4.2.1.2 Operational Impacts

Socioeconomics

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

Historic and Archeological 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 impact water quality in Castor and Four Mile Creeks and the Savannah River swamp primarily by lowering instream temperatures to meet the State of South Carolina's Class B water classification standard of 32.2°C. Water temperatures from the tower discharge would be at a maximum of about 32°C (Table 2-4) under extreme summer conditions. During an average summer (June-August), the water discharged from the tower would be about 29°C, which compares to an ambient creek temperature of 25°C. TC

The cooling tower would be designed and operated in a manner that would meet the Maximum Weekly Average Temperature (MWAT) criteria (EPA, 1977) to minimize thermal shock of fish that could occur with a reactor outage (Muhlbaier, 1986). Because expected instream temperatures during winter and spring average conditions would be raised more than 2.8°C above ambient due to the operation of the cooling-tower system, a Section 316(a) Demonstration study would be performed after construction and submitted to SCDHEC; this study would demonstrate if 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. BB-3

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 the K-Reactor once-through cooling tower. Effluents discharged would be similar to those associated with the present once-through system except that nonvolatile constituents would be slightly more concentrated due to evaporation losses of water in the tower. Chlorine biocide would be added to reactor cooling water to prevent biofouling of the cooling towers; it would be neutralized with sodium sulfite prior to discharge to Castor Creek. As discussed for K-Reactor, no adverse effects are expected on aquatic biota or water quality from these additions. 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 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; Du Pont, 1985b). BB-1 BB-2

Operation of the once-through cooling-tower system would result in the same small changes in the hydrology of Four Mile Creek and the associated swamp as those described for K-Reactor. The changes would not adversely impact the BC-10 stream system because the flow would be reduced only about 0.8 cubic meter per second when the reactor is operating. When C-Reactor is not operating, the stream flow in Four Mile Creek would continue to be reduced from 11.3 to 0.6 cubic meter per second, on average.

Air Quality

The operation of a once-through natural-draft cooling tower at C-Reactor could result in the formation of ground-level fog, ice, elevated visible plumes, and TE total-solids (drift) deposition on the ground. As discussed in Section 4.1.1.2 and Appendix B, a computer model (Fisher, 1974) was used to predict the atmospheric effects of cooling-tower operation.

The predicted maximum annual mean frequency of reduced ground-level visibility, maximum ice accumulation on horizontal surfaces, and the TC calculated maximum occurrence of visible plumes aloft (primarily on SRP Road 3) would be essentially the same as those presented for K-Reactor in Section 4.1.1.2. The calculated maximum occurrence would be 50 hours per year within 1.5 kilometers of the cooling tower, primarily on SRP Roads A-7, 3, and 5.

TC The calculated maximum annual total-solids deposition within 2 kilometers of the cooling tower would be about 0.5 kilogram per acre per year, the same as that for K-Reactor.

Noise

The operation of a once-through natural-draft cooling tower with gravity feed at C-Reactor would cause increases in noise levels. Cooling-tower noise would come from falling water. Beyond approximately 152 meters from the cooling tower, average sound levels would be below 70 decibels. [Continuous exposure TC to 70 decibels or less has been determined to cause no loss of hearing (EPA, 1974).] At the nearest offsite area, noise from C-Reactor activities would not be detectable.

Ecology

Vegetation and Wetlands

Deposition of drift from a once-through cooling tower for C-Reactor would be similar to that projected for K-Reactor (about 0.5 kilogram per acre per year TC within 2 kilometers). No adverse impacts on vegetation are expected because maximum deposition rates are well below critical values.

The most significant positive 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 when 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, 1987; 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, 1987). The reduction in effluent temperatures would, therefore, have a beneficial impact on wetland communities by significantly reducing wetland loss.

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, because the tower discharge would be located about 1.5 kilometers downstream from C-Reactor.

To assist in ongoing consultations with FWS, a HEP analysis (Mackey et al., 1987) was conducted; it identified the value of habitat to be gained or lost with the once-through cooling-tower alternative (see Section 4.6 and Appendix C for more details on HEP analysis). BC-3

Aquatic Habitat and Biota

The environmental consequences resulting from the operation of a once-through cooling-tower system on aquatic habitat and biota in Four Mile Creek and Castor Creek would be similar to those described for K-Reactor with this alternative. TC

Entrainment and Impingement

The estimated numbers of ichthyoplankton entrained and fish impinged from the operation of the once-through cooling-tower system for C-Reactor would be the same as those described for K-Reactor, because the two reactors draw cooling water from the same sources (1G and 3G canals) and would require the same circulating water volume.

Threatened and Endangered Species TC

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

The first sighting of an active bald eagle nest on the SRP occurred on June 5, 1986. The nest is below Par Pond dam in the Lower Three Runs Creek drainage basin. Because of the nest location and due to the implementation of management practices in accordance with the guidelines of the 1984 bald eagle recovery plan, the FWS issued a finding of "no effect" for this species in 1986 (Henry, 1986). TC

The American alligator 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 reactor operating conditions, the water temperature in Four Mile Creek exceeds the critical thermal maximum (38°C) for American alligators, thus precluding their presence (Sires, 1984). 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 improving the habitat for this species. However, fluctuating water levels and flow rate could inundate the nests, eggs, and hibernation sites.

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

BB-3 Based on studies of the endangered wood stork since 1983, this species forages in the SRP swamps and streams (Meyers, 1984; Coulter, 1986). In 1985, most wood storks foraged in the Four Mile Creek delta and in the swamp between Pen Branch and the Four Mile Creek delta following shutdown of C-Reactor in June (Du Pont, 1987). However, low fish densities, high water temperatures, and increased water depths from existing reactor operations generally limit the value of the creek and the adjacent swamp for wood stork foraging. Impacts to Four Mile Creek wood stork habitat resulting from the implementation of this alternative would be similar to those for the implementation of the same alternative for K-Reactor. Although the stream would be more attractive to fish and other vertebrates, the implementation of this alternative would not significantly improve the availability of wood stork foraging habitat because of high flows and water depth.

BC-3 Formal consultations were held between DOE and the FWS to comply with the Endangered Species Act of 1973. Based on these consultations, the FWS issued a biological opinion that the preferred alternative cooling systems should have no effect on endangered and threatened species (Parker, 1986; Henry, 1986).

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 streambed and floodplains, or those resulting from small process water leaks into the cooling water.

BC-22 As in the K-Reactor evaluation, the operation of the once-through cooling tower at C-Reactor 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 cooling tower would, however, decrease the amount of tritium discharged to the stream and, correspondingly, would increase the amount of tritium released to the atmosphere.

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 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 the cooling water evaporation. 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. BC-22

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. This location has the minimum atmospheric dilution, 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 increases in soft-tissue and effective whole-body doses to the maximally exposed individual due to the atmospheric release of tritium are summarized in Table 4-16.

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

	Incremental dose increase (mrem/yr)	
Age group	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 18 percent higher than the effective whole-body dose.

Population Dose - Collective doses resulting from atmospheric releases associated with this cooling alternative have been 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 Four Mile Creek. The release of tritium would be decreased 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.

Maximum Individual Dose - The annual decrease in soft-tissue and effective whole-body doses received by the maximally exposed individual (as described in Section 4.1.1.2) due to a decrease in the liquid release of tritium from C-Reactor would be the same as that for K-Reactor, which is summarized in Table 4-3.

Population Dose - Decreases in the collective dose to the population within 80 kilometers of the SRP and to the Beaufort-Jasper and Port Wentworth population groups due to a decrease in the liquid release of tritium from C-Reactor would be the same as those for K-Reactor, which are listed in Table 4-4.

Overall Changes in Offsite Doses

Table 4-17 summarizes changes in the effective whole-body dose received by the maximally exposed individual resulting from the operation of this cooling alternative. Changes in the collective dose resulting from the operation of a cooling tower at C-Reactor would be the same as those for K-Reactor, which are listed in Table 4-6.

Table 4-17. Changes in Effective Whole-Body Dose Received by Maximally Exposed Individual Resulting from Operation of C-Reactor Once-Through Cooling Tower (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 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.

TC 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 1.11×10^{-4} millirem, 2.13×10^{-2} person-rem, and

1.13×10^{-2} person-rem, respectively, and would increase the collective effective whole-body dose to the 80-kilometer population by 4.95×10^{-3} person-rem. These dose changes are very small in comparison to the normal year-to-year variations in natural background radiation.

