organ doses received by the maximally exposed individual resulting from the operation of this cooling alternative are summarized in Table 4-13. Changes in the effective whole-body population dose are indicated in Table 4-14.

The average background total-body dose to an individual living in the vicinity of the Savannah River Plant is 93 millirem per year. By extrapolation, the total-body dose to the 80-kilometer population is 79,200 person-rem; to the Port Wentworth water users, 18,600 person-rem; and to the Beaufort-Jasper water users, 10,900 person-rem. This cooling alternative would reduce the annual effective whole-body dose of the maximally exposed adult by 3.04×10^{-1} millirem, and that of the 80-kilometer population and the Port Wentworth and Beaufort-Jasper water users by 7.94×10^{-1}, 2.24×10^{-1}, and 1.18×10^{-1} person-rem, respectively. These changes are very small in comparison to variations in natural background radiation.

Table 4-13. Changes in Effective-Whole-Body and Small and Lower Large Intestine Doses Received by Maximally Exposed Individual Resulting from Operation of C-Reactor Recirculating Cooling Towers (millirem per year)

Source of exposure	Adult	Teen	Child	Infant
	EFFECTIVE WHOLE-BODY DOSE INCREMENT			
Atmospheric tritium releases[a]	9.15×10^{-4}	9.91×10^{-4}	6.87×10^{-4}	2.03×10^{-4}
Liquid tritium releases[a]	-1.85×10^{-3}(b)	-1.31×10^{-3}	-1.27×10^{-3}	-8.09×10^{-4}
Cesium transport	-3.03×10^{-1}	-2.32×10^{-1}	-1.01×10^{-1}	-9.75×10^{-4}
Net dose change	-3.04×10^{-1}	-2.32×10^{-1}	-1.02×10^{-1}	-1.58×10^{-3}
	SMALL AND LOWER LARGE INTESTINE DOSE INCREMENT[c]			
Atmospheric tritium releases[a]	1.08×10^{-3}	1.17×10^{-3}	8.09×10^{-4}	2.40×10^{-4}
Liquid tritium releases[a]	-2.18×10^{-3}	-1.53×10^{-3}	-1.50×10^{-3}	-9.48×10^{-4}
Cesium transport	-3.23×10^{-1}	-2.46×10^{-1}	-1.08×10^{-1}	-1.04×10^{-3}
Net dose change	-3.24×10^{-1}	-2.46×10^{-1}	-1.09×10^{-1}	-1.75×10^{-3}

[a]Tritium imparts a dose to soft tissues about 18 percent higher than to the whole body.
[b]Negative sign preceding number denotes a decrease in dose.
[c]Small and lower large intestine dose is directly comparable to soft-tissue doses resulting from tritium, because tritium imparts an equal dose to all soft tissues (i.e., all organs except bone).

Present SRP operations result in an effective whole-body dose of 5.92×10^{-2} millirem per year to the maximally exposed adult from tritium releases to the Savannah River from Four Mile Creek. This alternative would reduce the liquid tritium dose by 1.85×10^{-3} millirem per year and increase the atmospheric tritium dose by 9.15×10^{-4} millirem per year, resulting in an overall reduction of 9.35×10^{-4} millirem per year. Similarly, the current effective whole-body dose to the maximally exposed adult from cesium releases is 3.41×10^{-1} millirem per year. This alternative would reduce this dose by 3.03×10^{-1} millirem per year.

Health Effects

Risk estimators used to project health effects are 120 fatal cancers and 257 genetic effects per 1 million person-rem of collective dose. The risk estimators, by organ, are presented in Appendix G. According to these estimators

Table 4-14. Changes in Effective Whole-Body to Population Resulting from Operation of C-Reactor Recirculating Cooling Towers (person-rem per year)

Source of exposure	80-kilometer population	Beaufort Jasper	Port Wentworth	Total
Atmospheric tritium releases	4.22×10^{-2}	-	-	4.22×10^{-2}
Liquid tritium releases	-2.09×10^{-4}(a)	-9.56×10^{-2}	-1.81×10^{-1}	-2.77×10^{-1}
Cesium transport	-8.36×10^{-1}	-2.28×10^{-2}	-4.30×10^{-2}	-9.02×10^{-1}
Net dose change	-7.94×10^{-1}	-1.18×10^{-1}	-2.24×10^{-1}	1.14×10^{0}

[a]Negative sign denotes a decrease in dose.

and the organ doses presented in Appendix G, the population within 80 kilometers of the Savannah River Plant could experience a decrease of 6.49×10^{-5} cancer fatalities and 2.09×10^{-4} genetic disorders per year from the operation of this alternative cooling water system. The populations at Beaufort-Jasper and Port Wentworth downstream from the Savannah River Plant might experience decreases of 3.54×10^{-5} fatal cancer and 1.01×10^{-4} genetic disorders per year. This information is summarized in Table 4-15.

4.1.3 NO ACTION - EXISTING SYSTEM

The no-action alternative for C-Reactor would maintain the existing once-through cooling water system that withdraws water from the Savannah River and discharges it into Four Mile Creek. Chapter 3 and Appendix C describe the environmental baseline conditions that are associated with this system. This section summarizes the major environmental impacts of the existing system.

4.1.3.1 Water Quality and Hydrology

The annual average flow in Four Mile Creek downstream of the C-Reactor cooling water discharge point would continue to be about 11.3 cubic meters per second in excess of natural stream flow. The pattern of erosion upstream and deposition downstream would also continue, and the delta at the stream mouth would continue to grow.

Water temperatures in the creek downstream of the point of discharge from C-Reactor would have an annual average of about 38.5°C. Above the discharge, the mean temperature would be about 17.8°C. The highest temperatures would occur during extreme summer conditions, when the effluent would reach about 73°C, falling to about 48°C at the swamp. Ambient stream temperatures would be about 33°C at these times. In the winter months,

Table 4-15. Changes in Annual Health Effects

Population group	Genetic disorders	Fatal cancers
80-kilometer radius	-2.09×10^{-4}	-6.49×10^{-4}
Beaufort-Jasper	-3.50×10^{-5}	-1.32×10^{-5}
Port Wentworth	-6.64×10^{-5}	-2.22×10^{-5}
Total	-3.10×10^{-4}	-1.00×10^{-4}

temperatures in the creek and swamp would range from 66° to 39°C, while ambient stream temperatures would be about 9°C. These conditions would be present only when the reactor was operating. The continuation of the existing cooling water discharge from C-Reactor would not comply with the State of South Carolina's Class B water classification standards.

Lowered dissolved oxygen concentrations are an indirect effect of elevated water temperatures in the creek. Mean annual oxygen levels downstream of the discharge would be about 6.6 milligrams per liter. Concentrations frequently would fall below minimum State Class B standards (5 milligrams per liter) in portions of the creek primarily during reactor operations in the summer.

Nutrient concentrations in Four Mile Creek generally would be higher than those that would naturally occur in these waterways because of the higher concentrations of these substances in the Savannah River water used for cooling. Nitrate levels are also higher (e.g., above the discharge point) due to effluents from the upstream process areas. The thermal reaches of Four Mile Creek would display mean concentrations of total phosphorus, orthophosphates, nitrite, and Kjeldahl (total) nitrogen slightly lower than those of the Savannah River (but still higher than ambient creek levels) (Du Pont, 1985b). Ammonia concentrations in Four Mile Creek would also be slightly lower than in the river, but would still be about twice as great as those in nonthermal portions of the creek.

4.1.3.2 Ecology and Wetlands

Aquatic and adjacent terrestrial environments of Four Mile Creek would continue to be influenced by the thermal releases from C-Reactor. The flora along the creek would continue to be sparse, reflecting the influence of high flow and elevated water temperatures. In backwaters and shallow areas, thick mats of blue-green algae would continue to cover the bottom. Tag alder and wax myrtle would dominate the riparian vegetation. Further downstream toward the swamp, where the stream is braided over a marsh-like area and a few standing dead bald cypress remain, the deeper channels would be relatively free of vegetation, with thick growths of sedges along the banks. Mats of blue-green algae would also cover the shallower areas in these reaches. About 1147 acres of wetlands would continue to be affected in the Four Mile Creek floodplain and swamp; the loss of swamp and canopy would continue to proceed at the rate of approximately 28 acres per year.

Most aquatic invertebrate species would continue to be absent from the creek due both to the high water temperatures during operations and to the scouring effect of the effluent flow. In the downstream delta and swamp areas, macro-invertebrates would be present, but in lower species richness than those in comparable ambient areas. Fish would not inhabit the thermal reaches of Four Mile Creek except when the reactor is not operating or during periods when the Savannah River floods into the SRP swamp.

The fish fauna upstream of the discharge point would continue to be depauperate (i.e., poor or reduced) in both numbers and diversity. Fish would not be present in the mouth of the creek except during the winter, when they are attracted to the warm water plume, making them vulnerable to cold shock when the reactor is shut down. Fish in the Savannah River would not be affected by the discharge plume from Four Mile Creek; a year-round zone of passage around the plume would be present in the river.

High Savannah River flows would transport ichthyoplankton into thermally impacted portions of the swamp from adjacent unimpacted areas. In addition, some fish use thermally impacted areas for spawning during high river flows, because flow patterns for the heated water are altered dramatically during those periods (Du Pont, 1985b).

Waterfowl use of Four Mile Creek would continue to be associated primarily with the delta and slough areas where the creek empties into the swamp. These areas, as well as much of the Savannah River swamp near the Plant, would continue to provide foraging habitat for migratory species during fall and winter.

4.1.3.3 Entrainment and Impingement

No action would result in the continued loss of between 2.6×10^6 and 8.5×10^6 fish eggs and between 8.2×10^6 and 13.1×10^6 fish larvae each year (based on ECS, 1983; Paller et al., 1984; Paller, O'Hara, and Osteen, 1985). The principal taxa entrained as larvae would be Clupeidae (shad, herring, etc.), Centrarchidae (crappie, sunfish, etc.), and Cyprinidae (carp, etc.). The eggs of the American shad and the striped bass would be entrained most often.

The estimated average impingement on the intake screens of the 1G and 3G pump-houses (which provide cooling water to C- and K-Reactors) would range from about 15 to 24 fish per day, half of which could be attributed to C-Reactor, based on the 1982, 1983, and 1984 investigations (ECS, 1983; Paller et al., 1984; Paller and Osteen, 1985). The principal species affected would be bluespotted sunfish and threadfin shad. Redbreast sunfish and gizzard shad were also impinged frequently (Paller et al., 1984).

4.1.3.4 Endangered Species

Temperatures in the thermal region of Four Mile Creek during reactor operations would continue to exceed the critical thermal maximum for American alligators (Du Pont, 1985b). Four Mile Creek and swamp would continue to not be conducive to wood stork foraging due to its low fish densities, high water temperatures, and increased water depths. Shortnose sturgeon larvae and adults have never been collected from Four Mile Creek and neither would be expected if the no action alternative were taken.

4.2 ALTERNATIVES FOR K-REACTOR

The cooling water alternatives for K-Reactor are identical to those for C-Reactor (i.e., a once-through cooling tower, recirculating cooling towers, and no action). In many instances the expected environmental consequences resulting from construction and operation of the alternatives are also identical or similar to those discussed for C-Reactor. The following sections describe the expected environmental consequences of the alternatives for K-Reactor where different than those for C-Reactor.

4.2.1 ONCE-THROUGH COOLING TOWER

As discussed for the once-through cooling tower for C-Reactor, design evaluations and studies are in progress to optimize the performance and achieve cost savings in the construction and operation of once-through cooling towers without introducing major changes in the nature or magnitude of environmental impacts. The discussion of once-through cooling tower construction and operation impacts discusses the potential differences in the types of once-through cooling tower systems where those differences have not been previously discussed for the once-through cooling tower for C-Reactor.

4.2.1.1 Construction Impacts

Socioeconomics

Construction of the once-through cooling tower for K-Reactor would be accomplished in approximately 22 months, after a 9-month lead design period, assuming procurement for the C-Reactor cooling tower is completed prior to that for K-Reactor. Construction would involve a combined workforce for the towers in the C- and K-Areas. The estimated peak construction work for K-Reactor alone is estimated at 200 persons. As discussed for C-Reactor (Section 4.1.1.1) this would not result in any impacts to local communities or services.

Historic and Archaeological Resources

The most recent archaeological and historic resources survey of the Pen Branch watershed area, including Indian Grave Branch, was conducted from May through August 1984, as described in Appendix E. The survey study area encompassed the areas that would be disturbed by facilities associated with a once-through cooling tower (with gravity or pumped feed) for K-Reactor. The survey located 40 sites in the watershed (see Figure E-2 in Appendix E). None of the sites is in an area that would be affected by the construction of once-through cooling tower system.

Water Quality

The water quality impacts from construction of a once-through cooling tower (with pumped or gravity feed) for K-Reactor would be the same as those described for C-Reactor (Section 4.1.1.1).

Ecology

For a once-through cooling tower with pumped feed, approximately 65 acres of uplands would be disturbed by construction including about 5 acres for relocating utility lines, 35 acres for holding-pond construction, 2 acres for the cooling tower, and the remainder for the relocation of various other facilities and construction of service roads and parking areas. Construction activities are not expected to effect vegetation outside the immediate construction areas. At least 35 acres of reforested immature longleaf pine would be lost in the construction of the holding pond. An additional 20 acres of reforested upland pine/hardwood would be lost due to other construction activities.

For a once-through cooling tower with gravity feed, approximately 50 acres of uplands and bottomland hardwoods would be disturbed by the construction, including 15 acres for the gravity flow canal, 3 acres for the cooling tower, and the remaining 32 acres for the relocation of various other facilities and construction of service roads and parking areas. The construction of the discharge canal would require the removal of about 8 acres of loblolly pine seedlings and 7 acres of immature slash-pine sawtimber. The effluent canal from the cooling tower to Indian Grave Branch would require the removal of about 0.5 acre of bottomland hardwoods consisting mainly of sweet gum-nuttall oak-willow community.

The potential effects on fish and wildlife from the construction of a once-through cooling tower system would be similar to those associated with the construction of the once-through cooling tower at C-Reactor (see "Ecology" in Section 4.1.1.1).

Other Construction Impacts

Other construction impacts would be similar to those described for the once-through cooling tower system for C-Reactor (i.e., air quality, noise, solid waste, and onsite construction personnel exposure to radioactive releases). All applicable atmospheric emission standards will be met during construction, solid waste generated from construction will be disposed of in an approved manner, and fueling and maintenance of construction equipment would be performed under controlled conditions to minimize spills.

4.2.1.2 Operational Impacts

Socioeconomics

The small number of additional workers (4) associated with the operation of the once-through cooling tower at K-Reactor would not cause any noticeable socioeconomic impacts in the study area.

Historic and Archeological Resources

Operation of the once-through cooling tower (with gravity or pumped feed) would cause no impacts to historic and archaeological resources. During the operation of the cooling tower, effluent would be discharged to Indian Grave Branch, which is a tributary of Pen Branch. Expected flows in Indian Grave Branch and Pen Branch would be nearly the same as those at present, with little change in stream morphology. An archaeological and historic resources survey in the Pen Branch watershed area located no significant sites requiring impact mitigation.

Water Quality and Hydrology

The once-through cooling for K-Reactor alternative would lower the temperature in Pen Branch and the Savannah River swamp. Temperatures, even under extreme five-day average conditions, would comply with the State of South Carolina's Class B water classification standard of a maximum instream temperature of 32.2°C. The cooling effect would be very similar to that projected for Four Mile Creek for the once-through cooling-tower for C-Reactor.

Final tower design will meet the requirements stipulated for the Maximum Weekly Average Temperature (MWAT) for fish survival during a winter shutdown (EPA, 1977). Since expected ambient instream temperature during winter and spring average conditions are expected to be raised by more than 2.8°C due to operation of the cooling tower system, a Section 316(a) study would be performed after operation begins and submitted to the South Carolina Department of Health and Environmental Control in accordance with Consent Order 84-4-W. The Section 316(a) study will demonstrate whether effluent temperature conditions would ensure the protection of fish and wildlife in and on the waters affected by the discharge.

Cooling water discharges from the once-through cooling tower would raise dissolved oxygen concentrations and lower total suspended solids in the same manner as that described for C-Reactor once-through cooling tower. Effluents discharged would be similar to those associated with the present once-through system except some constituents would be slightly more concentrated due to evaporation in the tower. Discharges would meet all NPDES permit limits. When K-Reactor is not operating, the concentrations of chemical pollutants in Pen Branch would not change appreciably in the absence of the cooling water discharge because the stream meets State Class B water classification standards under these conditions (see Section 3.3.3 and Du Pont, 1985b).

Operation of the once-through cooling tower system would result in the same small changes in the hydrology of Pen Branch and the associated swamp as those described for C-Reactor. The changes would not adversely impact the stream system because the flow would be reduced only about 0.9 cubic meters per second when the reactor is operating. When K-Reactor is not operating the stream flow in Indian Grave Branch and Pen Branch will continue to be reduced from 11.3 to as low as 0.03 cubic meter per second. The subsurface hydrology in the vicinity of the holding pond (pumped feed) would also not be affected significantly.

The major difference between the pumped-feed and gravity-feed cooling-tower systems is the location of the discharge. For the gravity-feed system, the discharge point would be located about 2 kilometers further downstream Indian Grave Branch than the pumped-feed system. This 2-kilometer upstream section would revert to ambient flow conditions if the gravity-feed system were to be implemented.

Air Quality

Operation of a once-through cooling tower at the K-Reactor would have similar air quality impacts to those for the once-through cooling tower for C-Reactor.

The predicted maximum annual mean frequency of reduced ground-level visibility would be approximately 5 hours per year, occurring at 15 kilometers northwest of the once-through cooling tower for K-Reactor. Major roads affected would be SRP Roads A, C, D, 1, and South Carolina Highway 125. The predicted annual-mean frequencies of reduced ground-level visibility to less than 1000 meters would be less than 2 hours per year for all directions within 2 kilometers of the cooling tower. The maximum ice accumulation on horizontal surfaces would be no more than 1 millimeter beyond 0.8 kilometer in all directions from the cooling tower. The maximum predicted ice thickness would be 7 millimeters, occurring within 0.4 kilometer from the tower, with a total frequency of 138 hours per winter season.

The maximum occurrence of visible plumes aloft would be 75 hours per year in the immediate vicinity (0.4 kilometer) of the cooling tower. The plumes would be visible from SRP roads within 2 kilometers of the tower, for approximately 50 hours per year.

Figure 4-1 shows the isopleths of annual total solids deposition due to the operation of the once-through mechanical-draft cooling tower with pumped feed for K-Reactor.

The maximum annual total-solids deposition would be about 2.3 kilograms (5.1 pounds) per acre per year within 0.2 kilometer of the tower in all directions. At 2 kilometers, the predicted solids deposition is calculated to be about 1.0 kilograms (2.2 pounds) per acre per year.

Due to the different location of the gravity feed cooling tower (southwest of K-Reactor), the impacted areas would be slightly different with this

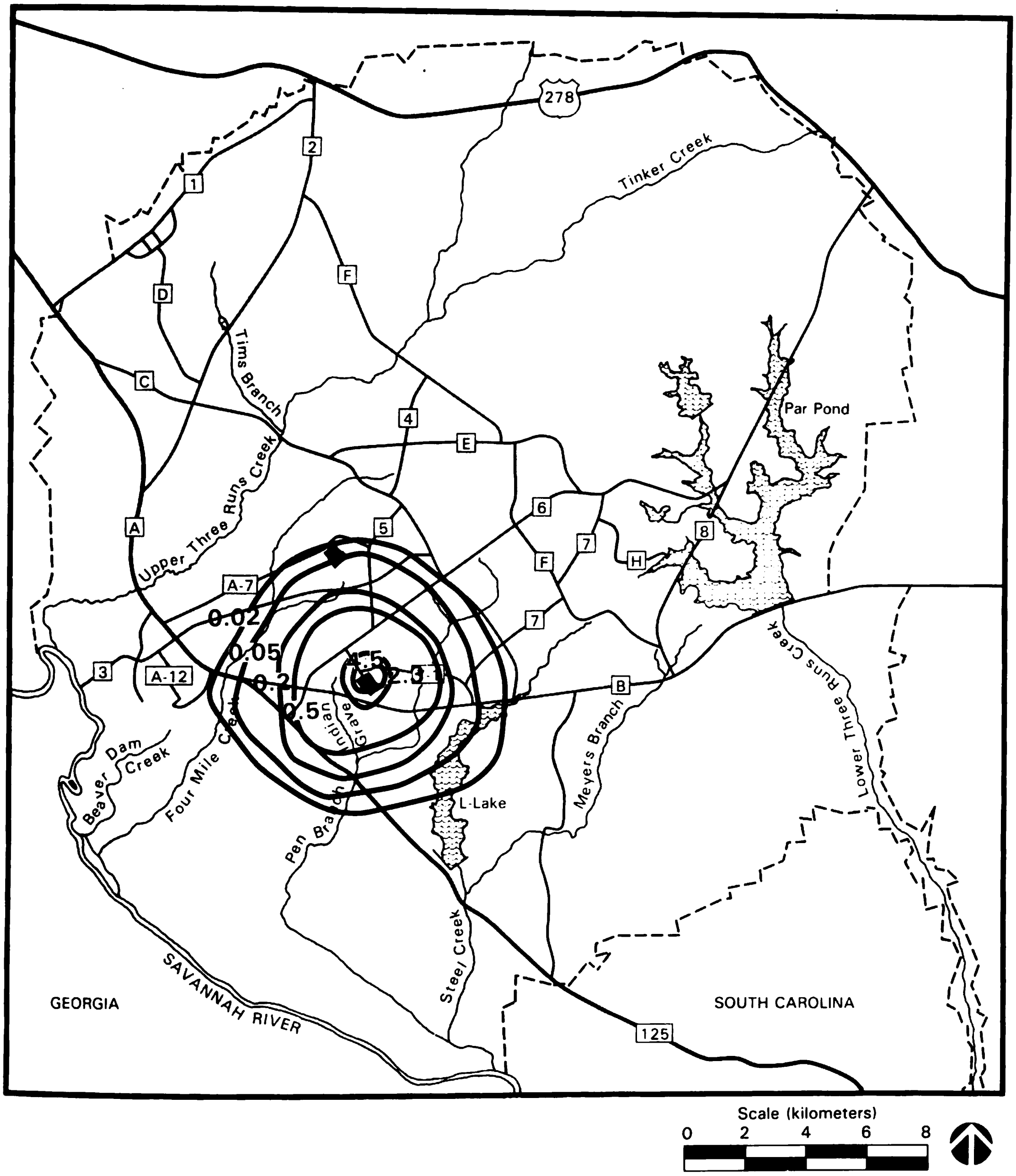

Figure 4-1. K-Reactor Once-Through Tower, Total Solids Deposition, Kilograms/Acre/Year

alternative from those associated with the pumped-feed once-through tower, with the isopleths shifted toward the south and southwest of the K-Reactor, without any change in the maximum release values near the towers.