Present tritium releases to the Savannah River from Four Mile Creek result in an effective whole-body dose of 5.92×10^{-2} millirem per year to the maximally exposed adult. 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

Using the risk estimators referred to in Section 4.1.1.2 and the organ doses presented in Appendix G, the population within 80 kilometers of the SRP 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 Plant could experience decreases of 3.84×10^{-6} fatal cancer and 9.87×10^{-6} genetic disorder per year. Changes in annual health effects related to the operation of a cooling tower at C-Reactor would be the same as those for K-Reactor, which are 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 C-Reactor would be accomplished in approximately 42 months following a 9-month design stage. Construction could involve a combined construction workforce for the cooling towers in K- and C-Areas. Section 4.1.2.1 describes the numbers and general types of workers required for construction of recirculating cooling towers for both K- and C-Reactors. This alternative would not impact local communities or services. AO-1 BC-9

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 (see Appendix E for more details).

Water Quality

The construction impacts of recirculating cooling towers on the water quality in Four Mile Creek would be the same as those described for a recirculating cooling tower for K-Reactor (Section 4.1.2.1). 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

BB-3 BC-9 The construction of recirculating cooling towers would result in the disturbance of approximately 60 acres of the habitat. This would include 21 acres for both cooling towers, 38 acres for the pipeline right-of-way, 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. 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.

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 stream 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 4.2.1.1. BC-9 BC-22 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 from airborne releases and 100 millirem per year from all pathways.

Other Construction Impacts

Other construction impacts would be similar to those described for a once-through cooling-tower system for K-Reactor (i.e., air quality, noise, solid waste, and outside construction personnel exposure to radioactive releases). All applicable atmospheric emission standards would be met during construction, solid waste generated from construction would 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 recirculating cooling towers at C-Reactor; the employment of these workers would not cause any socioeconomic impacts in the study area.

Historic and Archeological Resources

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

Water Quality and Hydrology

The effects of the operation of recirculating cooling towers on water quality would be similar to those described for K-Reactor (see Section 4.1.2.2). The operation of recirculating cooling towers would lower discharge temperatures such that the State of South Carolina's Class B water classification standard for maximum instream temperature (32.2°C) would be met throughout the year. However, the discharge from the cooling tower would raise the stream temperature in Four Mile Creek more than the 2.8°C maximum above ambient specified in the water classification standards. Accordingly, a Section 316(a) Demonstration study would be performed to demonstrate if a balanced biological community would be maintained. The flow of Four Mile Creek would be reduced from 11.3 to 1.7 cubic meters per second, similar to that described for Pen Branch with the operation of recirculating towers for K-Reactor (see Section 4.1.2.2). TE

Air Quality

Air quality impacts from the operation of recirculating cooling towers at C-Reactor would be identical to those addressed in Section 4.1.2.2 for the K-Reactor recirculating cooling-tower. BC-9

Noise

The operation of the C-Reactor recirculating cooling towers would cause increases in noise levels. The impacts would be similar to those described in Section 4.1.2.2.

Ecology

Vegetation and Wetlands

The vegetation near the recirculating cooling towers would not be affected adversely by drift from the towers. Operation of the recirculating cooling towers would result in an estimated total solids deposition of about 2.2 kilograms per acre per year within 2 kilometers and 22.7 kilograms per acre per year within 0.5 kilometer of the cooling towers. Because these rates would be much less than the critical values, no significant impacts on vegetation should occur with this alternative. BB-3 BC-9

The primary positive impact on vegetation would be a reduction in the loss of wetland habitat due to reductions in discharge temperature and flow. The operation of 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 1000 acres of wetland habitat that are presently subject to thermal discharges and flooding.

To assist in ongoing consultations with FWS, a HEP analysis (Mackey et al., 1987) was conducted; it identified the value of habitat to be gained or lost BC-3

BC-3 with the recirculating cooling-tower alternative (see Section 4.6 and Appendix C for more details on HEP analysis).

Aquatic Habitat and Biota

The environmental consequences resulting from the operation of a recirculating cooling-tower system on aquatic habitat and biota in Castor and Four Mile Creeks would be similar to those described for Indian Grave Branch and Pen Branch from K-Reactor discharges.

Entrainment and Impingement

BB-3 BD-9 The estimated numbers of ichthyoplankton entrained and fish impinged from operation of the recirculating cooling-tower system for C-Reactor would be the same as those described for K-Reactor because both reactors draw cooling water from the same sources (1G and 3G canals) and would require the same circulating water volume.

Threatened and Endangered Species

BB-3 Implementation of the recirculating alternative would result in a reduction of the effluent discharge in Four Mile Creek from about 11.3 to about 1.7 cubic meters 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. Habitat quality for the American alligator would be markedly improved over present conditions; inundation of nests, eggs, and hibernation sites from high water levels would be improbable.

TC Formal consultations were held between DOE and the FWS to comply with the Endangered Species Act of 1973. Based on these consultations, the FWS issued a biological opinion that the preferred alternative cooling systems should have no effect on threatened and endangered species (Parker, 1986; Henry, 1986).

Radiological Releases

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. The operation of 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 stream bed and transported to the Savannah River. The only radionuclide contained in the Four Mile Creek bed in significant amounts is cesium-137 (Appendix D). The reduced flow would result in a decrease of about 0.21 curie of cesium-137 released per year to the Savannah River.

BC-22 Maximum Individual Dose - Table 4-18 lists the changes in effective-whole-body and most-affected-organ (gonads) doses to the maximally exposed individual resulting from the decrease in cesium-137 released to the Savannah River.

Population Dose - Table 4-19 lists the decreases in the collective doses delivered to the affected population groups.

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

Age group	Incremental dose reduction (mrem/yr)	
	Effective whole body	Gonads[a]
Adult	1.20×10^{-1}	1.20×10^{-1}
Teen	9.21×10^{-2}	9.23×10^{-2}
Child	4.00×10^{-2}	4.01×10^{-2}
Infant	3.86×10^{-4}	3.86×10^{-4}

a. Dose to gonads 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).

BC-22

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

Population group	Incremental collective dose reduction (person-rem/yr)
80-km population	3.35×10^{-1}
Beaufort-Jasper	1.83×10^{-2}
Port Wentworth	6.67×10^{-2}
Total	4.20×10^{-1}

Tritium Releases

The following sections discuss changes in the doses to the maximally exposed individual at the SRP boundary and to offsite population groups (based on year 2000 projections) that are attributable to changes in atmospheric and liquid releases to Four Mile Creek of tritium resulting from operation of recirculating cooling towers.

<u>Atmospheric Releases</u> - 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 hypothetical individual who would receive the highest effective whole-body dose from atmospheric releases associated with this cooling alternative is the same as that described in Section 4.2.1.2.

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

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

	Incremental dose increase (mrem/yr)	
Age group	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 effective whole-body doses to the population within 80 kilometers of the SRP associated with this cooling alternative would increase by 4.22×10^{-2} person-rem per year 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 tritium released to the stream by 425 curies per year (about 1 percent of the total SRP releases of tritium to streams) as a result of evaporation of cooling water. Doses associated with the change in liquid releases are discussed below for both the population and the maximally exposed individual.

Maximum Individual Dose - 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 from C-Reactor is the same as that
TE for K-Reactor, which is summarized in Table 4-11.

Population Dose - Decreases in the effective whole-body dose to the population within 80 kilometers of the SRP and to the Beaufort-Jasper and Port Wentworth population groups due to a decrease in the liquid release of tritium from C-Reactor would be the same as those for K-Reactor, which are listed in Table 4-12.

Overall Changes in Offsite Doses

Table 4-21 summarizes 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. Table 4-22 lists changes in the effective whole-body population dose.

Table 4-21. Changes in Effective Whole-Body and Gonadal 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}	-8.06×10^{-4}	
Cesium transport	-1.20×10^{-1}	-9.21×10^{-2}	-4.00×10^{-2}	-3.86×10^{-4}	BC-22
Net dose change	-1.21×10^{-1}	-9.24×10^{-2}	-4.06×10^{-2}	-9.89×10^{-4}	
		GONADAL 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	-1.20×10^{-1}	-9.23×10^{-2}	-4.01×10^{-2}	-3.86×10^{-4}	BC-22
Net dose change	-1.21×10^{-1}	-9.27×10^{-2}	-4.08×10^{-2}	-1.09×10^{-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. Gonadal 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 recirculating cooling-tower alternative would reduce the annual effective whole-body dose to the maximally exposed adult by 1.21×10^{-1} millirem, and the collective effective whole-body dose to the 80-kilometer population and BC-22 the Port Wentworth and Beaufort-Jasper water users by 2.93×10^{-1}, 2.49×10^{-1}, and 1.14×10^{-1} person-rem per year, respectively. These changes

Table 4-22. Changes in Collective Effective Whole-Body Dose Resulting from Operation of C-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]	-9.58×10^{-2}	-1.82×10^{-1}	-2.78×10^{-1}
Cesium transport	-3.35×10^{-1}	-1.83×10^{-2}	-6.67×10^{-2}	-4.20×10^{-1}
Net dose change	-2.93×10^{-1}	-1.14×10^{-1}	-2.49×10^{-1}	-6.56×10^{-1}

a. Negative sign preceding number denotes decrease in dose.

BC-22 are very small compared with normal year-to-year variation in natural background radiation.

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 effective BC-22 whole-body dose to the maximally exposed adult from cesium releases is 1.37×10^{-1} millirem per year. This alternative would reduce this dose by 1.20×10^{-1} millirem per year.

Health Effects

Using the organ doses and the risk estimators discussed above and presented in Appendix G, the population within 80 kilometers of the Savannah River Plant could experience a decrease of 2.31×10^{-5} cancer fatality and 7.37×10^{-5} BC-22 genetic disorder per year from the operation of this system. The populations at Beaufort-Jasper and Port Wentworth downstream from the SRP could experience decreases of 3.98×10^{-5} fatal cancer and 1.06×10^{-4} genetic disorder per year. Table 4-23 summarizes this information.

4.2.3 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 (via the 1G and 3G intakes) and discharges it into Four Mile Creek. Chapter 3

Table 4-23. Changes in Annual Health Effects

Population group	Genetic disorders	Fatal cancers
80-kilometer radius	-7.37×10^{-5}	-2.31×10^{-5}
Beaufort-Jasper	-3.37×10^{-5}	-1.28×10^{-5}
Port Wentworth	-7.22×10^{-5}	-2.70×10^{-5}
Total	-1.80×10^{-4}	-6.29×10^{-5}

TC

and Appendix C describe the environmental baseline conditions associated with this system. This section summarizes the major environmental impacts of the existing system.

4.2.3.1 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 higher than the natural stream flow of 0.6 cubic meter per second. The pattern of erosion upstream and deposition downstream would 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 75°C, falling to about 44°C at the swamp. Ambient stream temperatures would be about 31°C at these times. In the winter months, temperatures in the creek and swamp would range from 72° to 35°C, while ambient stream temperatures would be about 11°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. TC

Lowered dissolved oxygen concentrations would continue to exist as a result 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 occur naturally 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.

4.2.3.2 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
TC at the rate of approximately 28 acres per year (Du Pont, 1987).

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, macroinvertebrates 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 be expected to be in low abundance 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
TC those periods (Du Pont, 1985b, 1987).

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

4.2.3.3 Entrainment and Impingement

The estimated numbers of ichthyoplankton entrained and fish impinged as a result of use of the no-action alternative for C-Reactor would be the same as
BB-3 those described for this alternative with K-Reactor (Section 4.1.3.3) because
BD-5 the two reactors draw cooling water from the same sources (1G and 3G canals) and would require the same circulating water volume.

4.2.3.4 Threatened and Endangered Species

Temperatures in the thermal region of Four Mile Creek during reactor operations would continue to exceed the critical thermal maximum for the American alligator (Du Pont, 1985b). Four Mile Creek and the swamp would continue to be unfavorable to wood stork foraging due to the 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 implemented. TC

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 4.0 cubic meters per second (five 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).

<u>Air Quality and Noise</u>

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

Habitat and Biota

Balanced communities in all biotic categories presently exist in all natural portions of the Beaver Dam Creek ecosystem and should remain after the implementation of this alternative. Predicted maximum water temperatures would not exceed 32°C and, therefore, would comply with the maximum of 32.2°C required for Class B waters of South Carolina. However, the other temperature criterion for Class B waters (maximum ΔT of 2.8°C above ambient) would be exceeded by as much as an average monthly value of 10°C in the immediate discharge area and by as much as 7°C at the creek mouth (see Appendix B, Tables B-4 and B-5). Accordingly, a Section 316(a) Demonstration would be conducted for NPDES compliance after this alternative system becomes operational. BB-3

Increased flow during the summer should increase aquatic habitat and the abundance and diversity of aquatic biota. However, terrestrial 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 probably would 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).

To compare and assess environmental impacts to the Beaver Dam Creek watershed before and after the implementation of this alternative, the stream system has been divided into two reaches on the basis of the presence of two distinct stream gradients: Reach 1 extends from the D-Area powerhouse cooling water discharge outfall (NPDES Outfall D-001) to the mouth of the Beaver Dam Creek delta; Reach 2 extends from the delta to the Savannah River.

BB-3

Beaver Dam Creek is a low potential impact area for phytoplankton, because phytoplankton do not contribute significantly to the food chain base. The food base throughout the creek consists of detrital material rather than phytoplankton, as is typical in lotic systems. Primary producers in the Beaver Dam Creek system consist mainly of periphyton and macrophytes (Du Pont, 1987).

Following implementation of this alternative, a diverse zooplankton community should remain in Beaver Dam Creek; this community should not be affected adversely by D-Area powerhouse operation. Rather, increased flow with mixing should enhance the zooplankton communities in the immediate discharge area by eliminating potential exposures to lethal temperatures (greater than 32°C). The maximum predicted summer temperatures in Reaches 1 and 2 would be 32°C and 31°C, respectively (see Appendix B, Tables B-4 and B-5). These temperatures are within the range tolerated by most, if not all, indigenous species; indeed, ambient summer water temperatures in many southeastern streams equal or exceed these values.

The zooplankton community should provide food for balanced indigenous macroinvertebrate and fish communities. The heated discharge should not alter the standing crop, community structure, or seasonal periodicity of zooplankton in the farfield study area from those values typical of the receiving water-body segment prior to SRP operation. Furthermore, the thermal plume resulting from powerhouse operation should not constitute a lethal barrier to the free movement (drift) of zooplankton.

The increased flows and reduced temperatures associated with this alternative should not cause significant deterioration of the habitat-formers community in the Beaver Dam Creek system. Because increased temperatures affect species composition by reducing diversity, altering species dominance, or even eliminating some species, the reduced temperatures should improve the habitat-formers community. Scouring due to the increased flow would affect primarily Reach 1 of Beaver Dam Creek. At present, macrophytes are not
BB-3 present in this reach of the stream due to water velocity and turbidity (Du Pont, 1987). The habitat-formers community in the delta and swamp areas should not be affected significantly by increased flows because fluctuations of flow and increases in current velocity through these areas would not be as rapid or severe as those in Reach 1.

During the summer months, increased pumping would reduce stream water temperatures in comparison to existing conditions, and would provide a thermal regime that should support a diverse macroinvertebrate community. The maximum predicted summer temperatures in the two reaches of the stream would not exceed 32°C and 31°C, respectively. These temperatures are within the range tolerated by most, if not all, indigenous species of macroinvertebrates.

Implementation of this alternative should not result in major changes to the structure and function of the existing macroinvertebrate community, although some minor shifts in the relative abundance of some taxa probably would occur. Increases in water velocity during increased pumping would favor such taxa as Ephemeroptera and Trichoptera, many species of which prefer faster flowing water. Conversely, species that prefer slow flowing water (i.e., amphipods and water mites) could exhibit some decline in density and relative abundance during certain periods of operation.

The increased water velocity could result in temporary increases in the drift rate of some species of macroinvertebrates, such as those that would occur after a heavy rainfall. However, the macroinvertebrate community should be able to sustain the slightly higher rates of drift and would not be affected adversely. Increased rates of macroinvertebrate drift would provide additional food for higher trophic levels (i.e., fish).

Increases in water depth of 10 to 20 centimeters often occur naturally in Beaver Dam Creek during periods of heavy rainfall and should not affect the macroinvertebrate community adversely. The rise in water level would inundate the edges of the stream and, during periods of extended pumping, could result in some increases in the overall amount of aquatic habitat available for colonization. When increased pumping stopped, the water levels should recede gradually and not result in significant stranding of macroinvertebrates.

Although no data are available on insect emergence patterns in Beaver Dam Creek, early emergence probably occurs at present due to the elevated thermal regime of the creek. Increased pumping should not alter the present emergence patterns, because water temperatures in the winter would not be altered. The cooler water temperatures that would exist in Beaver Dam Creek during the summer months could result in the addition of a few species of macroinvertebrates that cannot tolerate the present summer temperatures. However, no major shifts in species composition, density, or standing crop of the macroinvertebrate community of Beaver Dam Creek should occur. The macroinvertebrate community should provide the food necessary for the maintenance of a balanced indigenous fish community.