The air quality impacts, including ground-level fogging, icing, and salt deposition from natural draft towers would generally be less than those of mechanical draft towers with an exception of increased frequencies for visible plumes.

Noise

During the operation of a once-through mechanical-draft cooling tower with pumped feed for K-Reactor, increases in noise levels would occur in each area due to the operation of the cooling tower and pumps; the impacts would be similar to those described for C-Reactor.

Noise impacts of operation of the once-through cooling tower with gravity feed would be less than those associated with the once-through cooling tower with pump feed because there would not be any pumps operating which would contribute to increased noise levels. There would be no differences in noise levels between a mechanical- or a natural-draft tower.

Ecology

Vegetation and Wetlands

Deposition of cooling tower drift from a once-through cooling tower with pumped or gravity feed for K-Reactor would be similar to that projected for the once-through cooling tower for C-Reactor, with the exception that higher deposition rates [about 2.3 kilograms (5.1 pounds) per acre per year] would occur within 0.2 kilometer of the tower due to differences in local meteorological conditions. The rates at 2 kilometers would be the same as those estimated for C-Reactor [about 1.0 kilogram (2.2 pounds) per acre per year]. No impacts on vegetation are expected since maximum deposition rates are well below critical values.

The most significant impact on the vegetation resulting from operation of a once-through cooling tower system would be a reduction in the loss of wetland habitat due to thermal discharges. Because the stream would still be subject to variable flows, there would be incomplete reestablishment of upstream wetland communities along Indian Grave Branch and Pen Branch. From 1955 through 1984, about 680 acres of wetlands were affected in the Pen Branch floodplain and swamp due to thermal discharges and flooding (Du Pont, 1985b; Appendix F), with an average loss of about 26 acres per year in the swamp. The operation of a once-through cooling-tower system would eliminate additional losses in the stream corridor. Thermal effects are one of the three major factors (the others are flooding from reactor operation and river flooding) responsible for continuing swamp canopy loss (Du Pont, 1985b). The reduction in effluent temperatures would, therefore, have a positive effect on wetland communities by significantly reducing wetland loss rates.

To identify the value of habitat to be lost or gained and to assess the need for further mitigation, a Habitat Evaluation Procedure (HEP) analysis is currently being prepared to assist in ongoing consultations with the U.S. Fish and Wildlife Service.

Aquatic Habitat

The impacts of a once-through cooling tower system on fish and aquatic habitat in Indian Grave Branch and Pen Branch would be similar to those described for the C-Reactor once-through cooling tower.

Entrainment and Impingement

Operation of the once-through cooling-tower would not require any changes to the intake structure cooling water flow rates. Accordingly, expected entrainment and impingement impacts would be similar to current impacts for K-Reactor.

The entrainment rates at the 1G and 3G intakes, as determined by onsite studies (based on ECS, 1983; Paller et al., 1984; Paller, O'Hara, and Osteen, 1985), result in the loss of approximately 16.5×10^6 to 26.2×10^6 fish larvae during the April-to-July spawning season at the Plant. Estimated losses of fish eggs during this period range from 5.3×10^6 to 16.9×10^6 each year. Because about 50 percent of the water drawn into the two intakes is used for cooling K-Reactor, about half the eggs (2.6×10^6 to 8.5×10^6) and larvae (8.2×10^6 to 13.1×10^6) losses can be attributed to the operation of this facility. The taxonomic groups whose larvae are most impacted by entrainment through the 1G and 3G intakes are the Clupeidae (shad, herring, etc., always greater than 50 percent of the total), the Centrarchidae (crappie, sunfish, etc.), and the Cyprinidae (carp, etc.). The eggs of the American shad and the striped bass were entrained most often and accounted for 70 percent of all eggs entrained.

Current levels of impingement at the 1G and 3G intakes would not be expected to change with the operation of a once-through cooling tower. The 1982, 1983, and 1984 studies at the site indicate that 179, 2300, and 1840 fish were impinged on 12, 98, and 107 sampling dates, respectively by the two intakes combined (ECS, 1983; Paller et al., 1984; Paller and Osteen, 1985). The projected average impingement rate based on these investigations ranged from 15 to about 24 fish per day, about half of which can be attributed to K-Reactor operations. The species caught most often are the bluespotted sunfish, threadfin shad, redbreast sunfish, and gizzard shad.

Endangered Species

Several inactive red-cockaded woodpecker colonies are located in the Pen Branch area. However, because this species lives in mature pine forests rather than wetland or bottomland hardwoods near the creek, the operation of the once-through cooling tower would not impact the habitat of this endangered woodpecker.

The endangered American alligator occurs on the SRP site in both flowing-water and lake environments. Temperatures in the thermal region of Pen Branch under present operating conditions are higher than 50°C in the summer, which exceeds the critical thermal maximum of 38°C for the alligator. Thus, alligators cannot inhabit major portions of the stream during reactor operation. The implementation of this alternative would lower the water temperature in Pen Branch to approximately 24°C during winter months and to 30°C in the summer, values which would be well below the alligator's maximum critical temperature. This alternative would produce no adverse impacts on the American alligator in Pen Branch; it is expected to provide additional habitat for this species.

As discussed for C-Reactor, the implementation of a once-through cooling tower for K-Reactor would produce no adverse impacts on the shortnose sturgeon.

Endangered wood storks from the Birdsville colony forage in the SRP swamps. On July 2, 1983, 24 wood storks were observed foraging just north of the Pen Branch delta (Du Pont, 1985b). However, low fish densities, high water temperatures, and increased water depths from reactor flows limit the value of this habitat for wood storks. Impacts to Pen Branch wood stork habitat resulting from the implementation of this alternative would be similar to those for the implementation of the same alternative for C-Reactor. The stream would be more attractive to fish and other vertebrates. The implementation of this alternative would not destroy any wood stork habitat and could enhance foraging habitat in Pen Branch during reactor down times.

Consultations with the U.S. Fish and Wildlife Service (FWS) on the American alligator, red-cockaded woodpecker, and wood stork are in progress. The need for preparation of a biological assessment for each of these species will be determined through this formal consultation process. The National Marine Fisheries Service (NMFS) has previously concurred in DOE's determination that the population of shortnose sturgeon in the Savannah River would not be affected adversely by SRP operations (Oravetz, 1983).

Radiological Releases

The radiological releases associated with the discharge of cooling water from K-Reactor are those resulting from either the remobilization of radionuclides contained in the Indian Grave Branch and Pen Branch streambeds and floodplains, or those resulting from small process water leaks into the cooling water in the reactor's heat exchangers and releases into the process sewer.

The operation of the once-through cooling tower (either mechanical draft or natural draft) would not result in any significant changes in the remobilization of radionuclides contained in the streambeds and floodplains, because the flow rate of cooling water discharged to the creek would remain essentially unchanged. The operation of the once-through cooling tower, however, would decrease the amount of tritium discharged to streams and correspondingly increase the amount of tritium released to the atmosphere because of evaporation from the cooling tower. The following sections present a discussion of changes in the doses to the maximally exposed individual at the site boundary and to offsite population groups (based on year 2000 projections) that are attributable to the change in atmospheric and liquid releases of tritium resulting from operation of the once-through cooling tower.

A once-through mechanical draft cooling tower with gravity feed would have essentially the same doses as those discussed in the following sections for a once-through mechanical draft cooling tower with pumped feed. The gravity-feed cooling tower would cause a slightly higher dose to the maximum individual at the site boundary since the gravity-feed cooling tower is closer to the SRP boundary; however, the change in dose is negligible. A natural-draft tower would also result in atmospheric doses to the maximum individual that would be slightly higher than a mechanical-draft tower because of the higher release height of the natural-draft tower. This difference in doses is also negligible.

Details of the dose assessment methodology and parameters are discussed in Appendix G which also includes tables showing specific organ doses by pathway and age group.

Atmospheric Releases

The amount of tritium released annually to the atmosphere is expected to increase by 50 curies as a result of evaporation experienced during cooling, or the same as that for the once-through mechanical-draft cooling tower for C-Reactor. Changes in dose commitments resulting from the increased release of atmospheric tritium are summarized below.

Maximum Individual Dose - The hypothetical individual who would receive the highest effective whole-body dose from atmospheric releases associated with this cooling alternative is assumed to reside continuously at the SRP boundary about 8.8 kilometers west of K-Reactor. The selection of this location was based on distance to the plant boundary and meteorological dispersion characteristics. This individual is assumed to receive the doses by inhalation and by the ingestion of meat, vegetation, and cow's milk.

The annual increase in soft-tissue and effective whole-body doses to the maximally exposed individual due to the atmospheric release of tritium is summarized in Table 4-16.

Population Dose - Collective doses resulting from atmospheric releases associated with this cooling alternative are calculated for the population within 80 kilometers of the Plant. The annual collective dose to this population would increase by 4.97×10^{-3} person-rem as a result of the increase in tritium released to the atmosphere.

Liquid Releases

The operation of the once-through cooling tower would reduce the amount of tritium released to the stream. The release of tritium would be decreased by 50 curies per year as a result of evaporation experienced during cooling, or the same as the once-through mechanical-draft cooling tower for C-Reactor. Doses associated with the change in liquid releases for both the population and the maximally exposed individual would be the same as shown on Tables 4-3 and 4-4 for the once-through mechanical-draft cooling tower with pumped feed for C-Reactor.

Table 4-16. Increase in Annual Doses to Maximally Exposed Individual Resulting from Atmospheric Releases of Tritium from K-Reactor Once-Through Cooling Tower (Pumped Feed)

Age group	Incremental dose increase (mrem/yr) Effective whole body	All soft tissue[a]
Adult	1.05×10^{-4}	1.23×10^{-4}
Teen	1.14×10^{-4}	1.34×10^{-4}
Child	7.86×10^{-5}	9.24×10^{-5}
Infant	2.33×10^{-5}	2.74×10^{-5}

[a]Tritium imparts an equal dose to all soft tissues (i.e., all organs except bone) that is 18 percent higher than the effective whole body dose.

Overall Changes in Offsite Doses

Changes in the effective whole-body dose received by the maximally exposed individual resulting from the operation of this cooling alternative are summarized in Table 4-17. Changes in the collective dose are the same as described in Section 4.1.1.2, Table 4-6, for C-Reactor.

The average background total-body dose to an individual living in the vicinity of the Savannah River Plant is 93 millirem per year. By extrapolation, the total-body dose to the 80-kilometer population is 79,200 person-rem; to the Port Wentworth water users, 18,600 person-rem; and to the Beaufort-Jasper water users, 10,900 person-rem.

This cooling alternative would reduce the annual dose to the effective whole body of the maximally exposed adult and to Port Wentworth and Beaufort-Jasper water users by 1.14×10^{-4} millirem, 2.13×10^{-2} person-rem, and 1.13×10^{-2} person-rem, respectively, and increase the dose to the 80-kilometer population by 4.95×10^{-3} person-rem. These dose changes are very small compared with the normal variations in natural background radiation.

Present SRP operations result in an effective whole-body dose of 5.18×10^{-2} millirem per year to the maximally exposed adult from tritium releases to the Savannah River from Indian Grave Branch and Pen Branch. This alternative would reduce the liquid tritium dose by 2.19×10^{-4} millirem per year and increase the atmospheric dose by 1.05×10^{-4} millirem per year, resulting in an overall reduction of 1.14×10^{-4} millirem per year.

Table 4-17. Changes in Effective Whole-Body Dose Received by Maximally Exposed Individual Resulting from Operation of K-Reactor Once-Through Cooling Tower (Pumped Feed) (Millirem per Year)[a]

Source of exposure	Adult	Teen	Child	Infant
Atmospheric tritium releases	1.05×10^{-4}	1.14×10^{-4}	7.86×10^{-5}	2.33×10^{-5}
Liquid tritium releases	-2.19×10^{-4}[b]	-1.54×10^{-4}	-1.50×10^{-4}	-9.52×10^{-5}
Net dose change	-1.14×10^{-4}	-4.00×10^{-5}	-7.14×10^{-5}	-7.19×10^{-5}

[a]Tritium imparts a dose to soft tissues (i.e., all organs except bone) that is about 18 percent higher than the effective whole-body dose.
[b]Negative sign denotes a decrease in dose.

Health Effects

The change in annual health effects, based on the risk estimators and organ doses presented in Appendix G, would be the same as those discussed for the C-Reactor and listed in Table 4-7.

4.2.2 RECIRCULATING COOLING TOWERS

4.2.2.1 Construction Impacts

Socioeconomics

Construction of the recirculating cooling towers for K-Reactor would be accomplished in approximately 28 months after a 9 month lead design period and assuming that procurement for the recirculating cooling towers for C-Reactor is completed prior to that for K-Reactor. Construction would involve a combined construction workforce for the cooling towers in C- and K-Areas.

Section 4.1.2.1, contains an analysis of the numbers and general types of workers required for construction of recirculating cooling towers for both C- and K-Reactors. This alternative would not impact local communities or services.

Historic and Archaeological Resources

No sites within the Pen Branch and Indian Grave Branch watershed area would be affected by the construction of recirculating cooling towers.

Water Quality

The construction impacts of recirculating cooling towers on the water quality in Indian Grave Branch and Pen Branch would be the same as those described for once-through cooling tower for C-Reactor (Section 4.1.1.1). The principal impact would be some temporary localized increases in the suspended solids in the streams due to runoff and erosion from construction activities. The application of standard erosion control practices would minimize these temporary effects.

Ecology

The construction of recirculating cooling towers would disturb about 55 acres of upland forest (20 acres for the holding pond, 3 acres for the cooling towers, and the remainder for relocation of various facilities and for the construction of service roads and parking areas). No adverse effects on vegetation are expected outside the immediate construction areas. The construction of the holding pond would require the removal of 25 acres of immature slash pine pole timber. An additional 30 acres of reforested pine/hardwood and open fields would be impacted by other construction activities. Impacts on fish and wildlife from the construction of recirculating cooling towers would be similar to those associated with the construction of a once-through cooling tower.

Other Construction Impacts

Other construction impacts would be similar to those described for the once-through cooling tower system for C-Reactor. (i.e., air quality, noise, solid waste, and outside construction personnel exposure to radioactive releases) All applicable atmospheric emission standards will be met during construction, solid waste generated from construction will be disposed of in an approved manner, and fueling and maintenance of construction equipment would be performed under controlled conditions to minimize spills.

4.2.2.2 Operational Impacts

Socioeconomics

Six additional mechanics would be required to support the operation of the recirculating cooling towers at K-Reactor; these workers would not cause any socioeconomic impacts in the study area.

Historic and Archeological Resources

Operational activities related to the recirculating cooling towers for K-Reactor would not impact any historic and archaeological resources. During the operation of the towers, cooling water effluent flows in Indian Grave Branch and Pen Branch would be significantly reduced. An archaeological and historic resources survey in the Pen Branch watershed area located no significant sites requiring impact mitigation.

Water Quality and Hydrology

The operation of recirculating cooling towers on water quality would be similar to those described for recirculating cooling towers at C-Reactor (see Section 4.1.2.2). All effluent discharges would meet NPDES permit requirements and Class B water classification standards. Flow impacts to the stream hydrology of Indian Grave Branch and Pen Branch would be reduced from 11.3 to 1.7 cubic meters per second, similar to those described for Four Mile Creek with operation of recirculating towers for C-Reactor (see Section 4.1.2.2).

Air Quality

Air quality impacts from the operation of recirculating cooling towers at the K-Reactor would be similar to those addressed in Section 4.1.1.2 for the once-through cooling tower.

The calculated maximum annual-mean frequency of reduced ground-level visibility to less than 1000 meters would be 1 hour per year, occurring from approximately 3 to 22 kilometers southeast of the recirculating cooling towers and more than 7 kilometers northwest, north-northwest, and north of the towers. The maximum ice accumulation on horizontal surfaces would be no more than 1 millimeter beyond 0.8 kilometer in all directions from the towers. The maximum predicted horizontal-ice thickness would be about 6 millimeters, occurring within 0.4 kilometer from the towers with a total frequency of 500 hours per winter season.

The maximum occurrence of visible plumes aloft would be 100 hours per year within 0.4 kilometer from the cooling towers.

Figure 4-2 shows the isopleths of annual total solids deposition due to the operation of the K-Reactor recirculating tower. The maximum annual total-solids deposition is predicted to be about 22.7 kilograms (50.7 pounds) per acre per year within 0.8 kilometer from the cooling towers. At 2 kilometers, the predicted solids deposition is calculated to be about 6 kilograms (13.2 pounds) per acre per year.

Noise

During the operation of the K-Reactor recirculating cooling towers, increases in noise levels would occur due to the operation of the cooling towers and pumps; the impacts would be similar to those described for the once-through cooling tower for C-Reactor in Section 4.1.1.2.

Ecology

Vegetation and Wetlands

The vegetation near the recirculating cooling towers would not be adversely impacted by drift from the towers. Operation of the recirculating cooling towers would result in an estimated total solids deposition of about 6 kilograms (13.2 pounds) per acre per year within 2 kilometers and 22.7 kilograms

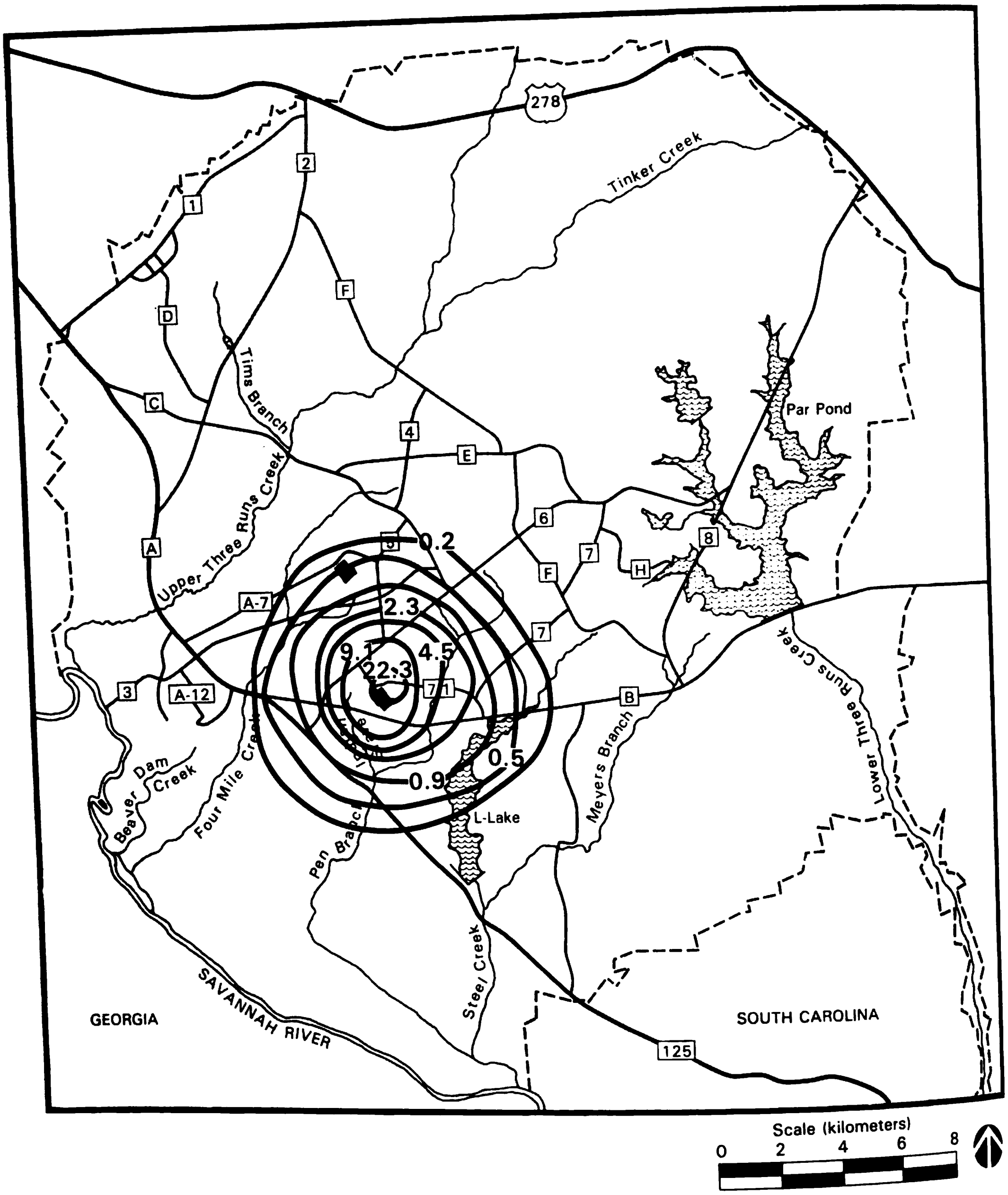

Figure 4-2. K-Reactor Recirculating Towers, Total Solids Deposition, Kilograms/Acre/Year

(50.1 pounds) per acre per year with 0.8 kilometer of the cooling towers. Since these rates are much less than the critical values reported, no significant impacts on vegetation are expected with this alternative.