The thermal plume resulting from the D-Area cooling water discharge would not interfere with the drift or upstream movement of macroinvertebrates, if such movement were possible. However, because Beaver Dam is an intermittent stream above the outfall, little, if any, drift or upstream movement is possible. Increased pumping should not have any impact on the community structure, standing crop, or seasonal periodicity of macroinvertebrates in the farfield BB-3
study area. The temperatures of the thermal plume would not constitute a barrier to either the drift or the upstream movement of macroinvertebrates.

The fish community of Beaver Dam Creek should not suffer appreciable harm from the operation of the D-Area powerhouse following increased flow with mixing. There should be no direct or indirect mortality from excess heat or cold shock. The absolute maximum monthly predicted water temperature at the powerhouse discharge compliance point would be 32°C and the maximum predicted average monthly value would be 29°C (see Appendix B, Tables B-4 and B-5). In contrast, the upper incipient lethal temperatures for representative and important species (largemouth bass, bluegill, and catfish) are in the mid- to upper 30s°C. Because the maximum average monthly temperature increase above ambient (ΔT) in the vicinity of the discharge following implementation of this alternative would be no more than 10°C, cessation of heated discharges during the winter months should not result in cold shock to fish. Reproductive success and growth of all indigenous species of fish should be similar to present conditions with this alternative; growth should be enhanced because the slight warming from the powerhouse discharge results in optimal growth temperatures occurring for more of the year than with ambient conditions. Maximal absolute temperatures (32°C) and average monthly ΔT values (4°C-10°C) should not block fish migration. Thus, the entire Beaver Dam Creek system would be available for fish habitation; the free movement of fishes between the headwaters of Beaver Dam Creek and the Savannah River would not be inhibited by powerhouse operations at any time during the year.

BB-3 The increased-flow alternative should not cause significant changes to spawning activities in Beaver Dam Creek. Cooler summer temperatures caused by increased flow and mixing could enhance summer spawning. However, this could be offset by the increased variability of flow and temperature resulting from implementation of this alternative.

Entrainment and Impingement

The increase in cooling water flow through the 5G intake resulting from the implementation of this alternative would occur only during periods when ambient Savannah River water temperatures approach 32.2°C (May through September). Entrainment studies conducted at the 5G intake annually from 1983 to 1985 have produced estimates that an average of 1.2×10^6 fish larvae and an average of 0.8×10^6 fish eggs are entrained during the February-July spawning season as a result of cooling water withdrawal for the D-Area powerhouse (DOE, 1987a; Appendix C). Specht (1985), using entrainment data collected at the 5G intake during 1984, estimated that approximately 3 percent additional fish eggs and larvae would be entrained annually if increased pumping were required during the May-to-September time period (based on the 32.2°C temperature requirement). Application of this increased factor to the entire 1983-1985 entrainment data set yields a projection of an additional 3.6×10^4 fish larvae and 2.4×10^4 fish eggs entrained each year if the increased pumping alternative were implemented during the May-to-September time period. With this increase, entrainment at the 5G intake structure resulting from the operation of the D-Area powerhouse would average 1.2×10^6 fish larvae and 0.8×10^6 fish eggs per year. The principal species affected would be the clupeids, centrarchids, and cyprinids. The overall impact to fishery resources would be minimal.

BD-5 The rate at which fish are impinged on the intake screens at SRP pumphouses 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 (Du Pont, 1985b). Current rates of impingement at the 5G intake structure are based on studies conducted annually from 1983 to 1985, which determined that an average of 1717 fish are impinged each year as a result of cooling water withdrawal for the D-Area powerhouse (DOE, 1987). During this 3-year sampling period, approximately 93 percent of all fish collected were impinged during the March-to-May time period. Rates of increased impingement based on Specht (1985), using sampling data collected during 1984, and on estimates of 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 led to projections that utilization of the increased-pumping alternative during 1984 would have resulted in an additional 14 fish being impinged at the 5G intake structure. Estimated annual impingement during 1984 was 213 fish (DOE, 1987); therefore, this amounts to a 6.6-percent increase. Application of this factor to the entire 1983-1985 impingement data set for the 5G intake yields a projected increase of 113 fish impinged per year when the increased pumping alternative is used. With this increase, impingement at the 5G intake structure resulting from the operation of the D-Area powerhouse would average 1831 fish per year. The principal species impacted would be the centrarchids and clupeids. The overall impact to fishery resources would be minimal.

Threatened and Endangered Species

American Alligator - Dense populations of alligators occur on Beaver Dam Creek and in the swamp associated with the creek (Du Pont, 1985b, 1987). 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, the increased flow from D-Area should not affect the American alligator adversely.

Bald Eagle - The first sighting of an active bald eagle nest on the SRP occurred on June 5, 1986. The nest is below Par Pond dam in the Lower Three Runs Creek drainage basin. Because of the nest location and due to the implementation of management practices in accordance with the guidelines of the 1984 bald eagle recovery plan, the FWS issued a finding of no effect to this endangered species in 1986 (Henry, 1986). BB-3

Wood Stork - 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 wood stork 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). Beaver Dam Creek was important to wood storks in 1983 and 1984 but no individuals were observed in 1985. In 1986, a total of 15 wood storks was observed at the Beaver Dam Creek delta (Du Pont, 1987).

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 on the initial water levels in foraging pools in the swamp, the 12- to 19-centimeter
BB-3 increase probably would reduce the availability of foraging sites in the Beaver Dam Creek delta area (Du Pont, 1987).

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, 1984a). 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. These activities could require a permit from the U.S. |TC

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
BB-3 threatened or endangered species would be affected by the construction of the pipeline, because no critical habitat has been identified in South Carolina. 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 equilibration occurred.

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.

With this alternative heated discharge water would no longer be released to Beaver Dam Creek; 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 also would be reduced; however, because much of the flow from Four Mile Creek joins the swamp near the mouth of Beaver Dam Creek, some heat would enter this area until 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 the ambient temperature of the river at the points of effluent release (see Table 2-8). 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

TE Discharge of thermal effluent directly to the river could result in a limited thermal attraction of fish to the immediate area of the diffuser. The most significant impact of this alternative 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 the Beaver Dam Creek floodplain and swamp due to thermal discharges and flooding (Du Pont, 1985b, 1987). 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, 1987). Implementation of this alternative would allow revegetation to continue, 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.

BD-5 Projections of current entrainment and impingement losses, based on ichthyoplankton studies conducted annually at the site from 1983 to 1985 (DOE, 1987a; Appendix C), indicate that operation of D-Area presently results in the estimated loss of an average 1.2×10^6 fish larvae (range: 0.7×10^6 to 1.8×10^6 larvae) and 0.8×10^6 fish eggs (range: 0.5×10^6 to 1.1×10^6 eggs) each year. The principal taxonomic groups affected are the clupeids, centrarchids, and cyprinids.

An estimated average of 1718 fish per year (range: 213 to 4679 fish per year) would continue to be impinged on the intake screens of the 5G pumphouse. The principal species impinged would be the centrarchids and clupeids. The overall impact on the fishery resources would continue to be minimal. BD-5

Threatened and Endangered Species

The operation of the direct-discharge system would have a significant impact on the habitats of the American alligator and the wood stork by decreasing the flow in Beaver Dam Creek from about 2.6 cubic meters per second under present operating conditions to about 0.2 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 winter months. Foraging habitat for the wood stork would be decreased significantly or eliminated. Beaver Dam Creek essentially would return to its original condition as an intermittent stream. BB-3

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 significant 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 D-Area 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, 1987). 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, 1987).

TC

Water temperatures in the creek and delta could reach 34°C under extreme summer conditions when ambient river temperatures are about 21°C (see Appendix B, Table B-3). Under average summer conditions, creek and delta temperatures would be approximately 29°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 continue to be influenced by the heated water discharged from the coal-fired steam plant. Aquatic flora in the creek would be sparse due to the elevated temperatures and flow of the effluent. Thermophilic bacteria and blue-green algae would continue to be the most abundant flora in the main channel (Gibbons and Sharitz, 1974). 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, 1987). 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, 1987). Ichthyoplankton in the creek would reflect the adult fish composition.

4.3.3.3 Entrainment and Impingement

BB-3
BD-5

With the no-action alternative, entrainment at the 5G intake would result in the continued loss of an average 1.2×10^6 fish larvae (range: 0.7×10^6 to 1.8×10^6 larvae) and 0.8×10^6 fish eggs (range: 0.5×10^6 to 1.1×10^6 eggs) each year (DOE, 1987a). The principal taxonomic groups that would be affected are the clupeids, centrarchids, and cyprinids.