The primary ecological impact on vegetation would be a reduction in the loss of wetland habitat due to reductions in discharge temperature and flow. K-Reactor operations have affected about 680 acres of wetlands in the floodplain and swamp (Du Pont, 1985b; Appendix F). Operation of the recirculating cooling towers would reduce the rate of growth of the delta. Reestablishment of vegetation through the process of natural succession would occur for approximately 500 acres of wetland habitat along the creek corridor and swamp.

Aquatic Habitat

The impacts of recirculating cooling towers on fishery resources aquatic habitat in Indian Grave Branch, Pen Branch, and the delta/swamp area would be similar to those described in Section 4.1.2.2 for the C-Reactor recirculating cooling-towers.

Entrainment and Impingement

Impacts on entrainment and impingement of fish eggs and larvae with implementation of this alternative for K-Reactor would be similar to those described for the C-Reactor recirculating cooling-towers in Section 4.1.2.2.

Endangered Species

Impacts of the recirculating cooling towers on endangered species would be similar to those described for the once-through cooling tower for K-Reactor (Section 4.2.1.2). The major difference would be in the reduced discharge flow from about 11.3 to about 0.6 cubic meter per second; this would allow the stream channel to revert approximately to its original width and would allow fish and invertebrates to inhabit the stream channel. This, in turn, would improve foraging habitat for the wood stork and provide potential habitat for the American alligator.

Consultations with the U.S. Fish and Wildlife Service concerning endangered species are in progress.

Radiological Releases

Remobilization of Radionuclides

The operation of recirculating cooling towers would reduce the flow rate of cooling water in Indian Grave Branch and Pen Branch, and, therefore, decrease the amount of radionuclides being remobilized from the creek bed and transported to the Savannah River. The only radionuclides contained in the Indian Grave Branch and Pen Branch beds in significant amounts are cesium-134 and cesium-137 (Appendix D). The reduced flow would result in a decrease of about 0.43 curie of cesium-134 and 0.18 curie of cesium-137 released per year to the Savannah River.

Maximum Individual Dose - The individual who would experience the greatest change in dose from cesium-137 remobilization is assumed to live near the Savannah River downstream from the Savannah River Plant. This individual is assumed to use river water regularly for drinking, to consume fish from the river, and to experience external exposures from shoreline activities. This individual is also assumed to drink more water and eat more fish than an average person.

The changes in effective-whole-body and most-affected-organ (small and lower large intestine) doses to the maximally exposed individual resulting from the decrease in cesium-137 released to the Savannah River are presented in Table 4-18.

Table 4-18. Decrease in Doses to Maximally Exposed Individual Resulting from Cesium-137 Redistribution Associated with K-Reactor Recirculating Cooling Towers

	Incremental dose reduction (mrem/yr)	
Age group	Effective whole body	Small and lower large intestine[a]
Adult	4.51×10^{-1}	4.86×10^{-1}
Teen	3.44×10^{-1}	3.70×10^{-1}
Child	1.50×10^{-1}	1.61×10^{-1}
Infant	1.45×10^{-3}	1.56×10^{-3}

[a]Dose to small and lower large intestine is directly comparable to soft tissue doses resulting from tritium since tritium impacts an equal dose to all soft tissues (i.e., all organs except bone).

Population Dose - Savannah River water is not used for drinking within 80 kilometers downstream of the Plant; therefore, the dose to the population in this area would come from fish and shellfish consumption, and shoreline activities.

The Beaufort-Jasper and Port Wentworth population groups use the Savannah River as a source of potable water. While these groups are more than 80 kilometers downstream of the Savannah River Plant (about 100 river miles downstream), their drinking-water doses have been calculated.

According to projections, by the year 2000 some 852,000 people will reside within 80 kilometers of the Savannah River Plant, 117,000 will consume water from the Beaufort-Jasper water-treatment plant, and another 200,000 will consume water from the Port Wentworth water-treatment plant. The decreases in the collective doses delivered to these population groups are presented in Table 4-19.

Table 4-19. Decrease in Effective Whole-Body Collective Dose Resulting from Cesium Redistribution Associated with K-Reactor Recirculating Cooling Towers

Population group	Incremental collective dose reduction (person-rem/yr)
80-km population	1.24×10^{0}
Beaufort-Jasper	3.39×10^{-2}
Port Wentworth	6.40×10^{-2}
Total	1.34×10^{0}

Tritium Releases

The following sections present a discussion of changes in the doses to the maximally exposed individual at the site boundary and to offsite population groups (based on year 2000 projections) that are attributable to the change in atmospheric and liquid releases to Indian Grave Branch and Pen Branch of tritium resulting from operation of the recirculating cooling tower.

Atmospheric Releases - The amount of tritium released annually to the atmosphere is expected to increase by 425 curies or the same as that for recirculating cooling towers for C-Reactor. Changes in dose commitments resulting from the increased release of atmospheric tritium are summarized below.

Maximum Individual Dose - The hypothetical individual who would receive the highest effective whole-body dose from atmospheric releases associated with this cooling alternative is assumed to reside continuously at the SRP boundary about 8.8 kilometers west of the K-Reactor. The selection of this location was based on distance to the plant boundary and meteorological dispersion characteristics. This individual is assumed to receive the doses by inhalation and by the ingestion of meat, vegetation, and cow's milk.

The annual increase in soft-tissue and effective whole-body doses received by the maximally exposed individual due to the atmospheric release of tritium is summarized in Table 4-20.

Population Dose - Collective doses resulting from atmospheric releases associated with this cooling alternative are calculated for the population within 80 kilometers of the Savannah River Plant. The annual collective dose to this population would increase by 4.22×10^{-2} person-rem as a result of the increase in tritium released to the atmosphere.

Table 4-20. Increase in Annual Doses to Maximally Exposed Individual Resulting from Atmospheric Releases of Tritium from K-Reactor Recirculating Cooling Towers[a]

Age group	Incremental dose increase (mrem/yr)	
	Effective whole body	All soft tissues[a]
Adult	8.92×10^{-4}	1.05×10^{-3}
Teen	9.65×10^{-4}	1.13×10^{-3}
Child	6.69×10^{-4}	7.87×10^{-4}
Infant	1.98×10^{-4}	2.32×10^{-4}

[a]Tritium imparts an equal dose to all soft tissues (i.e., all organs except bone) that is 18 percent higher than the effective whole-body dose.

Liquid Releases - The operation of this cooling alternative would reduce the amount of radioactivity released to streams by 425 curies per year, or the same as that for the recirculating cooling towers for C-Reactor. Doses associated with the change in liquid releases are discussed below for both the population and the maximally exposed individual.

Maximum Individual Dose - The hypothetical individual who would experience the greatest change in dose from liquid effluents is assumed to live near the Savannah River downstream from the Savannah River Plant. This individual is assumed to use river water regularly for drinking, to consume fish from the river, and to experience external exposures from shoreline activities. This individual is also assumed to drink more water and eat more fish than an average person.

The annual decrease in soft-tissue and effective whole-body doses received by the maximally exposed individual due to a decrease in the release of tritium to streams would be the same as discussed for the recirculating cooling towers for C-Reactor and listed on Table 4-11.

Population Dose - The decrease in the effective whole-body dose to the population within 80 kilometers and the Beaufort-Jasper and Port Wentworth population groups would the same as discussed for the recirculating cooling towers for C-Reactor and listed in Table 4-12.

Overall Changes in Offsite Doses

Changes in the effective-whole-body and most-affected-organ doses received by the maximally exposed individual resulting from the operation of this cooling alternative are summarized in Table 4-21. Changes in the effective whole-body population dose are listed in Table 4-22.

Table 4-21. Changes in Effective Whole-Body and Small and Lower Large Intestine Doses Received by Maximally Exposed Individual Resulting from Operation of K-Reactor Recirculating Cooling Towers (Millirem per Year)

Source of exposure	Adult	Teen	Child	Infant
	EFFECTIVE WHOLE-BODY DOSE INCREMENT			
Atmospheric tritium releases[a]	8.92×10^{-4}	9.65×10^{-4}	6.69×10^{-4}	1.98×10^{-4}
Liquid tritium releases[a]	-1.85×10^{-3}[(b)]	-1.31×10^{-3}	-1.27×10^{-3}	-8.09×10^{-4}
Cesium transport	-4.51×10^{-1}	-3.44×10^{-1}	-1.50×10^{-1}	-1.45×10^{-3}
Net dose change	-4.52×10^{-1}	-3.44×10^{-1}	-1.51×10^{-1}	-2.06×10^{-3}
	SMALL AND LOWER LARGE INTESTINE DOSE INCREMENT[c]			
Atmospheric tritium releases[a]	1.05×10^{-3}	1.13×10^{-3}	7.87×10^{-4}	2.32×10^{-4}
Liquid tritium releases[a]	-2.18×10^{-3}	-1.53×10^{-3}	-1.50×10^{-3}	-9.48×10^{-4}
Cesium transport	-4.86×10^{-1}	-3.70×10^{-1}	-1.61×10^{-1}	-1.56×10^{-3}
Net dose change	-4.87×10^{-1}	-3.70×10^{-1}	-1.62×10^{-1}	-2.28×10^{-3}

[a] Tritium imparts a dose to soft tissues (i.e., all organs except bone) that is about 18 percent higher than the effective whole-body dose.
[b] Negative sign preceding number denotes a decrease in dose.
[c] Small and lower large intestine dose is directly comparable to soft tissue doses resulting from tritium since tritium imparts an equal dose to all soft tissues (i.e., all organs except bone).

The average background total-body dose to an individual living in the vicinity of the Savannah River Plant is 93 millirem per year. By extrapolation, the total-body dose to the 80-kilometer population is 79,200 person-rem; to the Port Wentworth water users, 18,600 person-rem; and to the Beaufort-Jasper water users, 10,900 person-rem. This cooling alternative would reduce the annual effective whole-body dose of the maximally exposed adult by 4.52×10^{-1} millirem, and that of the 80-kilometer population and the Port Wentworth and Beaufort-Jasper water users by 1.20×10^{0}, 2.45×10^{-1}, and 1.30×10^{-1} person-rem, respectively. These changes are very small compared with normal variation in natural background radiation.

Present SRP operations result in an effective whole-body dose of 5.18×10^{-2} millirem per year to the maximally exposed adult from tritium releases to the Savannah River from Indian Grave Branch and Pen Branch. This alternative would reduce the liquid tritium dose by 1.85×10^{-3} millirem per year and increase

Table 4-22. Changes in Effective Whole-Body Dose to Population Resulting from Operation of K-Reactor Recirculating Cooling Towers (Person-rem per Year)

Source of exposure	80-kilometer population	Beaufort Jasper	Port Wentworth	Total
	EFFECTIVE WHOLE-BODY DOSE INCREMENT			
Atmospheric tritium releases	4.22×10^{-2}	-	-	4.22×10^{-2}
Liquid tritium releases	-2.09×10^{-4}(a)	-9.56×10^{-2}	-1.81×10^{-1}	-2.77×10^{-1}
Cesium transport	-1.24×10^{0}	-3.39×10^{-2}	-6.40×10^{-2}	-1.34×10^{0}
Net dose change	-1.20×10^{0}	-1.30×10^{-1}	-2.45×10^{-1}	-1.57×10^{0}

[a]Negative sign preceding number denotes decrease in dose.

the atmospheric tritium dose by 8.92×10^{-4} millirem per year, resulting in an overall reduction of 9.58×10^{-4} millirem per year. Similarly, the effective whole-body dose to the maximally exposed adult from cesium-137 releases is 4.86×10^{-1} millirem per year. This alternative would reduce this dose to 4.51×10^{-2} millirem per year.

Health Effects

Risk estimators used to project health effects are 120 fatal cancers and 257 genetic effects per 1 million person-rem of collective dose. According to these estimators and the organ doses presented in Appendix G, the population within 80 kilometers of the Savannah River Plant could experience a decrease of 9.90×10^{-5} cancer fatalities and 3.19×10^{-4} genetic disorders per year from the operation of this thermal-mitigation system. The populations at Beaufort-Jasper and Port Wentworth downstream from the Savannah River Plant might experience decreases of 4.09×10^{-5} fatal cancers and 1.10×10^{-4} genetic disorders per year. This information is summarized in Table 4-23.

4.2.3 NO ACTION - EXISTING SYSTEM

The no-action alternative for K-Reactor would maintain the existing once-through cooling water system that withdraws water from the Savannah River (via the 1G and 3G intakes) and discharges it into Pen Branch via Indian Grave Branch. Chapter 3 and Appendix C describe the environmental baseline conditions associated with this system. This section summarizes the major environmental impacts of the existing system.

Table 4-23. Changes in Annual Health Effects

Population group	Genetic disorders	Fatal cancers
80-kilometer radius	-3.19×10^{-4}	-9.90×10^{-5}
Beaufort-Jasper	-3.81×10^{-5}	-1.41×10^{-5}
Port Wentworth	-7.21×10^{-5}	-2.68×10^{-5}
Total	-4.29×10^{-4}	-1.40×10^{-4}

4.2.3.1 Water Quality and Hydrology

The average flow in Pen Branch when K-Reactor is operating would continue to be about 11.3 cubic meters per second in excess of natural stream flow of 0.28 cubic meter per second.

Maximum water temperatures of the discharge would reach 73°C during extreme summer conditions with water temperatures at the delta about 52°C and ambient stream temperatures would be 33°C. Under average winter conditions, temperatures along Pen Branch would range from 66°C at the discharge point to 43°C in the delta. These conditions would be present only when K-Reactor was in operation. The continuation of the existing cooling water discharge from K-Reactor would not comply with the State of South Carolina's Class B water classification standards.

Dissolved oxygen concentrations would continue to be depressed in Indian Grave Branch and Pen Branch during reactor operations because of the elevated water temperatures. Concentrations in Indian Grave Branch just below the reactor discharge point would be expected to average about 5.4 milligrams per liter. The mean concentration in Pen Branch would be about 5.7 milligrams per liter, with a range of 3.3 to 11.1 milligrams per liter. Values occasionally would fall below minimum State Class B water classification standards (5 milligrams per liter) in both streams.

Generally, nutrient concentrations in the thermal reaches of the two streams would continue to be higher than in nonthermal reaches of the streams, due to inputs of nutrient-rich Savannah River water.

4.2.3.2 Ecology and Wetlands

The aquatic and terrestrial communities in and along Indian Grave Branch and Pen Branch would continue to be influenced largely by the heated discharges from K-Reactor. Blue-green algal mats, similar to those in Four Mile Creek, would continue to cover much of the sand and silt substrate in Pen Branch. Riparian vegetation would include sedges, grasses, wax myrtle, and buttonbush, while duckweed would be abundant in the many side pools and channels. The delta region of the stream would be characterized by an open and closed canopy of living and dead bald cypress and tupelo. A total of about 680 acres of wetlands would continue to be affected in the Pen Branch floodplain and delta; canopy losses would continue at the rate of about 26 acres per year.

Most aquatic invertebrate species would be absent from Indian Grave Branch and Pen Branch during reactor operations (DOE, 1984). Benthic invertebrate species would be more abundant in the delta area than in the main channel of Pen Branch (Du Pont, 1985b; Appendix C). The species composition would be very similar to that in Four Mile Creek. Resident populations of fish (sunfish, shiners, bullheads, etc.) would be present in the upper reaches of Pen Branch above the confluence with Indian Grave Branch; some spawning could continue (DOE, 1984). No fish would be present in the reaches of the creeks below K-Reactor during discharges of heated effluents; in addition, population numbers would be smaller in the swamp/delta area during reactor operation. Fish would be found in cooler refuge areas along the shoreline of the main thermal channels. The heated discharge water would cause no apparent impact on fish in the Savannah River. Ichthyoplankton would continue to be absent or at greatly reduced densities in Pen Branch. In the delta, the dominant ichthyoplankton would be mosquitofish, which are found principally in the cooler refuge areas (DOE, 1984).

Wildlife and habitat for wildlife in the Pen Branch delta system would be similar to those found in the Four Mile Creek area.

4.2.3.3 Entrainment and Impingement

The estimated numbers of ichthyoplankton entrained and fish impinged by K-Reactor would be the same as those for the no-action alternative for C-Reactor, because both reactors require the same volume of circulating water (see Section 4.1.3.3).

4.2.3.4 Endangered Species

Although temperature in the thermal affected areas of Indian Grave Branch and Pen Branch would exceed the critical thermal maximum for American alligators, a few individuals could be observed occasionally in cooler refuges along the margins of the creeks and delta (DOE, 1984). No wood stork observations would be expected in Pen Branch during reactor operations because the habitat is not suitable for foraging by this species; however, wood stork observations have occurred during periods of extended reactor shutdowns.

4.3 ALTERNATIVES FOR D-AREA COAL-FIRED POWERHOUSE

The alternatives for the D-Area coal-fired powerhouse are increased flow with mixing, direct discharge to the Savannah River, and no action. The following sections describe the environmental consequences of these alternatives.

4.3.1 INCREASED FLOW WITH MIXING

4.3.1.1 Construction Impacts

This alternative could be implemented immediately after compliance with applicable environmental approvals (Chapter 5). No construction activities would be required to implement this alternative; hence, there are no environmental impacts due to construction.

4.3.1.2 Operational Impacts

Socioeconomics

This alternative would produce no socioeconomic impacts, because it would not require any additional workers for operation.

Historic and Archaeological Resources

Operational activities related to this alternative would produce slight periodic increases in water flow in Beaver Dam Creek; however, no archaeological and historic resources would be impacted (Appendix E).

Water Quality and Hydrology

Water quality monitoring studies conducted in Beaver Dam Creek from 1973 to 1982 have shown that, with the exception of temperature, all South Carolina Class B water classification standards have been met (Du Pont, 1985b). This cooling water alternative would discharge through NPDES-permitted outfall D-001, which has daily maximum discharge limitations of 40 milligrams per liter of total suspended solids and 15 milligrams per liter of oil and grease, and a temperature limitation of 32.2°C.

The implementation of this alternative would reduce the effluent water temperatures in downstream areas, including the swamp (see Section 2.2.3.1) and would meet all NPDES permit requirements at outfall D-001, with the exception of a maximum rise in ambient stream temperatures of 2.8°C during the winter. A Section 316(a) demonstration study would be performed to determine whether a balanced biological community would be maintained. Water temperatures in Beaver Dam Creek during the spring and summer would more closely approximate the normal temperature regime of unaffected streams in the area after the implementation of increased pumping to meet permitted requirements.

Increased flow with mixing would produce temporary increases in suspended solids in the creek channel above the swamp due to the erosion of the streambed and banks or the resuspension of previously settled material caused by the intermittent increased flow. The total load of suspended material in Beaver Dam Creek, however, would be no higher than that experienced in previous years. This total loading would return to near previous levels after the stream channel has reached equilibrium, and the resultant stream water temperature would reduce heat-related loss of streambank vegetation.

Increased flow with mixing could cause the flow in Beaver Dam Creek at the SRP Health Protection Department monitoring station to increase to 4.5 cubic meters per second (six pumps) during periods of peak summer temperatures. This would result in changes in stream morphology as a result of erosion and sedimentation, as well as the increased volume of water that would be carried intermittently by the creek. Some fluctuations now occur in the flows in the stream as a result of the powerhouse loads and/or maintenance outages. Generally, these changes are small and occur infrequently.

To assess the potential impact of increased flows, DOE conducted a pump test in Beaver Dam Creek during a 7-day period in June 1985. Under normal conditions, three pumps at the 5G pumphouse provide cooling water to D-Area. During the test, one additional pump and then two additional pumps were brought into service to study the impacts on water levels in the swamp. Water levels were monitored at eight locations along the creek and in the swamp. The results of the test indicated that water levels in the upper and lower channels of the creek rose and then declined to some extent. With four pumps operating, the water level increased by about 10 centimeters within 8 hours and then declined by 2 centimeters during the next 2 days. Following the activation of the fifth pump, the total rise in the water level was initially 17 centimeters over the pretest conditions; however, the water surface fell about 5 centimeters during continued pumping the next 5 days. Water levels in the swamp increased by 14 centimeters during the test and were still increasing at a rate of 0.5 centimeter per day when the pump test ended. With the increased flow alternative, pump tests indicate that the water levels in Beaver Dam Creek and swamp should increase between 12 and 19 centimeters over present levels during those times when flow will be augmented (Specht, 1985).

Air Quality and Noise

Increased flow with mixing would produce a small increase in average noise levels in the immediate area of the pumps when increased pumping is required during the summer. At the nearest offsite area, the increased levels of noise would be negligible. In the area of the pumps and in other areas where workers might be exposed to equipment noise, workers would wear protective equipment in accordance with applicable standards and regulations. Increased flow with mixing would cause no increase in local atmospheric emissions of pollutants due to the increased pumping, but would require additional electricity and attendant emissions. Emissions currently meet all applicable air quality standards.

Ecology

Cooling water discharged from D-Area would not exceed the State of South Carolina's Class B water classification standards following the implementation of this alternative. Water temperatures during the spring and summer would average 2°C above ambient creek temperatures at the point of discharge to the creek (Table 2-7) and about 7°C above ambient during winter.

Increased flow during the summer would increase aquatic habitat and should increase the abundance and diversity of fish and macroinvertebrates. However, wildlife habitat would be reduced and associated wildlife would be displaced temporarily during periods of increased pumping. An estimated 4 acres each of uplands and wetlands would be inundated temporarily because of intermittent flooding from increased flow.

The increase in pumping might cause a temporary increase in the erosion of the stream channel. The adverse effects of siltation on aquatic organisms and their habitats are well documented (Ellis, 1936; Hynes, 1970; Marzolf, 1980; Adams and Beschta, 1980). These temporary increases in siltation could result in reduced primary productivity and reduced populations of some benthic invertebrates, and could reduce fish spawning and feeding habitat downstream if increased pumping were to occur during the spawning season. However, increased pumping probably would not be required during the peak spawning period of fish in Beaver Dam Creek. The expected erosion and the resulting siltation would equilibrate rapidly under an increased flow regime. Most adverse impacts from increased siltation in streams are temporary, and biota quickly recolonize after the disturbance has ceased (Barton, 1977; Boschung and O'Neil, 1981).