Impingement of fish on the intake screens of the 5G pumphouse would continue to average 1718 per year (range: 213 to 4679 fish per year; DOE, 1987a). The principal species impinged would be expected to be sunfish and shad. BB-3 BD-5

4.3.3.4 Threatened and 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). BB-3

Endangered wood storks from the Birdsville rookery, which have been observed foraging in the Beaver Dam Creek area since 1982 (Du Pont, 1985b, 1987), should continue to use the area. BB-3

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 K- and C-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 approximately 0.8 cubic meter per second. The total water withdrawal from the river for the Plant, including once-through cooling towers at both K- and C-Reactors, would be 24 percent of the 7-day, 10-year low flow (7Q10; 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. TC

The existing withdrawal and return rates would be reduced substantially for the recirculating cooling-tower alternatives. The withdrawal rate of 1.6 cubic meters per second for each reactor would represent a decrease of approximately 9.7 cubic meters per second per reactor from the rate for the existing system. The total SRP withdrawal from the river, including recirculating cooling towers at both K- and C-Reactors, would be about 12 percent of the 7-day, 10-year low flow (7Q10) 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. AO-1 BC-9

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 temper-
TC ature of 32.2°C; the withdrawal rate for this alternative would increase from 2.6 (existing system) to 4.0 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 would return 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. In addition, overflow from Par Pond enters Lower Three Runs Creek. Beaver Dam Creek receives once-through cooling water from the D-Area powerhouse, and Four Mile Creek and Pen Branch receive once-through cooling water from K- and C-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 the implementation of alternative cooling water systems at K- and C-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 would provide 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, thereby 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, uses natural-draft cooling towers to dissipate waste heat before discharging to the river at temperatures below 33°C (NRC, 1985). TC

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 K- and C-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 K- and C-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 preferred alternative cooling systems for K- and C-Reactors and D-Area would disturb no more than about 60 acres of uplands, consisting of immature slash pine and reforested upland pine/hardwood, some open fields, and a relatively small area of bottomland hardwoods. BB-3 BC-9

In addition, the cumulative impacts from salt deposition from the operation of recirculating cooling towers at both K- and C-Reactors would result in an estimated 22.7 kilograms per acre per year at a distance of 0.5 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 that can cause reduced productivity of plants (Mulchi and Armbruster, 1981; INTERA, 1980). Beyond 2 kilometers (see Figure 4-4), the deposition rates decline even more with distance from the towers. Therefore, no significant cumulative impacts are expected with this combination of alternatives.

TE

4.4.3.2 Onsite Streams and 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 K- and C-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 K- and C-Reactor operations was about 54 acres). It is expected that some wetland areas previously damaged or destroyed would revegetate successively 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 K- and C-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 a significant 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 those for present conditions; for other combinations, there would be either a reduction or an increase in these effects.

The implementation of a once-through cooling-tower system for K- and C-Reactors and direct discharge for D-Area would not change existing levels of entrainment and impingement significantly. At present, the combined total loss of ichthyoplankton due to the operation of these three facilities averages 18.8×10^6 fish larvae and 10.1×10^6 fish eggs annually, or an average of 11.8 percent of the ichthyoplankton passing the SRP intakes, based on 1983-1985 studies (see Table C-24; DOE, 1987). Cumulative impingement currently averages 7603 fish per year (DOE, 1987). In addition, the species composition of the fishes lost to entrainment and impingement would not change with this combination of alternatives. Assuming that K- and C-Reactors would operate at levels comparable to that for L-Reactor, additional average entrainment losses of 8.8×10^6 fish larvae and 4.6×10^6 fish eggs (or an average of 5.4 percent of the ichthyoplankton passing the SRP intakes; see Table C-24) and additional average impingement losses of 2942 fish would occur annually as a result of the operation of these facilities. Accordingly, cumulative annual losses from entrainment and impingement due to the operation of these four facilities would average 27.6×10^6 fish larvae and 14.8×10^6 fish eggs (or an average of 17.2 percent of the ichthyoplankton passing the SRP intakes; see Table C-24) and 10,545 fish, respectively. BD-5

The implementation of a recirculating cooling-tower system 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 larvae and about 2.1 x 10^6 fish eggs per year. Cumulative impingement losses would decrease to about 2571 fish per year. Species composition of fish lost to entrainment and impingement would not change with this combination of alternatives. Cumulative annual losses from entrainment and impingement due to the operation of these facilities plus L-Reactor would average 12.6 x 10^6 fish larvae and 6.7 x 10^6 fish eggs and 3369 fish, respectively.

The implementation of a once-through cooling-tower system for K- and C-Reactors in combination with the increased-pumping alternative for the D-Area powerhouse would increase entrainment and impingement in proportion to the increase in cooling water withdrawn for the powerhouse. Cumulative entrainment losses would increase to about 18.84 x 10^6 fish larvae and 10.12
BD-5 x 10^6 fish eggs per year, while cumulative impingement losses would increase to about 7665 fish per year. Cumulative annual losses from entrainment and impingement due to the operation of these facilities plus L-Reactor would average 27.64 x 10^6 fish larvae and 14.77 x 10^6 fish eggs and 10,608 fish, respectively.

The implementation of a recirculating cooling-tower system in combination with increased pumping at D-Area would result in a net reduction in cooling water withdrawal and a proportional decrease in entrainment and impingement levels. Cumulative entrainment losses would decrease to approximately 3.84 x 10^6 fish larvae and 2.12 x 10^6 fish eggs per year, while impingement would decrease to about 2683 fish per year. Cumulative annual losses from entrainment and impingement due to the operation of these facilities plus L-Reactor would average 12.64 x 10^6 fish larvae and 6.77 x 10^6 fish eggs and 5626 fish, respectively.

4.4.3.5 Threatened and Endangered Species

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

At present, the American alligator does not inhabit Pen Branch or Four Mile
BB-3 Creek because of the high water temperatures associated with reactor operations. The implementation of once-through cooling towers would enable the alligator and other organisms to inhabit these thermal areas. However, fluctuating water levels and flow rates could destroy alligator eggs, nests, and hibernation sites. The recirculating cooling-tower alternatives would enable the alligator to inhabit these areas; however, because of the marked decrease in flows, the inundation of eggs, nests, and hibernation sites would be improbable. 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 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 implementation of once-through cooling towers would improve existing habitat for the endangered wood stork, but the availability of foraging habitat would be restricted due to water depths and flow rates. Recirculating cooling towers would cause significantly reduced discharge rates and should enhance the availability of wood stork foraging habitat. The increased-flow-with-mixing alternative for D-Area would decrease the availability of wood stork foraging habitat during periods of increased flow. BB-3

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 SRP include operating or planned SRP facilities, the two-unit Alvin W. Vogtle Electric Generating Plant (one unit operating, the other still 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 K- and C-Reactors.

SRP facilities operating 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, the FPF, and the 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. The first unit of this two-unit power plant became operational in June 1987. The second unit for the Vogtle Power Plant is not expected to reach full operation until the early 1990s. TC

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, and the Vogtle Nuclear Power Plant. The doses associated with two of the SRP reactors, K and C, depend on the alternative cooling water system implemented.

TE The tables in this section list effective whole-body doses for the offsite, maximally exposed individual and collective effective whole-body doses for the offsite population. The text compares these doses with applicable limits and with natural background radiation. Appendix G contains detailed individual and collective doses for all age groups and important organs due to releases from nuclear facilities on, and within 80 kilometers of, the Savannah River Plant. Essentially all the collective dose results from operation of SRP facilities. These facilities also contribute approximately half the effective whole-body dose to the maximally exposed individual.

Table 4-24 presents the cumulative doses assuming present cooling water systems for K- and C-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 4-24. Cumulative Effective Whole-Body Doses with Present Cooling Water Systems (Existing Conditions) for K- and C-Reactors

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

Table 4-25 presents the cumulative doses assuming a once-through cooling tower for each of K- and C-Reactors - the preferred cooling alternative. These doses represent the sum of existing operation doses and changes in doses associated with operation of once-through cooling towers for K- and C-Reactors.

Table 4-26 presents the cumulative doses assuming recirculating cooling towers for K- and C-Reactors. The use of recirculating cooling towers results in the largest change in doses associated with operation of K- and C-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. While other combinations of cooling systems can be chosen, for example, a once-through cooling tower for the C-Reactor combined with recirculating cooling towers for the K-Reactor, the doses presented represent bounding values.

Table 4-25. Cumulative Effective Whole-Body Doses with a Once-Through Cooling Tower for K- and C-Reactors

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

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

	Maximum individual (mrem/yr)	Collective (person-rem/yr)
Adult	3.06	
Teen	2.49	79.6
Child	1.88	
Infant	0.94	

BC-22

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 per year 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.

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

4.4.5 AIR QUALITY

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

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

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

Table 4-27. Cumulative Health Effects

Alternative	Cancer fatalities per year	Genetic disorders per year
Existing operations	0.0110	0.0198
Operations with a once-through cooling tower for each of the C- and K-Reactors	0.0110	0.0198
Operations with recirculating cooling towers for each of the C- and K-Reactors	0.0109	0.0195

The second combination, consisting of recirculating towers at both K- and C-Reactors, produced higher impacts and maximum impacted areas; therefore, this combination is described further in the following paragraphs.

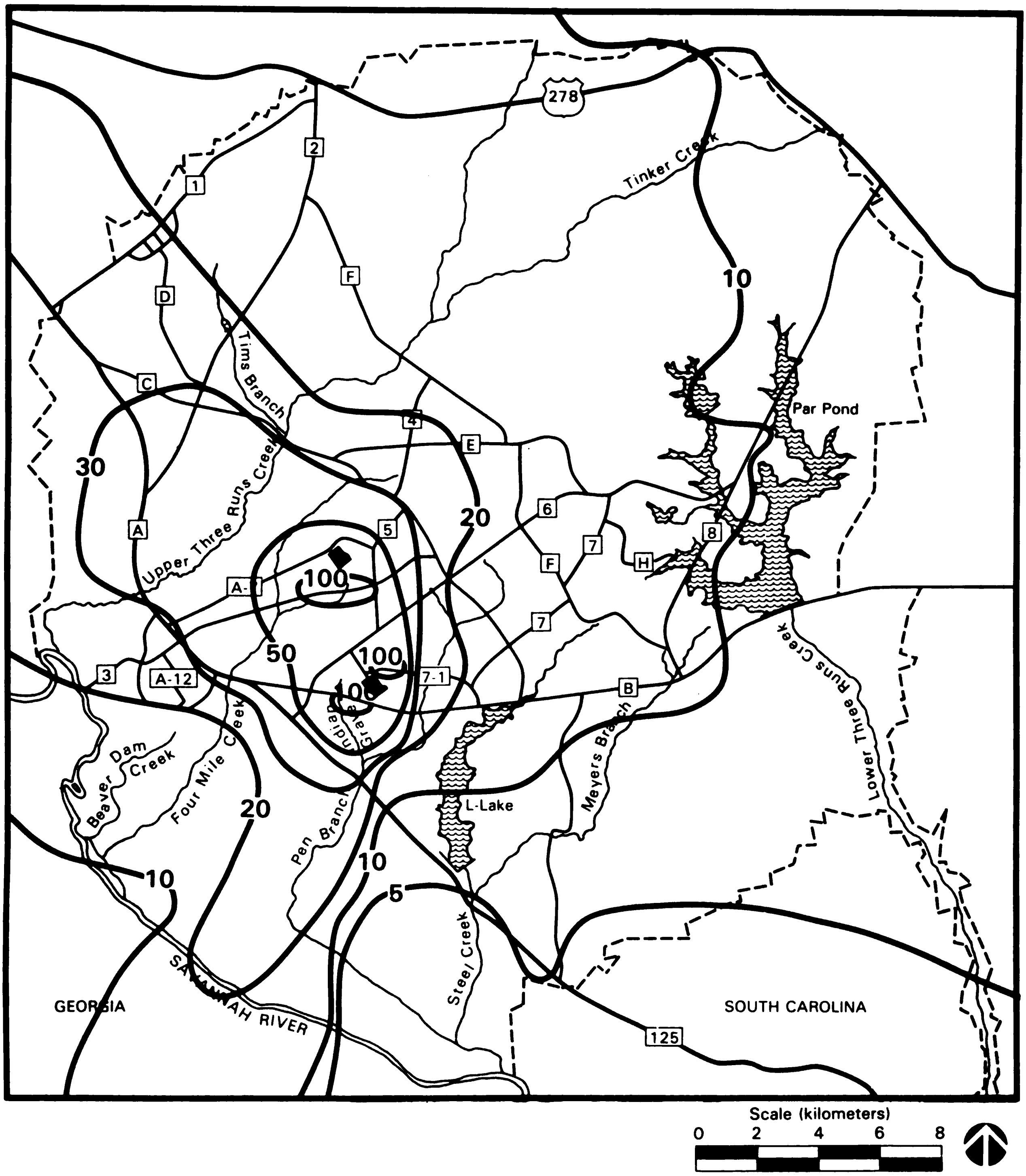
BC-22 The combined calculated maximum annual-mean frequency of reduced ground-level visibility to less than 1000 meters, due to the operation of recirculating cooling towers at both the K- and C-Reactors would be approximately 4 hours per year at 8 kilometers northwest of the C-Reactor towers. The calculated annual-mean frequencies of reduced ground-level visibility to less than 1000 meters would be less than 3 hours per year within 2 kilometers of each tower.

Because the K- and C-Reactors are about 4.8 kilometers apart, the maximum ice accumulations within 0.4 kilometer of the towers and their frequencies would be the same as those presented in the individual analyses. Figure 4-3 shows the isopleths of frequency of occurrence of elevated visible plumes for recirculating cooling towers at both K- and C-Reactors. BC-22 The calculated mean maximum occurrence of visible plumes would be 100 hours per year at 0.6 kilometer from the K- and C-Reactor cooling towers. The frequency of visible plumes would be approximately 50 hours per year within 2 kilometers of each tower system in all directions.

Figure 4-4 shows the isopleths of annual solids deposition due to the operation of recirculating cooling towers at both K- and C-Reactors. BC-22 The estimated maximum annual total-solids deposition would be 22.7 kilograms per acre per year at a distance of 0.5 kilometer from each tower.

4.5 UNAVOIDABLE/IRREVERSIBLE IMPACTS OF ALTERNATIVES

The following sections describe impacts of the alternative cooling water systems that cannot be avoided by reasonable mitigation measures. They also describe irreversible and irretrievable commitments of resources and short-term uses and long-term environmental implications for the alternative cooling water systems.