Entrainment and Impingement

The increase in cooling water flow into the 5G intake due to the implementation of this alternative would occur only during periods when ambient water temperatures approach 32.2°C during parts of May through September. Entrainment studies performed at the 5G intake in 1982, 1983, and 1984 (based on ECS, 1983; Paller et al., 1984; Paller, O'Hara, and Osteen, 1985) indicate that between 0.7×10^6 and 1.8×10^6 fish larvae and between 4.6×10^5 and 1.2×10^6 fish eggs are entrained at this intake during the February-July spawning season (Appendix C). Specht (1985) estimated that approximately 3 percent more fish eggs and larvae would be entrained if increased pumping had been required during the May-to-September time period based on 1984 entrainment data for the 5G intake and meeting the 32.2°C temperature requirement. Therefore, based on the 1984 data, an estimated additional 3 percent or 0.1×10^6 fish eggs and larvae (using estimates of 1.2×10^6 eggs and 1.8×10^6 larvae) would be entrained each year if the increased pumping alternative were implemented during the May-to-September time period. The principal species affected are the sunfish (i.e., bluespotted, redbreast, and bluegill) and shad (i.e., gizzard and threadfin).

The rate at which fish are impinged on the intake screens at SRP is related not only to the volume of water pumped but also to such factors as river water level, water temperature, and the density and species of fish in the intake canal (Paller et al., 1984). The current rates of impingement at the 5G intake screens during 1982, 1983, and 1984 indicate that 49, 1304, and 65 fish were impinged on 12, 98, and 107 sampling dates, respectively (ECS, 1983; Paller et al., 1984; Paller and Osteen, 1985). During this 3-year sampling period, from 61 to 96 percent of all fish collected were impinged during the March-to-May time period. Rates of increased impingement were based on limited information concerning the rate of increased pumping, the number of pumps operating, and the number of days that pumping would be required during the spring and summer to meet the 32.2°C temperature requirement. A 3-percent increase in impingement was used as the factor for the increased amount of impingement. Therefore, the implementation of this alternative would result in approximately 7 to 142 additional fish being impinged each year based on data from 1982 to 1984 and the resulting overall impact would be minimal. The principal species impacted would be sunfish (i.e., bluespotted and redbreast) and shad (i.e., gizzard and threadfin).

Endangered Species

American Alligator - Dense populations of alligators occur on Beaver Dam Creek and in the swamp associated with the creek (Du Pont, 1985b). These large populations probably occur because of the excellent breeding/nesting habitat associated with the backwaters along the creek and a reduction of alligator mortality. The mildly thermal effluent can provide refugia for alligators in the winter or, alternatively, enhance the growth rate of juveniles, which increases their survivability.

A minimum of 28 alligators representing all size classes (equivalent to age classes) longer than 1 meter inhabit this stream (based on aerial surveys from December 1983 to March 1984). Subsequent ground surveys in April and May 1984 resulted in the capture of 11 alligators representing age classes of 1-, 2-, and 3-year-olds. The backwater areas along the creek probably support a self-sustaining alligator population because all age classes of juveniles and adults have been observed (Du Pont, 1985b).

The primary impacts of this alternative on the alligator would be cooler effluents during the summer and intermittently increased water levels caused by the larger cooling water flows. Effluent temperatures under this alternative would be well below the alligator's critical thermal maximum during the summer; these temperatures are not expected to produce negative impacts on survivability. The heated effluent would continue to provide a thermal "refuge" for the alligator during the winter. This winter refuge would continue to enhance the growth rate and lower the mortality in juvenile age classes. Water level increases less than about 35 centimeters are not likely to impact alligator nesting sites in Beaver Dam swamp (personal communication, R. Siegel, Savannah River Ecology Laboratory); thus, no impacts to alligators should result from the increase in water level when increased pumping is required.

Wood Stork - To feed successfully, the wood stork must forage in shallow pools (less than 25 centimeters) of murky or muddy water, which have high concentrations of fish. High prey concentrations normally occur during the dry seasons (spring and summer) when declining stream levels and evaporation create shallow pools of water that trap and concentrate fish (Du Pont, 1985b). The pools in which wood storks feed are often ephemeral and commonly dry up (Du Pont, 1985b). Wood storks must forage continually over large areas to locate new sources of food (Meyers, 1984). Foraging sites that are part of the more permanent wetlands, such as those along primary and secondary creeks, would be increasingly important to a rookery in drier years (FWS, 1984a).

The availability of prey evidently determines the breeding success of a colony (Kahl, 1964). If conditions are unfavorable during the early part of the breeding season, adults will not lay eggs. If early conditions are suitable but later deteriorate, adults commonly will abandon eggs or nestlings. The critical period for nestling survival is from hatching to 6-8 weeks of age (early May to early July for the SRP area). An estimated 50 percent of the 16.5 kilograms (live weight) of fish required to fledge a wood stork is consumed during the middle one-third of the nesting cycle.

The third and fourth weeks are critical to nest life in terms of the energy demands on the adults. During this period, food consumption by the young reaches a maximum and only one parent might be foraging at a time (the other parent will guard the nestlings and protect them from the environment) (Kahl, 1964). Around the first week of June, both parents begin foraging for their young; between July and September, the young of the year are fledged and have started to forage on their own.

Based on 1983 data, the last wood stork observed feeding on the Savannah River Plant occurred on August 1, 1983. By August 15, the majority of the storks had dispersed from the Birdsville colony; by August 24, all had dispersed. Aerial and ground surveys for wood storks continued until September 27, but there were no additional observations of foraging on the Plant (Meyers, 1984).

During 1984, an average of 13 wood storks were observed during 89 surveys between May and mid-November (Coulter, 1986). The Steel Creek delta, Beaver Dam Creek, and the swamp between Pen Branch and Four Mile Creek were used by the woodstork to the greatest extent in 1984. However, on only 3 of the 12 occasions when wood storks were observed on Four Mile Creek were there more than two storks in each siting (Coulter, 1986).

The primary impacts on the wood stork from the implementation of this alternative for D-Area would be intermittently increased water levels and decreased effluent temperatures during the summer. Effluent temperatures would be below 32.2°C during these months, thereby having minimal impact on foraging habitat.

Based on flow testing, the increased flow would raise water levels in the swamp by approximately 12 to 19 centimeters (Specht, 1985). Optimal average water depths for wood stork foraging is 25 centimeters. Depending upon the initial water level in foraging pools in the swamp, the 12- to 19-centimeter increase in the water level could result in water levels that are not conducive for foraging activities.

If increased pumping occurs when wood storks are actively foraging in the area and prey were optimally concentrated, the prey could be dispersed temporarily by the increased flow; however, because the water levels fall quickly in response to a decrease in pumping, this habitat would again be available to the wood stork. Because the wood stork is an opportunistic feeder, it would probably utilize this foraging source after it is reestablished. Flow fluctuations can also enhance foraging habitats by delaying or preventing such habitat from drying up, as noted by the U.S. Fish and Wildlife Service in its consultation for Steel Creek (FWS, 1984b). In addition, increased pumping would delay the reestablishment of a closed canopy, which could continue to provide foraging habitat for the wood stork.

Red-Cockaded Woodpecker - Nesting and foraging habitats for the red-cockaded woodpecker occur near Route 278 in the northeastern corner of the Plant and between Lower Three Runs Creek and Meyers Branch. D-Area operations would have no impact on these habitats.

Shortnose Sturgeon - Increased flow from this alternative would have no effect on the population status of shortnose sturgeon in the Savannah River. Suitable habitat exists above and below the Plant, based on the presence of spawning sturgeon and larvae.

Entrainment of shortnose sturgeon eggs and larvae in the D-Area intake cooling water is not likely because of their demersal (bottom) and adhesive nature. In addition, spawning occurs in the Savannah River during February and March (Matthews and Muska, 1983), before any increased pumping that would be required during the May-to-September mitigation period. Previous studies have found no shortnose sturgeons on the SRP cooling water intake screens, and there is no evidence that juveniles or adults inhabit the intake cove. Moreover, healthy shortnose sturgeon are unlikely to be impinged, given pumphouse intake velocities and sturgeon swimming speeds (Du Pont, 1985b). In addition, the National Marine Fisheries Service (NMFS) has previously concurred in DOE's determination that the population of shortnose sturgeon in the Savannah would not be affected adversely by SRP operations (Oravetz, 1983).

Radiological Releases

Because the cooling water discharge from the D-Area powerhouse does not contain radionuclides, there would be no direct radiological releases or impacts associated with the operation of increased flow with mixing. The increased flow to Beaver Dam Creek from increased flow with mixing would result in a slight reduction in the concentrations of tritium in the creek, which are due to releases from the moderator rework facility.

Remobilization of radionuclides such as cesium-137 from the Beaver Dam Creek bed would be insignificant, because radionuclides with the potential for remobilization are present only in very minute quantities in the creek bed (Boyns and Smith, 1982; Du Pont, 1981a, 1981b; Du Pont, 1985c; Lower, 1984b; Lower and Hayes, 1984).

4.3.2 DIRECT DISCHARGE TO SAVANNAH RIVER

4.3.2.1 Construction Impacts

Socioeconomics

The direct discharge alternative for the D-Area would involve construction of a new pipeline and discharge system from D-Area facilities to the Savannah River. The construction would be accomplished in approximately 22 months, and would involve a peak construction workforce of 40 persons.

The analysis presented in Section 4.1.1.1 indicates that a large number of construction workers living in the general vicinity of the SRP are expected to become available for employment in the next few years. Because these construction workers already reside in the SRP area, no impacts to local communities and services due to immigrating workers would be expected.

Historic and Archaeological Resources

An archaeological and historic resources survey was conducted that encompassed the specific area west of Beaver Dam Creek that would be disturbed by pipeline construction activities associated with the direct discharge alternative for D-Area. No evidence of archaeological resources was found during the survey; therefore, no impacts are anticipated from implementation of this alternative.

Water Quality and Hydrology

The principal impact to water quality during construction would be some temporary localized increases in suspended solids in the Savannah River and swamp due to runoff and erosion from land areas and to dredging on the river bank. Appropriate engineering construction measures would be utilized to control erosion and drainage.

Some temporary structures (e.g., access roads, cofferdams, berms) might have to be used during the construction of the pipeline from D-Area into the river. These structures would be planned to minimize any disruption of natural water flows by using such measures as bypass channels and culverts. Following construction, the waterways would be restored to their previous state as much as possible. No permanent changes in existing flow patterns in the stream, river, or swamp are anticipated.

Construction of the discharge sparging system along the river banks would require limited dredging through the natural levee separating the Savannah River from the swamp. This activity would require a Section 404 permit from the U.S. Army Corps of Engineers. A Section 401 certificate from SCDHEC would also be required to ensure that construction- and operation-related discharges into navigable waters comply with the applicable effluent limitations and water quality standards of the Clean Water Act.

Ecology

An estimated 1 acre of wetlands and 5 acres of uplands would be disturbed by construction of the pipeline and associated rights-of-way from the D-Area plant to the Savannah River. Construction activities are not expected to produce adverse effects on vegetation outside the immediate construction areas. Approximately 4 of the 6 acres that would be affected consist of regenerated loblolly pine and bottomland hardwoods.

During construction, wildlife (e.g., birds, turtles, and small game animals) would leave the immediate area of construction when activities increased. The process of clearing the right-of-way and installing the pipe could result in the loss of some small mammals, such as shrews and mice, and some amphibians and reptiles such as salamanders and snakes. No critical habitats for endangered species would be affected by the construction of the pipeline. When construction was completed, areas no longer needed for construction would be replanted with appropriate grasses, shrubs, or trees and thus made available for use by wildlife.

Temporary increases in siltation would result in impacts on some benthic organisms and could temporarily affect fish spawning in the immediate area of the discharge structure if construction were to occur during the spawning season. These effects would be temporary, and biota should recolonize after the disturbance ceased or equilibrated.

Other Construction Impacts

Solid waste (excluding clearing debris) would be placed in containers for disposal in an approved manner. Because of the proximity of the construction to waterways, special care would be taken to prevent spills of fuels or chemicals. All applicable atmospheric emissions standards would be met during construction.

There would be no significant radiological impacts associated with the installation of a pipeline from the D-Area powerhouse condensers to the Savannah River, because no discharges of radioactivity would occur.

4.3.2.2 Operational Impacts

Socioeconomics

No socioeconomics impacts are expected from the operation of the new pipeline, because maintenance of the pipeline and discharge system would be performed by existing maintenance crews.

Historic and Archaeological Resources

The operation of the direct discharge of cooling water to the Savannah River would not cause any impacts to historic and archaeological resources.

Water Quality and Hydrology

Before SRP operations began in 1952, Beaver Dam Creek is believed to have been an intermittent stream (Jacobsen et al., 1972). The removal of the present condenser cooling water discharge could result in the creek's reverting to its former status, although some of the existing discharges from D-Area would still enter the waterway (e.g., rework area process sewer, miscellaneous powerhouse wastewater, sanitary plant effluent, and ash basin effluent). The total flow from these sources would be about 0.18 cubic meter per second. Overflow from the raw-water basin would be about 0.3 cubic meter per second, but could vary from about 0.1 to 0.8 cubic meter per second. These effluents would continue to meet the State of South Carolina Class B water classification standards; no adverse impact on the creek is expected.

Heated discharge water would no longer be released to Beaver Dam Creek with this alternative; therefore, the principal change in existing water quality in the stream would be the reduction in water temperature to ambient levels. Temperatures in some portions of the swamp would also be reduced; however, because much of the flow from Four Mile Creek joins the swamp near the mouth of Beaver Dam Creek, some heat from C-Reactor would still enter this area before the implementation of a cooling water system for C-Reactor. Additional heat would be released directly to the Savannah River at the discharge points along the effluent pipeline sparging system. The temperature of the discharge is expected to be about 8°C above ambient temperature of the river at the points of effluent release. Outside a small mixing zone, temperatures would meet State water quality criteria, and therefore there would be no adverse impact on the river.

Nutrient concentrations in Beaver Dam Creek would be somewhat reduced from present levels with this alternative. The concentrations of most nutrients are now higher than those in other unimpacted streams on the SRP site because of the Savannah River water that is circulated through the cooling water system of the powerhouse. Removal of the effluent discharge from the creek, therefore, would lower the nutrient concentrations in Beaver Dam Creek.

The flow in Beaver Dam Creek would be reduced from the present annual average discharge of about 2.6 cubic meters per second to about 0.5 cubic meter per second during normal operations, not including any intermittent flow after rainfall. Water levels and flow in the swamp at the mouth of Beaver Dam Creek would also be reduced, but not as much as in the stream itself because flow from Four Mile Creek would still enter the swamp near the mouth of Beaver Dam Creek. Nonetheless, the diversion of a flow of 2.1 cubic meters per second would result in a lowering of the water levels in this region of the Savannah River swamp. This impact would be evident most of the year, except during the spring or at other times when river flooding inundates much of the swamp adjacent to the Savannah River Plant.

Air Quality and Noise

No significant environmental impacts in air quality or noise levels are expected during operation of the direct discharge cooling system.

This alternative would cause no increase in atmospheric emissions of pollutants; steam generation rates would remain the same; all applicable air quality standards would be met.

Ecology

Discharge temperatures at the diffusion in the river could result in a limited thermal attraction of fish to the immediate area. The most significant impact that implementation of this alternative would have on the ecology of Beaver Dam Creek would be a significant reduction in flow. The upper reaches of the stream would continue to be an intermittent stream. Portions of the creek downstream from the existing discharge canal that are bordered by swamp would consist of interspersed shallow pools and/or slow-moving water. Accordingly, the aquatic habitat available for colonization by fish and macroinvertebrates would be less than at present and would approximate pre-SRP conditions. During winter and spring flooding, portions of the Beaver Dam Creek area would be inundated with Savannah River water and would serve as a spawning and nursery area for resident species of fish (e.g., sunfish, minnows, and darters), as well as migratory species (e.g., blueback herring). However, less spawning and nursery habitat would be available than at present.

Many areas of Beaver Dam Creek that are currently inundated by discharges from D-Area would undergo successional vegetation redevelopment into a more mesic scrub-shrub community. From 1952 through 1974, 412 acres of wetlands were affected in Beaver Dam Creek floodplain and swamp due to thermal discharges and flooding (Du Pont, 1985b). The temperature of the effluent began to decrease in 1973 and continued to decline until 1978; a concurrent net reversal of delta canopy loss occurred. During this period, about 5 acres of canopy in the Beaver Dam Creek area were restored, and by 1984 a total of about 30 acres had regrown. Currently, the affected Savannah River swamp canopy of Beaver Dam Creek totals about 382 acres and is recovering at a rate of about 3 acres per year (Du Pont, 1985b). Implementation of this alternative would allow revegetation to accelerate, leading to conditions that more or less prevailed prior to 1952.

Entrainment and Impingement

This alternative would not require changes to the intake structures or the receiving water flow rates. Accordingly, the entrainment and impingement rates associated with direct discharge would be similar to those resulting from present operations.

Projections of current entrainment and impingement losses, based on ichthyoplankton studies at the site (ECS, 1983; Paller et al., 1984; Paller, O'Hara, and Osteen, 1985), indicate that operation of D-Area presently results in the loss of between 0.7×10^6 and 1.8×10^6 fish larvae and between 4.6×10^5 and 1.2×10^6 fish eggs each year (Table C-13, Appendix C). The implementation of this alternative would not change these rates. The principal species that would be affected are shad, herring, and crappie.

From about 220 to 4745 fish would continue to be impinged annually on the intake screens of the 5G pumphouse (see Appendix C). The principal species impinged would be sunfish, shad, and herring. The overall impact on the fishery resources would be minimal.

Endangered Species

Operation of the direct-discharge system would have a significant impact on the habitats of American alligators and wood storks by decreasing the flow in Beaver Dam Creek from about 2.6 cubic meters per second under present operating conditions to about 0.5 cubic meter per second. Implementing this alternative would decrease or eliminate nesting habitat for the American alligator and would eliminate any thermal refugia that might have existed during the winter months. Foraging habitat for the wood stork would be decreased significantly or eliminated. Beaver Dam Creek would essentially return to its original condition as an intermittent stream.

Flood conditions would result only from storm runoff after rains and Savannah River flooding. Based on pump test data (Section 4.3.1.2), it is reasonable to assume that any flooding that occurred in Beaver Dam Creek from surface runoff would be of short duration and that the water level in Beaver Dam Creek swamp would return to its original level within approximately 24 hours after rainfall had stopped.

Because the thermal effluent would be discharged directly to the Savannah River, there would be a small thermal plume at the outfall structure; however, there would continue to be a large zone of passage for all fishes, including the endangered shortnose sturgeon. There would be no impacts on the shortnose sturgeon due to entrainment and impingement.

Radiological Releases

Because the cooling water discharge from the D-Area powerhouse does not contain radionuclides, there would be no direct radiological releases from D-Area to the Savannah River. The annual release of tritium from the Moderator Rework Facility to Beaver Dam Creek, and eventually to the Savannah River, would remain unchanged. The release is a function of the operation of the rework facility and does not depend on the operation of the powerhouse or its mode of discharge. The only effect of the reduced flow in Beaver Dam Creek on tritium releases - resulting from direct discharge from the powerhouse to the Savannah River - would be an increase in its concentration in the creek.

Remobilization of radionuclides such as cesium-137 from the Beaver Dam Creek bed would be insignificant, because radionuclides with the potential for remobilization are present only in very minute quantities (Boyns and Smith, 1982; Du Pont, 1981a, 1981b; Du Pont, 1985c; Lower, 1984b; Lower and Hayes, 1984).

4.3.3 NO ACTION - EXISTING SYSTEM

The no action alternative for the D-Area coal-fired powerhouse would maintain the existing once-through cooling water system that withdraws water from the Savannah River and discharges it to Beaver Dam Creek. Chapter 3 and Appendix C describe the existing environmental baseline conditions associated with this system. This section summarizes the minor impacts that would not change for the no-action alternative.

4.3.3.1 Water Quality and Hydrology

The mean discharge to Beaver Dam Creek from the D-Area powerhouse would continue to be about 2.6 cubic meters per second (range: 1.2 to 4.5 cubic meters per second) (Du Pont, 1985b). The water from the creek would mix with part of the flow from Four Mile Creek in the Savannah River swamp before it discharges to the river through the mouth of Beaver Dam Creek (Du Pont, 1985b).

Water temperatures in the creek and delta could reach 36°C under extreme summer conditions when ambient river temperatures are about 28°C and ambient stream temperatures are about 33°C. Under average summer conditions, creek and delta temperatures would be approximately 31°C. Comparable winter temperatures would be about 15° to 16°C (Lower, 1984a). The continuation of the existing cooling water discharge in D-Area would meet the Class B water classification standards for temperature most of the time, but would exceed the limit during warm-weather periods and concurrent high powerhouse loadings.

4.3.3.2 Ecology and Wetlands

The aquatic and terrestrial ecology of the Beaver Dam Creek area would be influenced by the heated water discharged from the coal-fired powerhouse. Aquatic flora in the creek would be sparse due to the elevated temperatures and flow of the effluent. Riparian vegetation would be dominated by wax myrtle and tag alder. Portions of the Beaver Dam Creek delta would continue to show evidence of revegetation because of the decline of water temperatures, which began in the 1970s (DOE, 1984). More species of macroinvertebrates would occur in Beaver Dam Creek than in the other thermally impacted streams.

In general, fish density would be higher in Beaver Dam Creek than in either Four Mile Creek or Pen Branch, but lower than in the nonthermal streams (Du Pont, 1985b). The fish species present in the creek in greatest numbers as adults would be mosquitofish, sunfish, and gizzard shad (Bennett and McFarlane, 1983). Relative abundance and species composition would increase toward the creek mouth and swamp, where greater habitat diversity occurs and temperatures are somewhat moderated (Du Pont, 1985b). Ichthyoplankton in the creek would reflect the adult fish composition.

4.3.3.3 Entrainment and Impingement

Entrainment at the 5G intake would continue to result in the loss of between 4.6×10^5 and 1.2×10^6 fish eggs and between 0.7×10^6 and 1.8×10^6 fish larvae each year. The principal species that would be affected are shad, herring, and crappie.

Impingement of fish on the intake screens of the 5G pumphouse would continue to average approximately 1 to 13 per day. The principal species impinged would be sunfish, shad, and herring.

4.3.3.4 Endangered Species

The area in and around Beaver Dam Creek would continue to provide habitat for a dense population of American alligators. Backwater areas would continue to provide breeding and nesting habitat and probably support a self-sustaining alligator population based on the presence of juvenile and adult individuals in the creek area (Du Pont, 1985b).

Wood storks from the Birdsville rookery, which have been observed using the Beaver Dam Creek area for foraging since 1982 (Du Pont, 1985b), would be expected to continue to use the area.

4.4 CUMULATIVE IMPACTS OF ALTERNATIVE COOLING WATER SYSTEM CONSTRUCTION AND OPERATION

This section describes the cumulative impacts of the construction and operation of the cooling water alternatives for C- and K-Reactors and the D-Area coal-fired powerhouse on surface-water usage, thermal discharges, ecological systems, radiological releases, and air quality. These impacts have been evaluated in conjunction with the releases from other SRP facilities and from major facilities near the Savannah River Plant.

4.4.1 SURFACE-WATER USAGE

The Savannah River Plant withdraws a maximum of 37 cubic meters of water per second from the Savannah River, primarily for use as cooling water. Plant operations consume approximately 2.4 cubic meters per second of this water; the remainder returns to the river via onsite streams.

The existing withdrawal and return rates would remain essentially the same for the once-through cooling tower alternative. The water consumed by evaporation in each tower would be about twice the evaporation loss of approximately 0.5 cubic meter per second from the existing flow as it cools along the flow path. The total water withdrawal from the river for the Plant, including once-through cooling towers at both C- and K-Reactors, would be 24 percent of the 7-day, 10-year low flow (159 cubic meters per second) and 13 percent of the average flow (295 cubic meters per second). Only about 3.4 cubic meters per second of the 159-cubic-meter-per-second low flow would be consumed.

The existing withdrawal and return rates would be substantially reduced for the recirculating cooling-tower alternatives. The withdrawal rate from the river of 1.7 cubic meters per second for each reactor would represent a decrease of approximately 9.6 cubic meters per second per reactor from the rate for the existing system. The total SRP withdrawal from the river for the Plant, including recirculating cooling towers at both C- and K-Reactors, would be about 12 percent of the 7-day, 10-year low flow and about 7 percent of the average flow. As with the once-through tower, the water consumed in the recirculating towers would be about 0.5 cubic meter per second more than that consumed by the existing system.

For both the direct discharge and increased pumping alternatives for D-Area, the withdrawal of river water would be unchanged during normal climatological conditions. During very hot periods, however, the amount of water withdrawn from the river for the increased pumping alternative would be increased to meet the Class B water classification standard of a minimum instream temperature of 32.2°C; the withdrawal rate for this alternative would increase from 2.6 (existing system) to 4.5 cubic meters per second, resulting in a slightly higher total withdrawal than that discussed above for the once-through and recirculating cooling-tower alternatives. This additional water returns to the river via Beaver Dam Creek, thereby causing no effects to total SRP consumptive surface-water losses.

4.4.2 THERMAL DISCHARGE EFFECTS

4.4.2.1 Onsite Streams and Savannah River Swamp

Cooling water is now directly discharged from the SRP via four streams - Beaver Dam Creek, Four Mile Creek, Pen Branch, and Steel Creek. Also, overflow from Par Pond enters Lower Three Runs. Beaver Dam Creek receives once-through cooling water from the D-Area powerhouse, while Four Mile Creek and Pen Branch receive once-through cooling water from C- and K-Reactors, respectively. Steel Creek receives cooling water from L-Reactor via a once-through cooling lake and - in its lower reaches - from K-Reactor via Pen Branch and the intervening swamp. The principal cumulative impact of implementation of alternative cooling water systems at C- and K-Reactors and the D-Area powerhouse would be a reduction in the total amount of waste heat dissipated to all onsite streams and the Savannah River swamp. A cumulative impact that would result from this reduction in thermal discharge would be the revegetation of surrounding areas through natural plant succession and, thus, an increase in total wetland habitat. In addition, a reduction in thermal discharge would allow previously affected thermal streams to be recolonized by fish and macroinvertebrates and provide for additional spawning habitat for fish. A zone of passage for anadromous fish and other aquatic organisms in SRP thermal streams and the Savannah River swamp would be provided, thus creating more available habitat for these organisms in completing their life cycles.

Implementation of the once-through cooling tower alternative would result in thermal plumes from C-Reactor and the D-Area powerhouse interacting within the Savannah River swamp. However, thermal performance studies have indicated that this interaction would reduce thermal effects in this area of the swamp. In addition, the thermal discharge from K- and L-Reactors would interact via Pen Branch and Steel Creek in the Savannah River swamp with the implementation of the once-through cooling tower alternative. Thermal performance studies indicate that temperatures in Pen Branch would be about 2°C cooler than those in Steel Creek at their confluence during winter, when thermal plumes could be most evident.

4.4.2.2 Savannah River

In the vicinity of the Savannah River Plant, the Savannah River receives thermal discharges from the Urquhart Steam Station at Beech Island, South Carolina, as well as from the Plant. In addition, the Alvin W. Vogtle Nuclear Power Plant, near Hancock Landing, Georgia, across the river from the Plant, will use natural-draft cooling towers to dissipate waste heat before discharging to the Savannah River at temperatures below 33°C (Georgia Power Company, 1985).

As the result of water storage in Clarks Hill Reservoir above Augusta, Georgia, and its hypolimnetic discharge, the temperature of the Savannah River is as much as 8°C below the temperature that would normally occur during the summer if the reservoir did not exist (Neill and Babcock, 1971). The temperature of the river generally increases naturally as the water flows from Clarks

Hill Reservoir past the SRP. 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 at temperatures as high as 6°C above ambient river temperatures. The Vogtle Nuclear Power Plant would discharge about 0.7 cubic meter per second of cooling water to the Savannah River with a winter thermal plume 2 meters wide extending 9.8 meters downstream from the single-port discharge pipe (NRC, 1985). This winter thermal plume would not extend beyond its permitted mixing zone or interact with SRP or Urquhart discharges.

The cumulative impact upon the Savannah River with the implementation of alternative cooling water systems at C- and K-Reactors and the D-Area powerhouse would be a reduction in the total amount of waste heat discharged to the Savannah River via onsite streams. These discharges would not interact with Urquhart or Vogtle generating stations. Removal of SRP thermal discharges would result in an increased zone of passage in the Savannah River for anadromous fish and other aquatic organisms and would allow for more available habitat for aquatic organisms in the river.

Implementation of the direct discharge alternative to the Savannah River for D-Area and implementation of once-through cooling towers for C- and K-Reactors would result in winter and spring plumes entering the Savannah River, raising the temperature in the immediate area of the confluence of the streams with the river more than 2.8°C above ambient. Even though there would be a thermal plume present during the winter and spring at the immediate confluences of the mouths of Beaver Dam, Four Mile, and Steel Creeks, and the Savannah River, it would not create a thermal blockage of the river. Also, a zone of passage would continue to be available for anadromous fish and other aquatic organisms.

4.4.3 ECOLOGY

4.4.3.1 Terrestrial Areas

The cumulative impact of the construction of cooling towers for C- and K-Reactors and the alternatives for D-Area would cause the disturbance of a maximum of about 155 acres of uplands consisting of immature slash pine and reforested upland pine/hardwood and some open fields.

In addition, the cumulative impacts from salt deposition from the operation of recirculating cooling towers at both C- and K-Reactors would result in an estimated 22.7 kilograms (50 pounds) per acre per year at a distance of 0.8 kilometer from each tower. These rates represent the highest values associated with any of the various combinations of alternatives and are much less than those reported by Mulchi and Armbruster (1981) and INTERA (1980) that can cause reduced productivity of plants. However, beyond 2 kilometers (see Figure 4-8), the deposition rates are considerably below the critical values reported that might cause reduced productivity. Therefore, no significant cumulative impacts are expected with this combination of alternatives.

4.4.3.2 Onsite Streams and the Savannah River Swamp

The cumulative effects of the construction of any combination of the cooling water alternatives on the aquatic environment would be minimal because the reaches of Pen Branch and Four Mile Creek in the vicinity of the proposed activities are presently sparsely inhabited by aquatic organisms due to existing thermal stress. No construction is required for the increased-flow-with-mixing alternative for D-Area, and the direct-discharge system would have minimal impact due to its proposed location along previously disturbed areas and construction practices which would minimize turbidity and siltation.

The principal cumulative impact of the operation of cooling towers for C- and K-Reactors and either increased flow or direct discharge at D-Area would be the reduction of water temperatures in onsite streams and the adjacent swamp to ambient or near-ambient levels. Among the most important effects of removing the existing thermal stress from these environments would be the discontinuation of the loss of wetlands along the waterways (e.g., the combined loss in 1984 due to C- and K-Reactor operations was about 54 acres). It is expected that some wetland areas previously damaged or destroyed would successively revegetate due to the lowered water temperatures. However, increased flow and intermittent flooding (with the once-through towers and the increased-flow-with-mixing alternatives) would still limit wetland revegetation in some locations. The continued existence of open canopy areas would benefit some species (e.g., waterfowl and wood stork). There would also be a beneficial effect of the lower water temperatures on aquatic biota. Foraging and spawning habitats and zones of passage in the streams and swamp that were previously inaccessible to fish due to the heated discharge would now be open to these organisms. Populations in headwater areas above the reactor discharge points would no longer be isolated from the main streams, the swamp, and the Savannah River. Also, the potential for cold shock in the thermal portions of the streams and swamp would be reduced. The cumulative effect of this would be to increase the area of aquatic habitat in SRP streams and the adjacent swamp and thereby increase the populations of fishes and other aquatic organisms in comparison to existing conditions. Productivity of the Savannah River might increase in this area of the river due to increased contributions of progeny from the onsite streams and swamp.

The cumulative effect of the installation of recirculating cooling towers at C- and K-Reactors and of direct discharge of D-Area effluent to the Savannah River would have somewhat less positive impacts. This combination of alternatives would greatly decrease thermal stress in the onsite streams and portions of the adjacent swamp; however, they would also cause significant decreases in flow in these waterways. Therefore, although these alternatives would provide some increases in available aquatic habitat compared to present conditions, the beneficial effects would be less than those experienced with the once-through towers and increased-flow-with-mixing options due to lowered water levels in the streams and some portions of the swamp. These lowered water levels could be more conducive to wood stork foraging habitat in Four Mile Creek and Pen Branch, but would totally eliminate the foraging habitat in Beaver Dam Creek.

4.4.3.3 Savannah River

The cumulative effect on the Savannah River of the implementation of cooling towers would be a reduction in the total amount of waste heat discharged from the onsite streams. This would increase the size of the zones of passage in the river adjacent to the Savannah River Plant and thereby would allow greater flexibility in movement of anadromous fish and other aquatic organisms through that section of the river.

The direct-discharge alternative for D-Area, combined with once-through towers for the two reactors, would result in thermal plumes entering the river in winter and spring near the confluences with Beaver Dam Creek, Four Mile Creek, and Steel Creek. The maximum temperature above ambient, which would be about 2.8°C within these plumes, would not create any thermal barrier in the river or cause any other adverse impact on fishes or other aquatic organisms.

4.4.3.4 Entrainment and Impingement

The cumulative entrainment and impingement impacts of some combinations of the cooling water alternatives would remain the same as present conditions; for other combinations, there would be a reduction in these effects.

Implementation of once-through cooling towers for C- and K-Reactors and direct discharge for D-Area would not significantly change existing levels of entrainment and impingement. Currently, the combined total loss of ichthyoplankton due to the operation of these three facilities is between 5.8×10^6 and 18.1×10^6 fish eggs and between 17.6×10^6 and 28.0×10^6 larvae per year (ECS, 1983; Paller et al., 1984; Paller, O'Hara, and Osteen, 1985). Cumulative impingement rates are now between 18 and 37 fish per day (15 to 24 for C- and K-Reactors combined and a maximum of 13 for D-Area) (ECS, 1983; Paller et al., 1984; Paller and Osteen, 1985). The species composition of the fishes lost to entrainment and impingement also would not change with this combination of alternatives.

The implementation of recirculating cooling towers in combination with direct discharge at D-Area would lower the cumulative effects of both entrainment and impingement. The reduced flow requirements for the cooling water systems of the two reactors would result in a decline in annual entrainment losses from current combined levels to about 3.8×10^6 fish eggs and about 5.8×10^6 larvae per year. Cumulative impingement losses would decrease to about 16 fish per day. Species composition of fish lost to entrainment and impingement would not change with this combination of alternatives.

4.4.3.5 Endangered Species

The red-cockaded woodpecker and the shortnose sturgeon would not be affected by any of the alternatives individually and would not be affected by their combined construction or operation.

The American alligator currently does not inhabit Pen Branch or Four Mile Creek due to high water temperatures. The implementation of once-through cooling towers could result in additional habitat suitable for the American alligator in both streams, particularly because water temperatures still would be somewhat elevated in the winter but not within the lethal range. In the case of the recirculating towers, temperatures also would be suitable for alligators, but the flows and water levels would be greatly reduced from present levels, thereby limiting the available habitat area. The implementation of the increased-flow-with-mixing alternative at D-Area would not appreciably change the value of the existing alligator habitat in Beaver Dam Creek. Therefore, the cumulative impact of any combination of these alternatives would be a general increase in the available habitat for the American alligator in these areas.

The implementation of the direct-discharge alternative for D-Area in combination with either cooling-tower alternative would have a deleterious cumulative impact on the alligator. The direct-discharge alternative for D-Area would reduce the existing alligator habitat in Beaver Dam Creek by removing the beneficial thermal environment that now exists and by significantly lowering water levels and flows in the stream.

The wood stork would not be adversely affected by the cumulative impact of the implementation of cooling towers for C- and K-Reactors and the increased-flow-with-mixing alternative for D-Area, (i.e., there would be no destruction of any foraging habitat). It is expected that there might be some overall improvement of wood stork habitat due to reduced temperatures and decreased flow in Pen Branch and Four Mile Creek. Habitat might also be improved due to intermittent increased flow in Beaver Dam Creek during the summer, a normally drier period; however, water levels might be too deep to permit foraging in some areas during these periods.

There would be a cumulative loss of foraging habitat for the wood stork with any combination of alternative cooling water systems that included direct discharge from the D-Area powerhouse. This alternative would reduce the water levels in Beaver Dam Creek and thereby reduce or eliminate the value of this area for foraging by the wood stork.

4.4.4 RADIOLOGICAL RELEASES

Nuclear facilities within an 80-kilometer radius of the Savannah River Plant (SRP) include operating or planned SRP facilities, the Alvin W. Vogtle Electric Generating Plant (under construction), the Barnwell Nuclear Fuel Plant (not 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 with the alternative cooling water systems being considered for C- and K-Reactors of the Savannah River Plant.

Facilities operating at the Savannah River Plant include four 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 Materials Facility (FMF) for producing fuel forms for the naval reactor program, the Fuel Production Facility (FPF) for recycling enriched uranium used as reactor fuel, and the Defense Waste Processing Facility (DWPF) for immobilizing high-level radioactive wastes stored in tanks at the Savannah River Plant. The FMF is expected to become operational in late 1986; the FPF and DWPF are not expected to become operational until the late 1980s.

The Alvin W. Vogtle Nuclear Power Plant is being constructed by the Georgia Power Company near the southwestern border of the Savannah River Plant across the Savannah River. 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 late 1980s.

The Barnwell Nuclear Fuel Plant is located adjacent to, and east of, the Savannah River Plant. 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 to the atmosphere.

The cumulative offsite radiation dose, therefore, is the sum of the doses above natural background from SRP operation with four reactors and their support facilities, the planned FMF, FPF, and DWPF at the Savannah River Plant, and the Vogtle Nuclear Power Plant. The doses associated with two of the SRP reactors, C and K, depend on the alternative cooling water system implemented.

In the tables below, effective whole-body doses are presented for the offsite, maximally exposed individual and effective whole-body collective doses are presented for the offsite population. A comparison of these doses with applicable limits and with natural background radiation is presented in the text. Detailed individual and collective doses for all age groups and important organs from nuclear facilities on, and within 80 kilometers of, the Savannah River Plant are presented in Appendix G. Essentially all of the collective dose results from operation of SRP facilities. These facilities also contribute approximately half of the effective whole-body dose to the maximally exposed individual.

Table 4-24 presents the cumulative doses assuming present cooling water systems for the C- and K-Reactors (existing operation). The doses shown are for the year 2000, when it is expected that all described facilities will be in operation and when radioactive releases from L-Reactor will have reached an equilibrium.

Table 4-25 presents the cumulative doses assuming a once-through cooling tower (gravity feed or pumped feed) for each of the C- and K-Reactors - the preferred cooling alternative. For the impact assessment of the once-through alternative, doses were analyzed for a pump feed, mechanical draft cooling

Table 4-24. Cumulative Effective Whole-Body Doses with Present Cooling Water Systems (Existing Conditions) for C- and K-Reactors

	Maximum individual (mrem/yr)	Collective (person-rem/yr)
Adult	3.25	80.7
Teen	2.64	
Child	1.94	
Infant	0.94	

Table 4-25. Cumulative Effective Whole-Body Doses with a Once-Through Cooling Tower (Gravity Feed or Pumped Feed) for C- and K-Reactors

	Maximum individual (mrem/yr)	Collective (person-rem/yr)
Adult	3.25	80.6
Teen	2.64	
Child	1.94	
Infant	0.94	

tower. Doses would be similar for other once-through configurations such as pumped-feed natural-draft cooling towers and gravity-feed towers (either mechanical draft or natural draft). These doses represent the sum of existing operation doses and changes in doses associated with operation of once-through cooling towers (either gravity feed or pumped feed) for the C- and K-Reactors.

Table 4-26 presents the cumulative doses assuming recirculating cooling towers for each of the C- and K-Reactors. The use of recirculating cooling towers results in the largest change in doses associated with operation of the C- and K-Reactors.

The summary dose tables show that existing operations result in the highest cumulative doses, whereas recirculating cooling towers result in the lowest cumulative doses. The decrease in doses associated with the recirculating cooling towers is greater than that for once-through cooling towers (gravity feed or pumped feed). While other combinations of cooling systems can be chosen, for example, a once-through cooling tower (gravity feed or pumped feed) for the C-Reactor combined with recirculating cooling towers for the K-Reactor, the doses presented represent bounding values.

Table 4-26. Cumulative Effective Whole-Body Doses with Recirculating Cooling Towers for C- and K-Reactors

	Maximum individual (mrem/yr)	Collective (person-rem/yr)
Adult	2.49	
Teen	2.06	78.0
Child	1.69	
Infant	0.94	

The maximum cumulative individual doses are well below the average total-body dose of 93 millirem per year from natural radiation received by an individual living near the SRP site. The doses are also lower than the DOE limits of 100 millirem per year from all pathways and 25 millirem per year to the total body from the air pathway. The collective doses are also much lower than the 109,000 person-rem, total, received from natural radiation by the population living within 80 kilometers of the Savannah River Plant and the Beaufort-Jasper and Port Wentworth drinking-water populations.

The health effects associated with the cumulative-dose impacts for each of the alternative cooling water methods discussed above are presented in Table 4-27.

4.4.5 AIR QUALITY

The cumulative impacts of C- and K-Reactor on air quality are evaluated and presented below. Four combinations of cooling tower systems were considered to predict potential maximum impacts. These combinations are as follows:

1. Once-through towers at both C- and K-Reactors

2. Recirculating towers at both C- and K-Reactors

3. Once-through tower at C- and recirculating tower at K-Reactor

4. Recirculating tower at C- and once-through at K-Reactor.

In analyzing the above combinations, the magnitude of impacts generally was the same; however, the impacted area is somewhat different depending upon the specific combination. The combination that provided the maximum impacted area and, hence, bounds the cumulative air quality impacts is presented below.

The calculated maximum annual-mean frequency of reduced ground-level visibility to less than 1000 meters, due to operation of once-through cooling towers at both the C- and K-Reactors combined was approximately 10 hours per year at

Table 4-27. Cumulative Health Effects

	Cancer fatalities per year	Genetic disorders per year
Existing operations	0.0110	0.0198
Operations with a once-through cooling tower (gravity feed or pumped feed) for C- and K-Reactors	0.0110	0.0198
Operations with recirculating cooling towers for each of the C- and K-Reactors	0.0108	0.0191

13 kilometers from the C-Reactor tower. The calculated annual-mean frequencies of reduced ground-level visibility to less than 1000 meters was less than 2 hours per year within 2 kilometers of each tower.

Because the C- and K-Reactors are separated by about 4.8 kilometers, the maximum ice accumulations within 0.4 kilometer of the towers and their frequencies are the same as those presented for the individual analyses. Figure 4-3 shows the isopleths of frequency of occurrence of elevated visible plumes for once-through cooling tower at both C- and K-Reactors. The maximum occurrence of visible plumes was calculated to be 100 hours per year at 0.4 kilometer from the C-Reactor cooling tower. The maximum was approximately 50 hours per year within 2 kilometers of each of the tower systems in all directions.

Figure 4-4 shows the isopleths of annual solids deposition due to operation of recirculating cooling towers at both C- and K-Reactors. The maximum annual total-solids deposition was estimated to be 22.7 kilograms per acre per year at a distance of 0.8 kilometer from each cooling tower.

4.5 UNAVOIDABLE/IRREVERSIBLE IMPACTS OF ALTERNATIVES

The impacts of the alternative cooling water systems that cannot be avoided by reasonable mitigation measures are described below. Also described are irreversible and irretrievable commitments of resources and short-term uses and long-term environmental implications for the alternative cooling water systems.