BB-3
BC-9

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

BB-3
BC-9

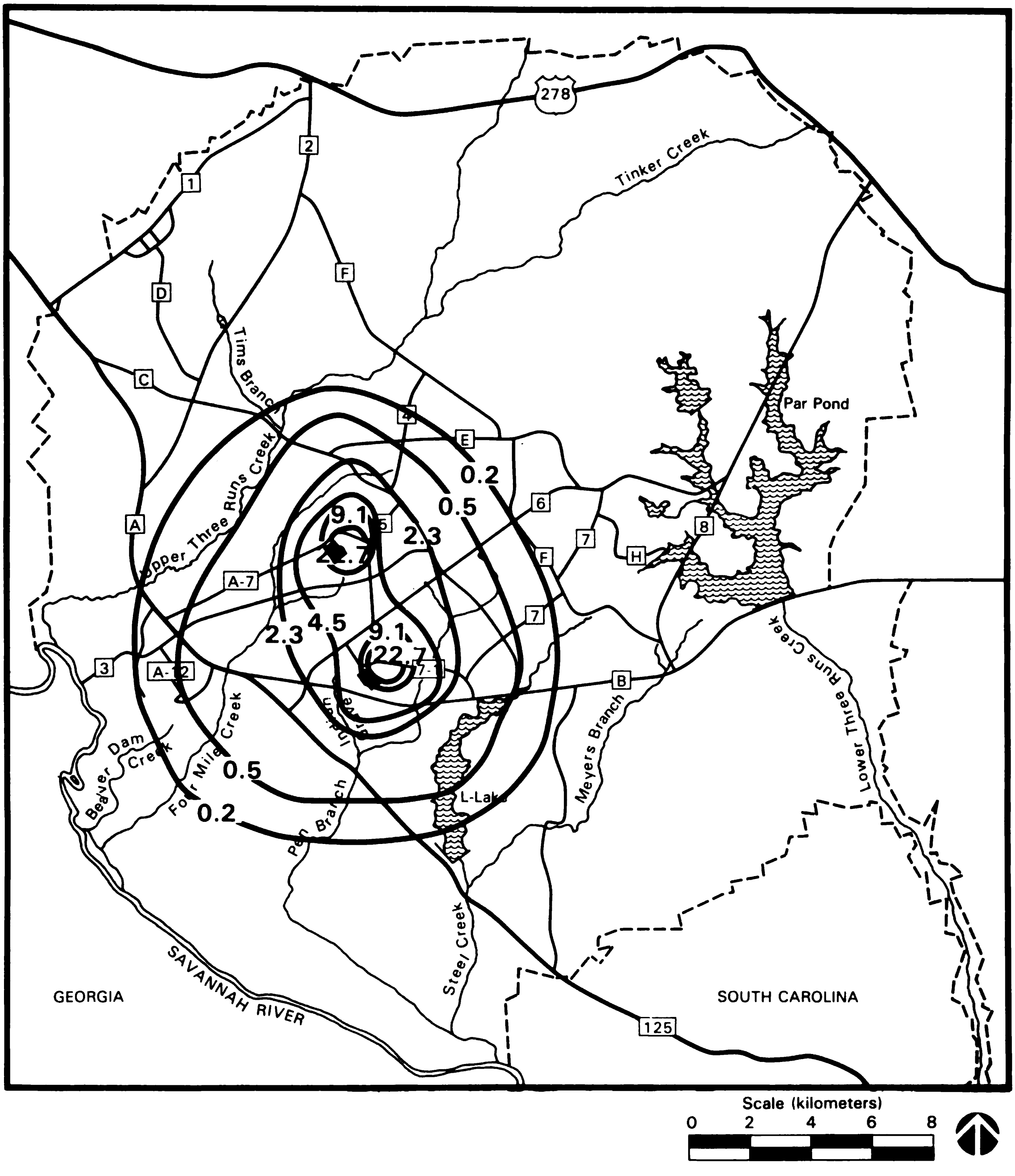


Figure 4-4. K- and C-Reactor Recirculating Towers, Total Solids Deposition, Kilograms/Acre-Year

4.5.1 UNAVOIDABLE ADVERSE IMPACTS

For the once-through cooling towers for K- and C-Reactors, annual entrainment (26.8×10^6 eggs and larvae) and impingement (5884 fish) losses would be similar to those resulting from current operations. With the implementation 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 implementation of the gravity-feed, once-through, cooling-tower alternative would result in disturbance of approximately 25 and 35 acres of uplands for K- and C-Reactors, respectively, as a result of construction and the relocation of facilities.

With the implementation of the recirculating cooling-tower alternatives for K- and C-Reactors, cooling water discharge flows would be reduced from 11.3 to 1.1 cubic meters per second, resulting in reduced habitat area for spawning and foraging. Construction and relocation of facilities would disturb approximately 50 and 60 acres of uplands for K- and C-Reactors, respectively. BC-10 BC-19 BD-3

The increased-flow alternative for the D-Area powerhouse would increase flow to 4.0 cubic meters per second during extreme summer conditions. TC The expected increase in impingement (additional loss of 113 fish per year) and entrainment (about 6.0×10^4 eggs and larvae) due to increased flow through the 5G pumphouse would be small, and the overall impact would be minimal because entrainment and impingement rates are low during the summer. 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 currently are 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. 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 25 and 35 acres of upland areas would be required for construction and relocation activities for the once-through towers and 50 and 60 acres for the recirculating towers, respectively, for K- and C-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 K- AND C-REACTORS AND D-AREA

This section contains a summary comparison of the once-through cooling towers, the recirculating cooling towers and the no-action (continuation of present operations) alternatives for the K- and C-Reactors and the increased flow with mixing, direct discharge, and no-action alternatives for the D-Area powerhouse. For each of the three facilities, selection of the no-action alternative would result in a continuation of present cooling water discharges that would not comply with the State of South Carolina's Class B water classification standard of a maximum instream temperature of 32.2°C. The construction and operation of either once-through or recirculating towers for K- and C-Reactors and implementation of either increased flow with mixing or construction and operation of direct discharge to the Savannah River for the D-Area powerhouse would result in discharges that would comply with this
TC standard. Construction and operation of once-through or recirculating cooling towers for K- and C-Reactors and implementation of increased flow with mixing for the D-Area powerhouse would also require the conduct of Section 316(a) studies to determine whether a balanced biological community would be maintained, because discharges from these alternatives would exceed the State of South Carolina's Class B water classification standard of a maximum instream temperature rise above ambient of 2.8°C. The following comparison discusses the major differences that would occur from the implementation of each of the alternatives.

TC For the various cooling water alternatives, the following relative rankings of future wildlife effects were determined from the Habitat Evaluation Procedures Analysis (Mackey et al., 1987). Effects to terrestrial wildlife from construction of the once-through and recirculation cooling towers were considered to be essentially equal, since in both cases either type of tower would be constructed at the same location, and pipeline and other support facilities would affect essentially the same locations. Small stream fish species benefit more from the recirculation alternative in the upper reaches of the creeks. In the middle and lower stream reaches, species such as the catfish and sunfish benefit more from the once-through alternative. In the deep swamp environment, those fish which are more likely to use the swamp during the spawning period benefit more from the recirculation alternative. In the Savannah River swamp, wading birds benefit more from the recirculation alternative. Overwintering waterfowl such as the mallard benefit more either from the present SRP operations or from the once-through cooling tower. The once-through and no action alternatives would maintain the existing "marsh" type environment in the swamp for wintering waterfowl or permit expansion of this type of habitat. TC

4.6.1 ALTERNATIVES FOR K-REACTOR

Either of the two cooling-tower alternatives would significantly reduce the thermal impacts in each respective stream and the Savannah River swamp. The major environmental difference between these alternatives is that the recirculating cooling towers would withdraw less water from the river (about 1.6 cubic meters per second) and release less to the creek (about 1.1 cubic meters per second) than the once-through tower (about 11.3 and 10.5 cubic meters per second, respectively). This would result in reduced entrainment losses of fish eggs and larvae and reduced impingement losses of adult and juvenile fish with the recirculating towers. The reduced flows in Pen Branch and Four Mile Creek and their deltas would also result in successional re-establishment of a greater amount of wetlands than would occur with the once-through cooling-tower alternative; on the other hand, the lower flow would also reduce the existing amount of aquatic habitat in the streams and parts of the swamp than would occur with the once-through tower.

Both alternatives would allow the reestablishment of aquatic fauna and floral communities spawning and foraging in presently uninhabited areas. However, the once-through cooling-tower alternative would exhibit a greater amount of water-level fluctuation, causing some stress to aquatic organisms. Implementation of recirculating cooling towers would reduce thermal effects over what would occur with once-through towers, except that flooded habitat area would be smaller. Most aquatic communities would benefit from the reduced flow and decreased magnitude of water level fluctuations with implementation of a recirculating system. Either alternative would exhibit no potential for cold shock, as the maximum weekly average temperature (MWAT) criteria (EPA, 1977) for winter shutdowns would be met. Dissolved solids concentrations in the discharge would be higher with the recirculating alternative because of cycles of concentration; however, total suspended solids discharge would be greatly reduced. BB-3

Although once-through cooling towers would improve American alligator (which has been classified as threatened due to "similarity of appearance") habitat over existing conditions, fluctuating water levels and high flow rates could destroy nests, eggs, and hibernation sites. This alternative would also minimize the availability of preferred foraging habitat for the endangered wood stork. Implementation of the recirculating cooling tower would greatly

BB-3 improve the habitat quality for the American alligator and the wood stork. Because of the reduced flow, eggs, nests, and hibernation sites of the American alligator should not be adversely affected.

The impacts of both systems on air quality would be similar; however, because the recirculating cooling-tower system includes two towers operated in series with 2.5 cycles of concentration, the maximum ice accumulation near the towers would be greater for the recirculating system (7 mm versus < 1mm), as would the maximum annual deposition of total solids (2.2 kilograms per acre per year at 2.0 kilometers of the tower versus 0.15 kilogram per acre per year for the once-through tower). Because these deposition rates are far below the levels that can cause reduced vegetation productivity (83 kilograms per acre per year), no impacts on vegetation or wildlife are expected from either cooling-tower alternative.

TC The operation of the once-through cooling tower would not cause any significant changes in the remobilization of radionuclides contained in the Pen Branch or Four Mile Creek streambeds, because flows in these streams would remain essentially unchanged. The operation of recirculating towers for both K- and C-Reactors would result in a calculated decrease of about 0.33 curie of cesium released to the Savannah River over a year due to the reduced flow. The implementation of either the once-through cooling tower or recirculating cooling towers would slightly reduce the radiological doses to the maximum individual and the 80-kilometer regional population, compared with the existing direct-discharge system, which are presently well within standards. The decrease in maximum individual and collective (population) doses, however, would be greater for recirculating cooling towers than for once-through towers.