4.5.1 UNAVOIDABLE ADVERSE IMPACTS

For the once-through cooling towers for C- and K-Reactors, annual entrainment (43.1×10^6 eggs and larvae) and impingement (8760 fish) losses would be similar to those resulting from current operations. With the implementation

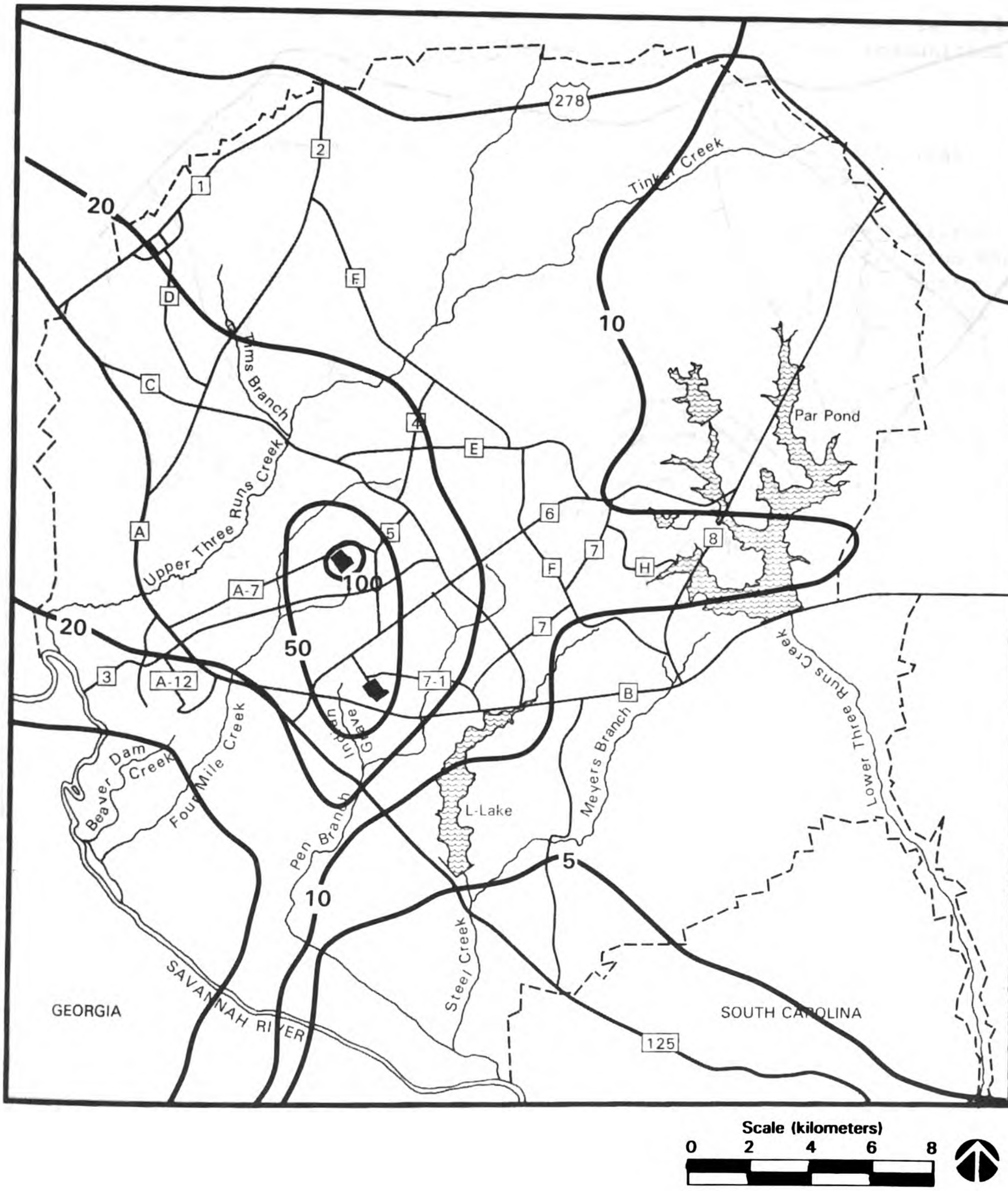

Figure 4-3. C- and K-Reactor Once-Through Towers, Frequency of Occurrence of Elevated Visible Plumes, Hours/Year

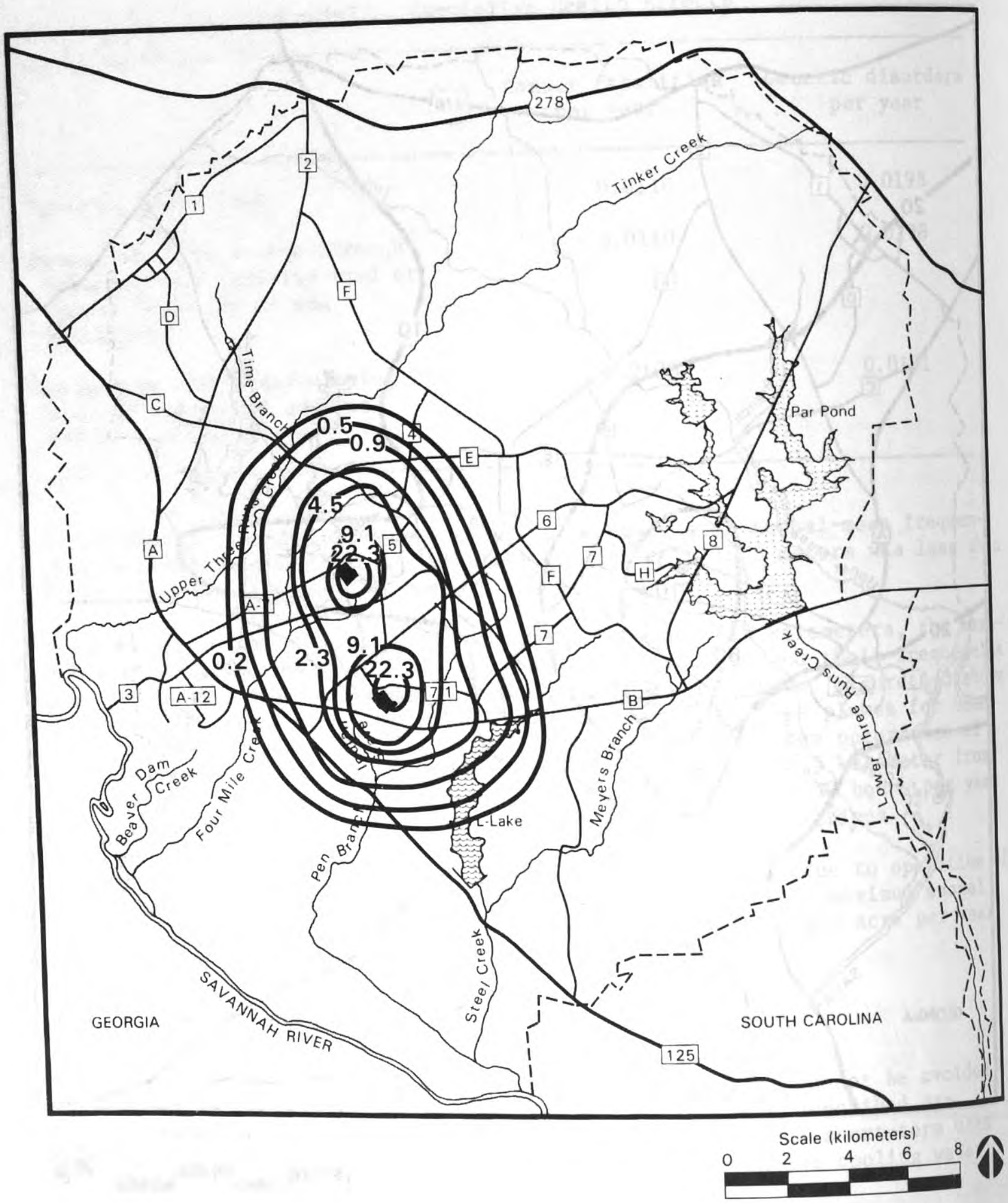

Figure 4-4. C- and K-Reactor Recirculating Towers, Total Solids Deposition, Kilograms/Acrea/Year

of once-through cooling towers, the streams would still be subjected to variable flows, thereby limiting reestablishment of upstream wetland communities along both creeks.

The once-through cooling tower alternatives (pumped-feed) for C- and K-Reactors would adversely affect about 90 and 60 acres of upland habitat, respectively, because of construction and relocation of facilities.

The implementation of the gravity-feed, once-through, cooling-tower alternative would result in environmental impacts similar to those expected from the pumped-feed once-through cooling tower for C- and K-Reactors. Construction and relocation of facilities would disturb approximately 45 and 35 acres of uplands for C- and K-Reactors, respectively.

With the implementation of the recirculating cooling-tower alternatives for C- and K-Reactors, cooling water discharge flows would be reduced from 11.3 to 0.6 cubic meters per second, resulting in reduced habitat area for spawning and foraging. Construction and relocation of facilities would disturb approximately 50 acres of uplands for C-Reactor and 55 acres for K-Reactor.

The increased-flow alternative for the D-Area powerhouse would increase flow to 4.5 cubic meters per second during extreme summer conditions. The expected increase in impingement (from 7 to 142 fish per year) and entrainment (about 0.1×10^6 eggs and larvae) due to increased flow through the 5G pumphouse would be small and the overall impact minimal because entrainment and impingement rates during the summer are low. Temporary increased flow during the summer would increase aquatic habitat. However, wildlife habitat would be reduced and associated wildlife would be displaced temporarily during these intermittent periods of increased pumping. Approximately 4 acres each of uplands and wetlands would be inundated temporarily because of intermittent flooding from increased flow.

The increase in pumping would also result in a temporary increase in the erosion of the stream channel; as a result, increased siltation could occur. Increased pumping could be required during the peak spawning period (May-June) of fish in Beaver Dam Creek. The expected erosion and the resulting siltation would equilibrate rapidly under an increased-flow regime.

The implementation of the direct-discharge alternative for the D-Area powerhouse would significantly alter the existing aquatic community of Beaver Dam Creek because of the reduced stream flow downstream from the discharge canal. Portions of the creek that are currently bordered by swamp would consist of shallow pools or slow-moving water. The reduced flows would also adversely affect the habitat of the currently abundant and reproducing American alligator population. In addition, the Beaver Dam Creek area is sometimes utilized by the wood stork for foraging habitat. Discharge of thermal effluent into the river rather than into the creek would reduce the area of suitable foraging habitat and could impact this species in this area. Approximately 5 acres of uplands and 1 acre of wetlands would be impacted by the construction of the discharge pipeline.

4.5.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Resources that would be irreversibly and irretrievably committed during operation of the cooling water alternatives include (1) materials that cannot be recovered or recycled and (2) materials consumed or reduced to unrecoverable forms. Irretrievable energy use would be equivalent to between 17,000 and 30,000 barrels of crude oil per year for the once-through cooling-tower alternative, for both C- and K-Reactors; there would be a reduction of the equivalent of 10,400 barrels of crude oil per year for the recirculating cooling-tower alternative for C- and K-Reactors. Increased cooling water withdrawal from the Savannah River for the D-Area increased-flow alternative would require additional energy consumption. Irretrievable energy use for pumphouse operations would increase by about 6 percent of the level of current operations. There would not be any additional energy requirements under the direct-discharge alternative.

4.5.3 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The short-term effects of the cooling water alternatives would include the loss of upland sites for their natural productivity. Approximately 90 and 60 acres (pumped feed) and 45 and 35 acres (gravity feed) of upland areas would be required for construction and relocation activities for the once-through towers, and 50 and 55 acres for the recirculating towers, respectively, for C- and K-Reactors. The short-term effects of the D-Area increased-flow and direct-discharge alternatives would include the unavailability of upland and wetland areas for natural productivity. Approximately 4 acres each of uplands and wetlands would be affected by the increased-flow alternative. For the direct-discharge alternative, the impacted areas would include 5 acres of uplands and 1 acre of wetlands. In the long term, the upland vegetation and wetlands could become reestablished through the process of natural selection.

4.6 COMPARISON OF ALTERNATIVES FOR C- AND K-REACTORS AND D-AREA

This section contains a summary comparison of the once-through cooling towers, the recirculating cooling towers and the no-action (continue present operations) alternatives for the C- and K-Reactors and the increased flow with mixing, direct discharge, and no-action alternative for the D-Area powerhouse. In all cases, the no-action alternatives would result in a continuation of existing temperature and flow impacts of the SRP streams, swamp, and adjacent areas. Implementation of either of the other alternatives for any of the three facilities would significantly reduce most environmental impacts and would bring operations of the three facilities into compliance with State water classification standards.

4.6.1 ALTERNATIVES FOR C-REACTOR

4.6.1.1 Once-Through Cooling Tower

The estimated capital cost of constructing the once-through tower system is between $47 million (gravity feed) and $55 million (pumped feed). The increase in annual operating costs for C-Reactor above those for existing system would be between $1.9 million (gravity feed) and $3.1 million (pumped feed). Construction would be completed in about 18 months, after a 9-month design period.

The implementation of this alternative would reduce the thermal effects in Four Mile Creek and its delta while maintaining the current flow levels, thereby increasing the available aquatic habitat for fishes and other organisms. Continued wetland losses would decrease and some successional revegetation would occur. Entrainment and impingement losses would be about the same as with current operation. Improvement of potential habitat for the American alligator and the wood stork would be expected. Air quality impacts, including fogging and icing, elevated visible plumes, and total-solids (drift) deposition would be insignificant. The construction of the once-through cooling tower would disturb one known prehistoric site that has been determined to be insignificant.

About 50 additional curies of tritium would be released per year to the atmospheric pathway and about 50 curies less per year to the liquid pathway for this alternative. This would result in a reduction of the maximum individual dose of 1.1×10^{-4} millirem per year. The total collective dose would decrease by 2.8×10^{-2} person-rem per year. These dose changes are very small compared with existing operations and natural background. The dose to onsite construction personnel due to slightly elevated background levels of radiation produced by plant facilities would be 20 millirem per year based on 2000 hours in cooling tower construction.

The major environmental benefit of this alternative compared to the recirculating cooling tower would be that current flow rates in the creek and delta would be maintained, thereby providing more potential habitat for spawning and foraging by fishes. Its capital cost would be $25 million and $33 million less to construct than recirculating towers and could be constructed in 6 months less than the recirculating cooling tower.

The principal environmental benefit of these alternatives over the no-action alternative would be the reduction of thermal effects in Four Mile Creek and delta and an associated increase in dissolved oxygen levels, both of which would meet State of South Carolina Class B water classification standards.

4.6.1.2 Recirculating Cooling Towers

The capital cost to construct recirculating cooling towers for C-Reactor is estimated at about $80 million and would require about 24 months to construct, after a 9-month design period. The increase in operating costs for this system would be about $500,000 per year.

This alternative would reduce water temperatures in Four Mile Creek and its delta, but would also reduce the flow in these areas by about 92 percent. The reduction in thermal effects would allow recolonization by fishes and other organisms but would greatly reduce the habitat area. Losses of wetlands would essentially cease and an estimated 1000 acres would become reestablished through the process of natural plant succession. There would be no impacts associated with cold shock during the winter. Total annual entrainment (eggs and larvae) would be reduced from 21.6×10^6 to 3.3×10^6, while total annual impingement would be reduced from approximately 4380 to 657 individuals. Potential habitat for the endangered American alligator and wood stork would be improved. Impacts to air quality would be similar to those expected for a once-through tower and, although salt deposition would be higher than for once-through towers, levels would be far below those that would cause reduced vegetative productivity. The same prehistoric site that would be disturbed by construction of the once-through system would also be impacted by this alternative.

The operation of this alternative would reduce flows in Four Mile Creek, resulting in a decrease in the cesium-134 and cesium-137 release to the Savannah River of 0.4 curie per year. About 425 additional curies of tritium would be released per year to the atmospheric pathway and 425 less curies of tritium would be released per year to the liquid pathway. The reduction in cesium-134 and cesium-137 and the change in the release of tritium would result in a decrease in the maximum individual dose of about 3.0×10^{-1} millirem per year. The collective dose would decrease by about 1.1×10^{0} person-rem per year. The dose to onsite construction personnel due to slightly elevated background levels of radiation produced by normal operation of this alternative would be 20 millirem per year based on 2000 hours in cooling tower construction.

The principal environmental benefits of recirculating cooling towers compared to the once-through cooling-tower system would be the reestablishment of a greater amount of wetlands and the reduction in entrainment and impingement losses. The incremental cost would be about $2.6 million less to operate each year than the pumped-feed once-through cooling tower, and about $1.4 million less to operate than the gravity-feed once-through cooling tower. In addition, no Section 316(a) study would be required.

The major advantage over the no-action alternative would be the improvement in water quality in Four Mile Creek and its delta by the reduction of temperatures and the increase in dissolved oxygen concentrations.

4.6.1.3 No Action

There would be no capital costs or increases in annual operating costs with this alternative.

The no-action alternative would result in the continuation of thermal discharge effects in Four Mile Creek and the delta. The high water temperatures would prevent fish from using the waterways for foraging or spawning and would not meet State of South Carolina Class B water classification standards. A potential for cold shock would remain and annual wetland losses of about 28 acres per year would continue. Entrainment and impingement losses would be maintained at current levels. Habitat value for the endangered American alligator and wood stork would remain low. There would be no impacts on air quality or noise or on archaeological sites with this alternative.

The maximum individual dose would continue at about 3.3 millirem per year. The collective dose would be about 80.7 person-rem per year and is about 0.074 percent of natural background.

There are no important environmental benefits to the no-action alternative with respect to either the once-through or recirculating cooling towers. However, there would be a considerable cost savings (in excess of $80 million) over the other two systems.

4.6.2 ALTERNATIVES FOR K-REACTOR

4.6.2.1 Once-Through Cooling Tower

The capital cost for constructing a once-through cooling tower for K-Reactor would be between $45 million (gravity feed) and $54 million (pumped feed). Annual operating costs would average between $1.9 million and $3.1 million over present levels. Implementation of the system would require about 22 months, assuming that the procurement for the C-Reactor cooling system is completed before that for K-Reactor.

The impacts that would result from the implementation of this alternative would be similar to those described above in Section 4.6.1.1 for a once-through tower for C-Reactor, except that the affected area would be Pen Branch and adjacent habitats. There would be a reduction in the existing thermal effects on the aquatic and wetland environments with the implementation of this alternative. Air quality and noise effects would be minimal.

The radiological releases for K-Reactor would be similar to those described in Section 4.6.1.1 for C-Reactor.

An advantage of the once-through tower over recirculating towers would be that existing flow levels in the creek and delta would be maintained, thus providing more potential habitat for fish and other organisms. The system would also cost between $28 million and $19 million less than recirculating towers and could be constructed in 6 months less than the recirculating cooling towers.

The principal advantage of a once-through tower over no action would be the reduction of water temperatures and an increase in concentrations of dissolved oxygen in Indian Grave Branch and Pen Branch, such that K-Area cooling water discharges would meet State of South Carolina water classification standards.

4.6.2.2 Recirculating Cooling Towers

The estimated capital cost of constructing this system would be about $81 million and the estimated increase in annual operating costs for K-Reactor would be about $500,000. About 28 months would be required for construction to be completed, assuming that the procurement for the C-Reactor cooling system is completed before that for K-Reactor.

The environmental effects of constructing and operating recirculating cooling towers for K-Reactor would be similar to those that would result from their implementation at C-Reactor (see Section 4.6.1.2), except the streams to be affected would be Indian Grave Branch and Pen Branch.

This alternative would result in a decrease of cesium-134 and cesium-137 released to the Savannah River of 0.6 Ci per year. The radiological releases for K-Reactor would be similar to those described for C-Reactor in Section 4.6.1.2, except the total decrease in the maximum individual dose and collective dose due to cesium and tritium releases would be 4.5×10^{-1} millirem per year and 1.6×10^{0} person-rem per year, respectively.

The principal environmental benefits of this system over a once-through tower would be the successional reestablishment of a greater amount of wetlands and the reduction of losses due to entrainment and impingement. It would also cost about $2.6 million less to operate per year than with once-through pumped-feed system, and about $1.4 million less to operate than the gravity-feed, once-through, cooling-tower system.

4.6.2.3 <u>No Action</u>

The no-action alternative would result in no changes in the existing impacts on the aquatic and wetland environments associated with the Indian Grave Branch/Pen Branch system. These impacts would be similar to those described for Four Mile Creek and its delta (See 4.6.1.3).

This alternative would not comply with South Carolina's Class B water classification standards. Radiological releases would be the same as those described in Section 4.6.1.3 for C-Reactor, except cesium-137 releases from creek sediments would be slightly higher. There would be a considerable savings in construction (a minimum of $45 million) and operating (a minimum of $1.9 million per year) costs over those for the implementation of either cooling-tower system.

4.6.3 COMPARISONS FOR D-AREA

4.6.3.1 <u>Increased Flow with Mixing</u>

Increased flow could be implemented immediately without any capital costs. Annual operating costs would increase by about $30,000 per year.

The implementation of this alternative would reduce the thermal effect in Beaver Dam Creek during warm periods by temporarily increasing flow. The lowering of water temperatures would improve the aquatic habitat in the creek, which would permit greater use by aquatic organisms. Entrainment and impingement losses would remain about the same as with current operations because there is little fish spawning and few adults in the vicinity of the intake during the summer. Temporary wetland losses would only total about 4 acres during the periods when pumping is necessary. Endangered American alligator habitat would not be affected, but some decrease in the area of wood stork habitat might result from greater water depths during periods when extra pumping would be required to meet water classification standards. There would be no impacts to air quality, noise, release of radionuclides, or archaeological resources due to implementation of this alternative.

The principal advantage of this alternative over direct discharge would be that present flows in Beaver Dam Creek would be maintained, thereby preserving the existing aquatic habitat and habitat for the endangered American alligator and wood stork. Also, the estimated costs of implementing this alternative would be about $14 million less than those for the direct-discharge alternative.

The advantage of this alternative over no action would be the removal of thermal effects in the creek during periods of high summer temperatures and the attainment of State of South Carolina Class B water classification standards.

4.6.3.2 Direct Discharge

Construction of the discharge pipeline would require a capital cost of approximately $14 million and require about 22 months to complete. Its operation would increase annual operating costs by about $50,000 per year.

This alternative would lower water temperatures to ambient levels in Beaver Dam Creek by discharging the powerhouse effluent directly to the Savannah River. The removal of the discharge flow from Beaver Dam Creek would decrease water levels in the creek, thereby reducing available spawning and foraging habitat for aquatic organisms. An estimated 1 acre of wetlands and 5 acres of uplands also would be affected by the construction of the pipeline. There would be small increases in water temperatures within the discharge mixing zone in the river. Entrainment and impingement effects would be the same as for present operating conditions. The decrease in water level and removal of heated water from the creek would significantly degrade the existing endangered American alligator and wood stork habitat. There would be no impacts on air quality, noise, radiological releases, or archaeological resources.

The only advantage of direct discharge over the increased flow alternative would be the complete elimination of all thermal discharges from Beaver Dam Creek. The advantage of this alternative over no action would be the elimination of releases of heated water to the creek.

4.6.3.3 No Action

There would be no costs or delays associated with this alternative. It would maintain the existing environmental conditions in Beaver Dam Creek. Periodically, water temperatures would exceed the 32.2°C Class B water classification standards and would continue to limit the use of the area by aquatic organisms at these times. Entrainment and impingement losses would remain at present levels. The existing habitat for the endangered American alligators and marginal foraging habitat for wood storks would be unchanged.

The only environmental advantage to selecting the no-action alternative over increased flow would be the prevention of adverse impacts to about 4 acres of wetlands and 4 acres of uplands; there would also be a saving in estimated operating costs.

The principal environmental benefit of this alternative over direct discharge would be that it would maintain existing water flows and levels in Beaver Dam Creek, thereby maintaining habitat for the endangered American alligator and wood stork and aquatic organisms. It would also prevent adverse impacts to about 1 acre of wetlands and 5 acres of uplands due to construction. There would also be a capital cost savings of $14 million initially and $50,000 per year thereafter.

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CHAPTER 5

FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

This chapter summarizes the major Federal and State of South Carolina requirements that are applicable to the cooling water alternatives for C- and K-Reactors and the D-Area coal-fired powerhouse. Section 5.1 discusses applicable statutes and regulations. Sections 5.2 through 5.8 identify the actions that are needed or have been taken to satisfy these requirements. Table 5-1 lists the permits and other environmental approvals needed for implementation of the cooling water alternatives discussed in this EIS and the status of each.

In addition to securing these permits and complying with applicable standards, the U.S. Department of Energy (DOE), as a Federal agency, is also required to comply with a number of separate environmental requirements, such as the National Environmental Policy Act (NEPA) and wetlands/floodplains review requirements. DOE has established its own orders and regulations to ensure the environmental, health, and safety protection of its facilities (Section 5.9).

5.1 APPLICABLE STATUTES AND REGULATIONS

National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.)

The National Environmental Policy Act of 1969, as amended, requires "all agencies of the Federal Government" to prepare a detailed statement on the environmental effects of proposed "major Federal actions significantly affecting the quality of the human environment." This environmental impact statement has been prepared in accordance with the Council on Environmental Quality Regulations on Implementing the National Environmental Policy Act (40 CFR 1500-1508) and DOE Guidelines for Compliance with the National Environmental Policy Act (45 FR 20694, March 28, 1980), as amended.

Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)

DOE is required to comply with radiation guidance established pursuant the Atomic Energy Act of 1954, as amended [42 U.S.C. 2201(g)], which authorizes the establishment by rule, regulation, or order standards to protect health or minimize dangers to life or property. In accordance with the Energy Reorganization Act of 1974, DOE defense-related operations are not subject to the regulations of the Nuclear Regulatory Commission. DOE has issued extensive standards and requirements to ensure safe operations.

Executive Order 12088 (October 13, 1978)

This Executive Order requires Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the following Federal laws:

1. Toxic Substances Control Act (15 U.S.C. 2601 et seq.)

Table 5-1. Required Regulatory Permits and Notifications

Activity/facility	Requirement(s)	Agency	Status
Water			
Cooling water system construction	Construction permits	South Carolina Department of Health and Environmental Control, Industrial and Agricultural Wastewater Division	To be submitted by March 31, 1987 subject to the appropriation of funds funds by Congress
	Section 404 permit[a]	U.S. Army Corps of Engineers (COE)	To be submitted prior to construction
	Section 401 certification[b]	South Carolina Department of Health and Environmental Control, Industrial and Agricultural Wastewater Division	Requested by COE as as part of the dredge and fill permit process
	Section 10 permit for structures in navigable waters[a]	U.S. Army Corps of Engineers (COE)	To be submitted prior to construction
	Permit for structures in navigable waters[a]	South Carolina Budget and Control Board	To be submitted prior to construction

Table 5-1. Required Regulatory Permits and Notifications (continued)

Activity/facility	Requirement(s)	Agency	Status
Cooling water discharges	NPDES permit	South Carolina Department of Health and Environmental Control, Industrial and Agricultural Wastewater Division	Issued; modification to permit conditions to be made prior to operation of selected cooling water system
Compliance with delta 2.8°C temperature requirement[b]	316(a) (thermal impact) study	South Carolina Department of Health and Environmental Control, Industrial and Agricultural Wastewater Division	Plans for conducting studies to be submitted within two months following project completion
Water withdrawal water use	Quarterly reporting	South Carolina Water Resources Commission	Routine reports will continue to be submitted
Endangered species	Consultation/ biological assessment	U.S. Fish and Wildlife Service	Consultations with FWS in progress
Fish and Wildlife Coordination Act	Consultation/ consideration of fish and wildlife resources	U.S. Fish and Wildlife Service	Consultations with FWS in progress

Table 5-1. Required Regulatory Permits and Notifications (continued)

Activity/Facility	Requirement(s)	Agency	Status
Migratory Bird Treaty Act	Consultation with FWS	U.S. Fish and Wildlife Service	Consultation with FWS in progress
Anadromous Fish Conservation Act	Consultation with FWS	U.S. Fish and Wildlife Service	Consultation with FWS in progress
Historic preservation	Archaeological survey and assessment	South Carolina Historic Preservation Officer	Surveys and assessments completed; consultation with SHPO in progress.
Floodplains/wetlands[c]	Assessment and determination	U.S. Department of Energy	Notice to be published in Federal Register concurrently with Notice of Availability of the draft EIS; determination published after completion of final EIS.

[a]Applicable to the D-Area coal-fired powerhouse direct discharge alternative.
[b]Applicable to once-through cooling towers alternatives for C- and K-Reactors and the increased pumping alternative for the D-Area coal-fired powerhouse.
[c]Refer to Appendix F.

2. Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.)

3. Public Health Service Act, as amended by the Safe Drinking-Water Act (42 U.S.C. 300 (f) et seq.)

4. Clean Air Act (42 U.S.C. 7401 et seq.)

5. Noise Control Act (42 U.S.C. 4901 et seq.)

6. Solid Waste Disposal Act (42 U.S.C. 6901 et seq.), also referred to as the Resource Conservation and Recovery Act.

National Historic Preservation Act of 1966 (16 U.S.C. 470 et seq.)

No permits, certifications, or approvals related to historic preservation are required; however, DOE must provide the Advisory Council on Historic Preservation an opportunity for comment and consultation, as required by the Historic Preservation Act of 1966 (16 U.S.C. 470(f) et seq.). Section 106 of this Act requires any agency with jurisdiction over a Federal "undertaking" to provide the Council an opportunity to comment on the effect the activity might have on properties included in, or eligible for nomination to, the National Register of Historic Places.

In addition, Executive Order 11593 (May 13, 1971) requires Federal agencies to locate, inventory, and nominate properties under their jurisdiction or control to the National Register of Historic Places if those properties qualify. Until this process is complete, the agency must provide the Advisory Council an opportunity to comment on the possible impacts of the proposed activities on the properties.

Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) (May 24, 1977)

These Executive Orders require government agencies to avoid to the extent practicable any short- and long-term adverse impacts on floodplains and wetlands wherever there is a practicable alternative. DOE has issued regulations (10 CFR 1022), which establish DOE procedures for compliance with these Executive Orders.

Section 118 of the Clean Air Act, as amended (42 U.S.C. 7420)

Section 118 of the Clean Air Act, as amended, requires that each Federal agency, such as DOE, which has jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all Federal, State, interstate, and local requirements" with regard to the control and abatement of air pollution. Authority for regulation of air emissions has been delegated by the U.S. Environmental Protection Agency (EPA) to the South Carolina Department of Health and Environmental Control (SCDHEC), Bureau of Air Quality Control. SCDHEC requires air emission construction permits for the construction, alteration of, or addition to a source of air emissions. An air emission operating permit is required for any new and continuing source of air contaminants. A Prevention of Significant Deterioration (PSD) review is required for any proposed construction of a new major source or any modification of a major source that will result in a significant increase in the emission rate. EPA has also promulgated final regulations for airborne radiation limits at DOE facilities (40 CFR 61; 50 FR 5190).

Section 316(a) of the Federal Water Pollution Control, as amended (33 U.S.C. 1326)

Section 316(a) of the Federal Water Pollution Control Act, as amended, authorizes the EPA's Regional Administrator to set alternative effluent limitations on the thermal component of discharges if the owner/operator (DOE) demonstrates to the satisfaction of the Regional Administrator that the proposed effluent limitations are "more stringent than necessary to ensure the protection and propagation of a balanced, indigenous population of fish, shellfish, and wildlife in or on a body of water into which the discharge is to be made." Such a demonstration is to be made to SCDHEC, which has received the NPDES authority and is the decisionmaker, with program overview by EPA. The owner/operator must demonstrate, for the cooling water alternative to be implemented, that the critical functions of a particular trophic level are maintained in the water body as they existed before the introduction of heat and that the impact caused by the heated effluent will not result in appreciable harm to the balanced, indigenous community. The demonstration is to include scientific evidence that a balanced biological community will be maintained; there will be no adverse impacts to threatened and endangered species; no unique or rare habitats will be destroyed; a zone of passage for representative, important species will be provided; and receiving-water temperatures outside any (State-established) mixing zone will not exceed the upper temperature limits for survival, growth, and reproduction of any representative, important species occurring in the receiving water.

Section 404 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1344); River and Harbors Act of 1899 (33 U.S.C. 401 et seq.)

The Federal Water Pollution Control Act, as amended, requires all branches of the Federal Government engaged in any activity that might result in a discharge or runoff of pollutants to comply with Federal, State, interstate, and local requirements. Authority for implementation of these requirements has been given to the U.S. Army Corps of Engineers (COE) for the discharge of dredged or fill material into the waters of the United States (404 permits); SCDHEC has been delegated authority by EPA to regulate wastewater discharges (NPDES permits). Individual (case-by-case) permits issued by the COE under Section 404 of the Federal Water Pollution Control Act, as amended, are also reviewed by EPA (40 CFR 230). The discharge of dredged and fill material in headwaters of creeks where the natural flow is 0.142 cubic meter per second or less is covered under a "nationwide" permit issued by the COE.

The Rivers and Harbors Act of 1899 prohibits dredging, construction, or other work in or affecting navigable waters of the United States, except in compliance with Sections 9 and 10 of the Act. The COE is empowered to issue permits specifying acceptable activities in navigable waters (33 CFR 320.4, 321, 322, and 325).

The State of South Carolina's Budget and Control Board has a parallel permitting system with the COE (permits for construction in navigable waters, Regulation 19-450), which is administered by the South Carolina Water Resources Commission. The permit application submitted to the COE will be the same as that submitted to the State of South Carolina for its parallel system.

Section 401 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1341

Section 401 of the Federal Water Pollution Control Act, as amended, requires certification from SCDHEC by which discharges of dredged and fill material into navigable waters will comply with the applicable effluent limitations and water-quality standards of the Act. This certification is a prerequisite for the 404 permit.

South Carolina Pollution Control Act, as amended (Title 48, Chapter 1 of the 1976 Code of Laws of South Carolina)

This Act provides authority to SCDHEC to require construction permits for the construction of any wastewater-treatment facility and any wastewater collection and transmission system. It requires that an engineering report and specifications be submitted to SCDHEC along with a construction permit application. Construction cannot begin until SCDHEC has approved the engineering report and issued a construction permit.

Noise Control Act of 1972, as amended (42 U.S.C. 4901 et seq.)

Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies "to the fullest extent within their authority" to carry out programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)

The Endangered Species Act of 1973, as amended, is intended to prevent the further decline of endangered and threatened species and to bring about the restoration of these species and their habitats. The Act, which is jointly administered by the Departments of Commerce and the Interior, does not require a permit, certification, license, or other formal approval. Section 7 does, however, require consultation to determine whether endangered and threatened species are known to have critical habitats on or in the vicinity of the proposed action.

Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661 et seq.)

The Fish and Wildlife Coordination Act, as amended, requires that equal consideration be given to the conservation of fish and wildlife resources during the development of a water-related project. Specifically, the Act requires that consultation be carried out with the Fish and Wildlife Service (FWS) and appropriate State wildlife agencies with a view to the conservation of wildlife resources by preventing loss of and damage to such resources and by providing for the development and improvement thereof in connection with the project. DOE is required to give full consideration to the recommendations of the Secretary of the Interior and the State agency, and the project plan shall include such justifiable means and measures for wildlife purposes that the reporting agency finds should be adopted to obtain maximum overall project benefits. No permit is required by this Act. However, DOE, subsequent to its consultations with the FWS, will consider the mitigation of impacts to fish and wildlife resources in accordance with the FWS Mitigation Policy (DOI, 1981).

Migratory Bird Treaty Act (16 U.S.C. 703 et seq.)

The Migratory Bird Treaty Act was enacted primarily to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying the mode of harvest, hunting seasons, bag limits, etc. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill...any migratory bird." Thus, avian mortality attributable to SRP operations would be unlawful under the provisions of this Act. Although no permit for this project is required under the Act, DOE is required to consult with the FWS regarding impacts to migratory birds, and to evaluate ways to avoid or minimize these effects in accordance with the FWS Mitigation Policy (DOI, 1981).

Anadromous Fish Conservation Act (16 U.S.C. 757a-f)

The principal purpose of the Anadromous Fish Conservation Act is to enhance the conservation and development of the anadromous fishery resources of the United States that are subject to depletion from water resource development. Its applicability to the Savannah River Plant is that populations of anadromous fishes are to be sustained and their movements unobstructed by Plant operations. Although there is no permit required by this Act, DOE is required to consult with the FWS regarding impacts to anadromous fishes, and to evaluate ways to avoid or minimize these effects in accordance with the FWS Mitigation Policy (DOI, 1981). When an anadromous fish is also an endangered species, the National Marine Fisheries Service (U.S. Department of Commerce) would be involved through the Endangered Species Act.

Safe Drinking Water Act, as amended (42 U.S.C. 300f et seq.)

The Safe Drinking Water Act's primary objective is to protect the quality of public water supplies and all sources of drinking water. SCDHEC has primary enforcement responsibility through the State Safe Drinking Water Act of 1976, as amended (Title 44, Chapter 55 of the 1976 Code of Laws of South Carolina). SCDHEC administration and enforcement consist of construction permits, preliminary site inspections, final construction inspections, monthly sampling collections, and regular operations and maintenance inspections.

5.2 HISTORIC PRESERVATION

An archaeological survey and testing program was conducted by the Savannah River Plant Archaeological Research Program, South Carolina Institute of Archaeology and Anthropology, from May 16 through August 17, 1984, to determine the significant sites that would be affected by the implementation of cooling water alternatives for C- and K-Reactors in the Pen Branch and Four Mile Creek areas. During this survey, 65 discrete archaeological resource sites were located within these areas. Of these 65 sites, 23 are considered to be significant. However, the only site that potentially could be affected by proposed alternatives for C-Reactor is 38BR548, which is one of the 42 sites considered to be not significant. The proposed cooling water alternatives for K-Reactor involve none of the sites.

The 23 sites that are considered to be archaeologically significant are potentially eligible for nomination to the National Register of Historic Places. Consultation with the South Carolina State Historic Preservation Officer is presently under way and informal comments have indicated that none of these sites will be recommended for inclusion in the National Register.

An extensive archaeological survey was conducted by the Savannah River Plant Archaeological Research Program during October and November 1985 along Beaver Dam Creek to identify significant archaeological sites that could be affected by the cooling water alternatives for the D-Area powerhouse. During this survey, no significant archaeological sites were located that would be affected by the direct-discharge alternative. One significant site was identified that fell within the general area potentially affected by the increased-flow-with-mixing alternative. However, due to its specific location, this site would not be affected by erosion or inundation due to the increased pumping to the raw-water basin alternative. This site will be recommended by DOE to the State Historic Preservation Officer for eligibility for nomination to the National Register of Historic Places. DOE will also request a determination of "no effect" for this site if the increased-pumping alternative is selected. Consultations with the State of South Carolina Historic Preservation Officer are presently under way.

5.3 SOLID WASTE DISPOSAL

The SRP sanitary landfill is designed and operated according to SCDHEC guidelines for the purpose of receiving domestic waste from SRP construction and operational activities. The sanitary landfill site is being expanded to 67 acres. Solid nonhazardous wastes generated during construction of selected alternatives will be disposed of in this facility. No hazardous wastes will be generated as a result of implementing any cooling water alternative discussed in this EIS.

5.4 ENDANGERED SPECIES

The Endangered Species Act requires Federal agencies to ensure that none of their actions jeopardizes the continued existence of endangered or threatened species (or those that are proposed as such) or result in the destruction or adverse modification of designated critical habitat for such species. Federal agencies are required to consult with the FWS and/or the National Marine Fisheries Service (NMFS) regarding the implementation of a proposed action. If the FWS or the NMFS indicates that an endangered or threatened species (or one proposed as such) or critical habitat could be present in the area of the proposed action, a biological assessment must be prepared. This assessment is used as a basis for evaluating the effects on Federally protected species through the formal consultation process.

Consultations with the FWS on the American alligator, red-cockaded woodpecker, and wood stork are in progress. The need for preparation of a biological assessment for each of these species will be determined through this formal consultation process. The National Marine Fisheries Service (NMHS) had previously concurred in DOE's determination that the population of the shortnose sturgeon in the Savannah River would not be adversely affected by SRP operations (Oravetz, 1983).

5.5 WILDLIFE AND FISHERIES

Three regulations afford protection to wildlife and fisheries resources; they are the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, and the Anadromous Fisheries Conservation Act. None of these acts requires the application for or acquisition of a permit. Each Act, however, requires that DOE consult with the FWS about impacts to fish and wildlife.

Consultations are currently underway with the FWS to ensure that DOE will comply fully with these three Acts. To assist in these consultations, a Habitat Evaluation Procedure (HEP) analysis is currently being prepared. This analysis will identify the value of habitat to be gained or lost with the potential implementation of the cooling water alternatives discussed in this EIS and to assess the need for any further mitigation. A list of species in the affected areas will be developed and field data will be collected for parameters and tabulation of information by species and community types. U.S. Fish and Wildlife Service methodologies and models will be used in the HEP analyses.

5.6 WATER QUALITY

Section 402 of the Federal Water Pollution Control Act, as amended, is the basis for controlling "point source" discharges of pollutants into navigable waters of the United States through the National Pollutant Discharge Elimination System (NPDES); this system is administered by the EPA, which has delegated NPDES permitting authority in South Carolina to SCDHEC.

The following sections discuss the applicable State of South Carolina water classification standards, requirements, and water quality permits associated with the implementation of alternative cooling water systems for C- and K-Reactors and the D-Area coal-fired powerhouse.

Water Classification Standards

The State of South Carolina Class B water classifications standards (Regulation 61-68) applicable to the implementation of the cooling water alternatives include the following limits on the temperature of thermal effluents:

- Section D(8)(a) - The water temperature of all Class A and Class B free flowing waters shall not be increased more than 2.8°C above natural temperature conditions or exceed a maximum of 32.2°C as a result of the discharge of heated liquids unless a different temperature standard as provided for in Section E. has been established, a mixing zone as provided in D.(5) has been established, or a Section 316(a) determination under the Federal Water Pollution Control Act, as amended, has been completed.

- Section D(9) - The numeric standards of Section D. and Section E. of this regulation are applicable to any flowing waters when the flow rate is equal to or greater than the minimum 7-day average flow rate that occurs with an average frequency of once in 10 years (7Q10). Uses will be protected to the greatest extent possible, regardless of flow.

- Section D(5)(a) - Mixing zones that are used for waste-treatment effluents shall allow safe passage of aquatic organisms, and shall allow for the protection and propagation of a balanced indigenous population of aquatic organisms in and on the water body. The mixing zone size shall be based on critical flow conditions. The mixing zone shall not be an area of waste treatment nor shall it interfere with or impair existing recreational uses, existing drinking water supply uses, existing industrial or agricultural uses, or existing or potential shellfish harvesting uses.

Requirements

On January 3, 1984, DOE and SCDHEC mutually agreed on a Consent Order (84-4-W) that temporarily superseded the temperature requirements of the NPDES permit and established a process for SRP thermal discharge compliance with the State of South Carolina's water classification standards. This Consent Order was modified on August 27, 1985, to include an implementation schedule for the selected cooling water systems. Major requirements contained in the amended Consent Order and their status are briefly summarized below.

Comprehensive Cooling Water Study - DOE began a 2-year Comprehensive Cooling Water Study (CCWS) with data collection during Fiscal Years 1984 and 1985 to evaluate the environmental effects of present intakes and releases of cooling water by SRP facilities. The CCWS has two primary objectives: the first is to quantify the environmental effects associated with the large-volume withdrawal and discharge of cooling water on the Plant; the second is to evaluate the significance of any environmental impacts attributed to cooling water intake and discharge.

E. I. du Pont de Nemours and Company and the Savannah River Ecology Laboratory are conducting the CCWS for DOE. Participating in the study in a review and advisory capacity are the State of South Carolina, the State of Georgia, the U.S. Environmental Protection Agency (Region IV), the U.S. Fish and Wildlife Service (Region IV), and the U.S. Army Corps of Engineers (South Atlantic Division).

An annual SRP report (Du Pont, 1985) documents historic data pertinent to the study's objectives and new data developed during Fiscal Year 1984. A final report, to be issued following the end of the study in August 1986 will document additional data collected during Fiscal Year 1985 and conclusions. This EIS incorporates data from this ongoing study.

Thermal Mitigation Study - In compliance with the Consent Order, a Thermal Mitigation Study (DOE, 1984) describing the cooling water systems that could be implemented for C- and K-Reactors and the D-Area coal-fired powerhouse was submitted to SCDHEC on October 3, 1984.

Implementation Schedule - As outlined in the Consent Order, plans and specifications for the selected cooling water systems, subject to the appropriation of funds by Congress, are to be submitted to SCDHEC on or before March 31, 1987. The Consent Order further provides for the start of construction of the selected cooling water systems for C- and K-Reactors on or before September 30, 1987, with completion of the selected system for C-Reactor on or before March 31, 1989, and for the K-Reactor on or before July 31, 1989. The implementation schedule for the construction of the selected D-Area cooling water system is to be contained in a submittal of plans and specifications on or before March 31, 1987, and is to become enforceable after approval by SCDHEC. Within 2 months after completion of the cooling water systems, plans of study for successful 316(a) demonstrations are to be submitted to SCDHEC if the alternatives selected do not comply with the delta-2.8°C ambient temperature requirement. To comply with the provisions of the Consent Order, DOE (1) submitted an FY 1987 budget that includes funding for design (before September 30, 1985), (2) submitted an FY 1988 budget that includes funding for final design and start of construction, and (3) will submit an FY 1989 budget for completion of construction.

Permits - Before construction of the selected cooling water systems, DOE will submit the required wastewater construction permit applications to SCDHEC for its approval.

Construction of the pipeline and discharge sparging system for the D-Area direct-discharge alternative will require Section 10 and 404 permits from the Army Corps of Engineers. Section 401 certification from SCDHEC will also be required for this alternative to ensure that construction and operations-related discharges into navigable waters will comply with applicable water classification standards. If this alternative is selected, DOE will submit the necessary permit applications to the COE for its approval and the required SCDHEC certification before construction.

DOE will submit plans of study for conducting Section 316(a) demonstration studies within 2 months after completion of the selected cooling water systems if the selected cooling water systems do not meet the delta-2.8°C ambient temperature requirement (i.e., once-through cooling towers for C- and K-Reactors, and increased pumping to the raw water basin for the D-Area coal-fired powerhouse). The Section 316(a) demonstration studies will assess whether the thermal discharge conditions for the implemented cooling water systems will ensure the protection and propagation of a balanced indigenous population of fish and wildlife in and on the waters affected by the thermal discharge.

In addition to these permits, DOE will continue to report on a quarterly basis to the South Carolina Water Resources Commission surface- and groundwater use, including changes in surface-water withdrawals associated with the implementation of the selected cooling water systems.

5.7 FLOODPLAINS/WETLANDS

A floodplain/wetlands assessment is presented in Appendix F of this EIS. A notice of this floodplains/wetlands assessment will appear in the Federal Register at the same time as a notice of availability of this draft EIS. A floodplains/wetlands determination will appear in the Federal Register after completion of the final EIS.

5.8 AIR QUALITY

The authority for regulation of air emissions has been delegated by EPA to the SCDHEC Bureau of Air Quality Control. The Bureau issues construction and operating permits and performs Prevention of Significant Deterioration (PSD) reviews. Because existing facilities will supply steam and electric power for any needed construction activities, no new SCDHEC operating permits will be required for C- and K-Reactors or the D-Area powerhouse.

The implementation of cooling towers for C- and K-Reactors will not emit any air contaminants that are regulated by an air emission permit.

The EPA has retained jurisdiction for the regulation of airborne radionuclides. The Savannah River Plant operates within the limits of the EPA's final regulations (50 FR 5190). The cooling water alternatives discussed in this EIS will be within these limits.

5.9 DEPARTMENT OF ENERGY HEALTH AND SAFETY ORDERS

DOE is responsible for ensuring the health and safety of its own facilities and has established comprehensive health, safety, and environmental programs. DOE Orders pertaining to the construction and operation of cooling water alternatives include:

- Order 3790.1, "Occupational Safety and Health Program for Federal Employees," December 11, 1980
- Order 5440.1C, "National Environmental Policy Act," April 9, 1985
- Order 5480.1A, "Environmental Protection, Safety, and Health Protection Program for DOE Operations," August 13, 1981
- Order 5482.1A, "Environmental Protection, Safety, and Health Protection Appraisal Program," August 13, 1981
- Order 5483.1, "Occupational Safety and Health Program for a Government Owned Contractor Operated Facility," April 13, 1979
- Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," February 24, 1981
- Order 5700.6A, "Quality Assurance Guidelines," August 13, 1981
- Order 6430.1, "Department of Energy General Design Criteria Manual," December 12, 1983

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Oravetz, C. A. (Chief, Protected Species Branch, U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service), 1983. Letter to M. J. Sires, Assistant Manager for Health, Safety and Environment, U.S. Department of Energy, Savannah River Operations Office, F/SER 23:AM:CF, St. Petersburg, Florida.

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[a]This draft environmental impact statement was reviewed and approved in accordance with DOE Order 5440.1C, Implementation of the National Environmental Policy Act.
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EDUCATION	B.S., Wildlife and Fisheries Sciences, Texas A&M University
EXPERIENCE TECHNICAL SPECIALTY	Seven years. Ecological baseline studies, permitting and regulatory analyses
EIS RESPONSIBILITY	Prepared terrestrial and endangered species portions of Chapters 3 and 4 and Appendixes C and F

NAME — Jon A. Cudworth

AFFILIATION — NUS Corporation

EDUCATION — J.D., Thomas M. Cooley Law School
M.S., Resource Development, Michigan State University
B.S., Resource Development, Michigan State University

EXPERIENCE TECHNICAL SPECIALTY — Eight years. Environmental law and regulatory compliance, biological sciences

EIS RESPONSIBILITY — Performed technical review of Chapter 5

NAME — John A. Davis

AFFILIATION — NUS Corporation

EDUCATION — B.A., Environmental Studies, Edimboro State College

EXPERIENCE TECHNICAL SPECIALTY — Eight years. Land use and cultural resources; preparation of environmental reports, assessments, and impact statements; design and implementation of field studies

EIS RESPONSIBILITY — Performed technical reviews of cultural resources baseline and impact assessments

NAME — Raymond J. Dever, Jr.

AFFILIATION — NUS Corporation

EDUCATION — M.S.E., Water Resources, Princeton University
M.S., Environmental Engineering, California Institute of Technology
B.S./B.A., Civil Engineering/Urban Studies, Brown University

EXPERIENCE TECHNICAL SPECIALTY — Eleven years. Environmental impact studies, surface- and groundwater modeling and monitoring, facilities planning for water supply, wastewater, sludge, and solid waste

EIS RESPONSIBILITY — Prepared Section 4.5. Performed technical reviews of hydrology and water quality portions of Chapters 3 and 4

NAME Rachel S. Diamond

AFFILIATION NUS Corporation

EDUCATION M.R.P., Regional Planning, University of Pennsylvania
B.A., Ecology, Rutgers College

EXPERIENCE TECHNICAL SPECIALTY Six years. Regulatory analysis, environmental policy, environmental impact studies, terrestrial ecology, facility siting studies

EIS RESPONSIBILITY Performed technical review of Chapter 5

NAME John A. DiMarzio

AFFILIATION NUS Corporation

EDUCATION M.S., Geology, George Washington University
B.S., Geology, University of Maryland

EXPERIENCE TECHNICAL SPECIALTY Four years. Geologic studies, interpretation of stratigraphic record, slope instability studies

EIS RESPONSIBILITY Prepared geology description for Chapter 3

NAME Yawar H. Faraz

AFFILIATION NUS Corporation

EDUCATION B.S., Nuclear Engineering, University of Maryland

EXPERIENCE TECHNICAL SPECIALTY Two years. Environmental radiological impact analyses and dose assessments; nuclear reactor systems analyses

EIS RESPONSIBILITY Prepared radiological releases and remobilization sections of Chapter 4 and Appendix G

NAME Peter H. Feldhausen

AFFILIATION NUS Corporation

EDUCATION M.S., Geology, University of Wisconsin
B.S., Geology, University of Wisconsin

EXPERIENCE TECHNICAL SPECIALTY Twenty-eight years. Registered geologist and geophysicist; environmental assessment, geology/seismology, hydrology, radioactive cesium transport, alternative cooling water, wetlands assessment

EIS RESPONSIBILITY Assisted in preparation of geology, water quality, and radionuclide transport sections in Chapters 3 and 4 and Appendix D

NAME Gary P. Friday

AFFILIATION NUS Corporation

EDUCATION Ph.D., Fisheries and Wildlife, Michigan State University
M.A., Biology, North Texas State University
B.A., Biology, North Texas State University

EXPERIENCE TECHNICAL SPECIALTY Thirteen years. Aquatic and terrestrial ecosystems, terrestrial ecology, wildlife management, impact assessments

EIS RESPONSIBILITY Principal reviewer of terrestrial ecology sections in Chapters 3 and 4 and Appendixes C and F

NAME Morton I. Goldman

AFFILIATION NUS Corporation

EDUCATION Sc.D., Massachusetts Institute of Technology
M.S., Nuclear Engineering, Massachusetts Institute of Technology
M.S., Sanitary Engineering, Massachusetts Institute of Technology
B.S., Civil Engineering, New York University

EXPERIENCE TECHNICAL SPECIALTY Thirty-seven years. Corporate Technical Director; senior management of site evaluation, safety and environmental assessment, and environmental impact evaluation. Professional Engineer

EIS RESPONSIBILITY Primary reviewer for NUS Corporation

NAME	Arthur B. Gould, Jr.
AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.S., Game Management, Louisiana State University B.S., Wildlife Management, Auburn University
EXPERIENCE TECHNICAL SPECIALTY	Fourteen years. Wetland ecology, wildlife biology, botany, radio telemetry, environmental assessments
EIS RESPONSIBILITY	DOE-SR Task Manager for EIS preparation; principal reviewer of EIS for DOE

NAME	Anne Marie Hale
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geography, University of South Carolina B.S., Geography, University of South Carolina
EXPERIENCE TECHNICAL SPECIALTY	One year. Remote sensing and geographic studies
EIS RESPONSIBILITY	Prepared geography sections in Chapter 3 and assisted in preparation of endangered species sections of Chapter 3 and Appendix C

NAME	Rosalind Huang
AFFILIATION	NUS Corporation
EDUCATION	M.S., Physics, University of Maryland B.S., Physics, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Computer programming for solving problems in shielding and radiation and for processing meteorological data; development of plots, users guides, and documentation; verification and quality review of programs
EIS RESPONSIBILITY	Performed technical review of thermal effluent modeling in Appendix B and thermal performance sections in Chapter 2

NAME	Mary Alice Jennison
AFFILIATION	NUS Corporation
EDUCATION	B.S., Environmental Science, Florida Institute of Technology
EXPERIENCE TECHNICAL SPECIALTY	Three years. Statutory/regulatory analysis, site-specific environmental compliance plans, environmental impact studies
EIS RESPONSIBILITY	Contributed to Chapter 5

NAME	William E. Joyce
AFFILIATION	NUS Corporation
EDUCATION	B.S., Chemical Engineering, University of Connecticut
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Environmental impact studies, radiological dose impacts
EIS RESPONSIBILITY	Performed technical reviews of Appendixes B, D, and G

NAME	John M. Koerner
AFFILIATION	NUS Corporation
EDUCATION	Ph.D. Residency, Geography/Geology, University of Michigan M.A., Geography/Conservation, University of Colorado B.A., Geography/Botany, University of Michigan
EXPERIENCE TECHNICAL SPECIALTY	Twenty-two years. Environmental impact studies, environmental planning, terrestrial ecology, geomorphology, remote sensing, field surveys and mapping, demographics, permitting, public/legal involvement
EIS RESPONSIBILITY	Performed technical review of physical science sections in Chapters 3 and 4

NAME	Barton C. Marcy, Jr.
AFFILIATION	NUS Corporation
EDUCATION	M.S., Zoology-Ichthyology, University of Connecticut B.S., Biology, Wake Forest University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-two years. Environmental impact studies, ichthyoplankton and entrainment studies, fisheries and impingement, aquatic ecology, and marine biology
EIS RESPONSIBILITY	Principal Investigator for EIS preparation; principal technical reviewer of EIS for NUS Corporation. Prepared the Preface and Summary, Chapters 1 and 5, and Appendix H; principal reviewer of aquatic ecology sections in Chapters 3 and 4 and Appendix C

NAME	Geoff McGean
AFFILIATION	NUS Corporation
EDUCATION	B.A., Geography/Economics, Dartmouth College
EXPERIENCE TECHNICAL SPECIALTY	One year. Community relations, socioeconomic impact studies, demographic and economic analyses
EIS RESPONSIBILITY	Prepared socioeconomic sections of Chapters 3 and 4

NAME	David C. Navecky
AFFILIATION	NUS Corporation
EDUCATION	M.S., Water Resources Management, Michigan State University B.S., Environmental Science, Pennsylvania State University
EXPERIENCE TECHNICAL SPECIALTY	Three years. Hydrology/water quality baseline and impact assessment studies
EIS RESPONSIBILITY	Prepared hydrology sections of Chapter 3 and Section 4.5 (unavoidable/irreversible impacts)

NAME Richard S. Nugent

AFFILIATION NUS Corporation

EDUCATION Ph.D., Marine Science, University of Miami
M.S., Biology, Boston College
B.S., Biology, Boston College

EXPERIENCE TECHNICAL SPECIALTY Eighteen years. Environmental impact studies, aquatic ecology, marine and estuarine ecology, water quality

EIS RESPONSIBILITY Prepared descriptions of alternative cooling water system screening process in Chapter 2 and Appendix A, comparative impact sections in Chapters 2 and 4, and assisted in preparation of water quality impact sections in Chapter 4

NAME Joseph F. O'Brien

AFFILIATION NUS Corporation

EDUCATION M.Engr., Water Resources Engineering, Clemson University
M.S., Chemistry-Organic, Lehigh University
B.A., Chemistry, Lehigh University

EXPERIENCE TECHNICAL SPECIALTY Twelve years. Environmental impact and safety studies, rainfall-runoff analyses, water quality studies, water use studies, siting studies, flooding studies; ground-water hydraulics and transport

EIS RESPONSIBILITY Prepared subsurface hydrology description for Chapter 3

NAME James L. Oliver

AFFILIATION NUS Corporation

EDUCATION B.S., Biology, Murray State University

EXPERIENCE TECHNICAL SPECIALTY Fourteen years. Environmental research, limnological studies, thermal effects, ichthyoplankton and zooplankton studies, entrainment and impingement, fisheries ecology

EIS RESPONSIBILITY Assistant Principal Investigator for EIS preparation. Aquatic ecology sections for Chapters 3 and 4 and Appendix C

NAME William Lawrence Poppe

AFFILIATION NUS Corporation

EDUCATION Illinois Institute of Technology
University of Maryland

EXPERIENCE
TECHNICAL SPECIALTY Thirty-two years. Surveying, civil engineering (roads, earthwork, pipelines, drainage, erosion control), environmental studies, land planning

EIS RESPONSIBILITY Prepared cooling water alternative descriptions and resource utilization sections of Chapter 2

NAME Irwin J. Samec

AFFILIATION NUS Corporation

EDUCATION M.U.R.P., Urban and Regional Planning, Michigan State University
B.A., Sociology, Illinois Wesleyan University

EXPERIENCE
TECHNICAL SPECIALTY Fifteen years. Environmental impact statements and assessments, socioeconomic and land-use analyses, transportation studies, water resources and quality

EIS RESPONSIBILITY Principal technical reviewer of EIS for NUS Corporation

NAME Robert L. Schlegel

AFFILIATION NUS Corporation

EDUCATION Degree of Nuclear Engineering, Columbia University
M.S., Nuclear Engineering, Columbia University
B.S., Chemical Engineering, Massachusetts Institute of Technology

EXPERIENCE
TECHNICAL SPECIALTY Twenty years. Radiological dose assessments, environmental impacts

EIS RESPONSIBILITY Responsible for radiological characterization sections in Chapters 3 and 4 and Appendix G

NAME Michael Septoff

AFFILIATION NUS Corporation

EDUCATION M.S., Meteorology-Oceanography, New York University
B.S., Meteorology, City College of New York

EXPERIENCE TECHNICAL SPECIALTY Seventeen years. Meteorology/air quality, data analyses, environmental impact statements, environmental safety analyses, licensing activities

EIS RESPONSIBILITY Prepared characterization of meteorology and climatology for Chapter 3 and contributed to air quality impact section in Chapter 4

NAME John O. Shipman

AFFILIATION NUS Corporation

EDUCATION B.A., English Literature, Georgetown University

EXPERIENCE TECHNICAL SPECIALTY Nineteen years. Publications management; technical writing and editing; environmental assessments and impact statements

EIS RESPONSIBILITY Technical editor of the EIS

NAME Robert L. Shoup

AFFILIATION NUS Corporation

EDUCATION Ph.D., Nuclear Physics, Florida State University
B.S., Physics, Michigan State University

EXPERIENCE TECHNICAL SPECIALTY Fifteen years. Environmental impact statements; environmental, safety analysis, and licensing activities

EIS RESPONSIBILITY Primary reviewer for NUS Corporation

NAME: Robert P. Solomon

AFFILIATION: NUS Corporation

EDUCATION: B.S., Forest Biology, State University of New York

EXPERIENCE TECHNICAL SPECIALTY: Four years. Wetland assessment studies, computer-compatible geographic data base systems, aerial photo interpretation

EIS RESPONSIBILITY: Performed technical reviews of geography sections in Chapter 3

NAME: Seshagiri Rao Tammara

AFFILIATION: NUS Corporation

EDUCATION:
M.S., Chemical Engineering, University of Maryland
M.S., Environmental Engineering, University of Maryland
M.S., Chemical Engineering, Osmania University (Hyderbad, India)
B.S., Chemical Engineering, Osmania University

EXPERIENCE TECHNICAL SPECIALTY: Twelve years. Environmental impact studies, cooling-tower analyses, radiological impact and dose assessments, air quality impacts, thermal performance evaluations and thermal impacts

EIS RESPONSIBILITY: Prepared cooling-tower air quality impacts sections in Chapter 4

NAME: Jerry Tkac

AFFILIATION: NUS Corporation

EDUCATION:
Towson State University
Frederick Community College

EXPERIENCE TECHNICAL SPECIALTY: Eighteen years. Engineering design and drafting; site planning and land development, storm water management, piping systems, highways, collection basins, building and equipment locations

EIS RESPONSIBILITY: Prepared site maps for cooling water alternative descriptions in Chapter 2

NAME	Alan L. Toblin
AFFILIATION	NUS Corporation
EDUCATION	M.S., Chemical Engineering, University of Maryland B.E., Chemical Engineering, The Cooper Union
EXPERIENCE TECHNICAL SPECIALTY	Fourteen years. Hydrologic transport analyses
EIS RESPONSIBILITY	Prepared thermal performance sections of Chapter 2, cumulative thermal discharge effects in Chapter 4, and Appendix B

NAME	Douglas D. Tuckhorn
AFFILIATION	NUS Corporation
EDUCATION	M.S., Mechanical Engineering, Tennessee Technological University B.S., Aeronautical Engineering, Embry Riddle Aeronautical University
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Cooling-system analyses, cooling towers, spray ponds, heat rejection cost-benefit studies, mechanical equipment specifications, plant retrofit design, equipment layouts and arrangements
EIS RESPONSIBILITY	Performed technical review of cooling water alternative descriptions and resource utilization sections of Chapter 2

NAME	Robert H. Werth
AFFILIATION	NUS Corporation
EDUCATION	B.A., Physics, Gordon College
EXPERIENCE TECHNICAL SPECIALTY	Eleven years. Environmental impact studies, sound level studies, noise impact assessments, air quality analysis, permitting
EIS RESPONSIBILITY	Prepared noise impacts sections in Chapter 4

NAME	Patricia L. Wherley
AFFILIATION	NUS Corporation
EDUCATION	B.A., Geography, The George Washington University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Environmental impact studies, demographics, land use and socioeconomic studies, regulatory analyses, public participation programs
EIS RESPONSIBILITY	Performed technical reviews of geography, archaeological historical, and socioeconomic sections of Chapter 3 and 4 and Appendixes E and H

NAME	Philip C. Whitney
AFFILIATION	NUS Corporation
EDUCATION	B.S., Civil Engineering, University of Maine
EXPERIENCE TECHNICAL SPECIALTY	Thirty-seven years. Heavy industrial/utility construction, design, and engineering
EIS RESPONSIBILITY	Performed technical review of cooling water alternative description and resource utilization sections of Chapter 2

NAME	William E. Wisenbaker
AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.B.A., Management, Georgia State University B.S., Chemistry, University of Georgia
EXPERIENCE TECHNICAL SPECIALTY	Nineteen years. Air quality measurements, ecology, environmental impact assessment, compliance with regulations, environmental monitoring
EIS RESPONSIBILITY	Principal reviewer of EIS for DOE

NAME	Carl R. Yates
AFFILIATION	NUS Corporation
EDUCATION	M.S., Biology, West Virginia University B.S., Biology, University of Pittsburgh at Johnstown
EXPERIENCE TECHNICAL SPECIALTY	Four years. Radiological environmental monitoring programs, sample collection audits, land-use surveys, radiochemistry, aquatic ecology
EIS RESPONSIBILITY	Prepared descriptive radiological sections for Chapter 3 and Appendix D