Tables 4-28, 4-29, and 4-30 compare these alternatives, along with the expected natural state of Pen Branch within 15 years if reactor operations cease, for Reaches 1, 2, and 3, respectively, of that stream. The division of the Pen Branch watershed into these reaches was based on the presence of distinct stream gradients. These comparisons were made to assess the potential impacts of the alternatives on discrete reaches and the ability of the entire Pen Branch system to exhibit and maintain a balanced biological community. The following paragraphs describe potential effects of the alternatives on the Pen Branch system. (Similar effects should occur on Four Mile Creek for C-Reactor.)

BB-3 <u>Impacts On Reach 1</u>

Reach 1 extends from the K-Reactor outfall down Indian Grave Branch to its confluence with Pen Branch and on to SRP Road A; it encompasses approximately 1 percent (11 of 1100 acres) of the portion of the Pen Branch system that is influenced by K-Reactor cooling water discharges, as utilized for the HEP analysis (Mackey et al., 1987). In this reach, the stream is highly channelized and has its highest gradient, water temperatures, and flows.

With the no-action alternative, highly thermally tolerant species of algae would be the only biota to occur, in limited areas. No spawning activity would occur during reactor outages; limited spawning could occur during long reactor shutdowns, but the success of the spawn would be unsure.

Table 4-28. Comparison of Potential Environmental Impacts in Reach 1[a] of Pen Branch System (page 1 of 2)

Parameter	Alternative cooling water system: No action	Once-through cooling tower	Recirculating cooling towers	Natural stream[b]
Flow (variation), m^3/sec	11.3 (1-11.3)	10.5 (1-10.5)	1 (0.2-1)	0.03 (natural)
Temperature (°C) Maximum/ΔT	75/48	32/11	30/6	27/0
Vegetation				
Aquatic	Thermally tolerant algae only.	Limited macrophyte development due to high flows.	Increased macrophyte development, but less available habitat compared to once-through system due to lower flows.	Less available habitat, greater macrophyte species diversity, than recirculating system due to low natural flows.
Riparian	Not present due to high temperatures.	Limited development and distribution due to high flows.	Major increase in available habitats; shrub/herb community; greater species diversity than once-through system.	Highest species diversity; invasion by some nonwetland species.
Macroinvertebrates	Not present due to high temperatures.	Limited abundance and diversity due to flows; early emergence due to ΔT greater than 5°C; stranding could occur due to changing flow rates from reactor operations.	Less available habitat than once-through system, comparable or higher density; greater diversity, reduced potential for early emergence, little chance of stranding due to more stable flows.	Least available habitat due to reduced water volume compared to recirculating system. Highest species diversity, no potential for early emergence.

BB-3

Table 4-28. Comparison of Potential Environmental Impacts in Reach 1[a] of Pen Branch System (page 2 of 2)

Parameter	Alternative cooling water systems: No action	Alternative cooling water systems: Once-through cooling tower	Alternative cooling water systems: Recirculating cooling towers	Natural stream[b]
Fish	Limited utilization by heat-tolerant mosquitofish during reactor outages; no spawning by any species due to excessive water temperatures; however, limited spawning could occur during long shutdowns; not utilized by anadromous and/or riverine species.	Presence of species with high flow tolerance (i.e., minnows, suckers, darters); limited spawning due to fast flow, high gradient, and channelized banks. Limited utilization by anadromous or riverine species.	Maximum development of limited fish habitat and communities; highest fish biomass potential for this reach; higher spawning per unit area than once-through system due to reduced flows. However, access to this reach by fish from downstream reaches 2 or 3 is unlikely due to reduced flows, shallow water depth, and development of dense stands of aquatic vegetation in these reaches.	Less available habitat due to reduced water volume and less spawning success than recirculating system. Access to this reach from downstream reaches 2 or 3 would also be limited due to reduced flows, shallow water depth, and development of dense stands of aquatic vegetation within these lower reaches.
Endangered species (wood stork)	No utilization - lack of suitable habitat.	No utilization - lack of suitable habitat.	No utilization - lack of suitable habitat.	No utilization - lack of suitable habitat.
Waterfowl	No utilization - lack of suitable habitat.	Very low utilization - lack of suitable habitat.	Very low utilization - lack of suitable habitat.	Very low utilization - lack of suitable habitat.

a. Reach 1 comprises approximately 1 percent of the Pen Branch system that is influenced by reactor operation.
b. Stream system expected within a 15-year period after reactor operations cease.

BB-3

Table 4-29. Comparison of Potential Environmental Impacts in Reach 2[a] of Pen Branch System (page 1 of 2)

	Alternative cooling water system			
Parameter	No action	Once-through cooling tower	Recirculating cooling towers	Natural stream[b]
Flow (variation), m^3/sec	11.5 (1.17-11.5)	10.7 (1.17-10.7)	1.17 (0.2-1.17)	0.17 (natural)
Temperature (°C), Maximum/ΔT	63/30	32/6	29/3	26/0
Vegetation				
Aquatic	Thermally tolerant algae only.	Limited macrophyte development due to high flows; more available habitat than in Reach 1.	Increased macrophyte development over once-through system, but less available habitat due to reduced flows.	Less available habitat due to reduced flow volume, greater diversity than once-through system.
Riparian	Isolated communities limited to sandbars and stumps due to high flows and temperatures.	Isolated communities limited to sandbars and stumps due to high flow.	Major increase in available habitats; shrub/herb community development; greater species diversity due to reduced flows.	Highest species diversity; invasion by some nonwetland species.
Macroinvertebrates	Minimal use by thermally tolerant species (e.g., oligochaetes and nematodes).	Greater abundance and diversity than in Reach 1; moderate potential for early emergence due to ΔT; stranding possible due to variable flow rates from reactor operations.	Moderate improvement in available habitat over those in Reach 1 due to downstream reductions in flow and temperature. Some potential for early emergence. Little chance of stranding due to more stable flows.	Least amount of available habitat due to reduced water volume; highest species density; no potential for early emergence or stranding.

Table 4-29. Comparison of Potential Environmental Impacts in Reach 2[a] of Pen Branch System (page 2 of 2)

Parameter	No action	Alternative cooling water systems: Once-through cooling tower	Alternative cooling water systems: Recirculating cooling towers	Natural stream[b]
Fish	Limited habitat improvement over Reach 1; brief utilization by fish during reactor shutdowns; no spawning during reactor operations; some spawning could occur during long shutdowns.	Moderate improvement in habitat conditions (i.e., reduced temperatures and flows) compared to Reach 1; presence of flow-tolerant species; increased spawning; limited utilization by anadromous species.	Moderate improvement in habitat conditions over those in Reach 1 and once-through systems due to reduced temperatures and flows in upper reach. Reduced utilization and spawning near delta due to reduced flows in shallow depths and development of dense vegetation, which would limit potential access by anadromous and/or riverine species to upper part of Reach 2 and to Reach 1.	Less available habitat and spawning success than recirculating system, limiting access by anadromous and/or riverine species to upper reaches due to reduced flows and dense vegetation.
Endangered species (wood stork)	No utilization due to excessive temperatures and flow.	No utilization due to flows and excessive water depth.	Very low utilization.	Very low utilization due to reduced flows and dense vegetation.
Waterfowl	No utilization.	Moderate utilization in backwater areas.	Moderate utilization.	Moderate utilization.

a. Reach 2 comprises approximately 10 percent of the Pen Branch system that is influenced by reactor operations.
b. Stream system expected within a 15-year period after reactor operations cease.

BB-3

Table 4-30. Comparison of Potential Environmental Impacts in Reach 3[a] of Pen Branch System (page 1 of 2)

Parameter	Alternative cooling water system: No action	Once-through cooling tower	Recirculating cooling towers	Natural stream[b]
Flow (variation), m^3/sec	Highly variable; strongly influenced by Savannah River flows below delta.	Highly variable; strongly influenced by Savannah River flows below delta.	Highly variable; strongly influenced by Savannah River flows below delta.	Highly variable; strongly influenced by Savannah River flows below delta.
Temperature (°C) Maximum/ΔT	51/14	31/1	29/0	30/0
Vegetation				
Aquatic	Thermally tolerant algae and bacteria only.	Submerged macrophytes limited to edge of delta and lower braided stream area; extensive where present.	Less available habitat than with once-through system; greater abundance due to reduced flow and stable water depth.	Less available habitat than with recirculating system; dense concentrations.
Riparian	Delta - Thermally tolerant herbaceous flora.	Delta - Herbaceous marsh present; should extend into the cypress/tupelo die-off area.	Delta - Herbaceous marsh present but less extensive than once-through system; some shrub species present; old-field species would occur in drier areas.	Delta - Greater development of old-field community; less marsh and shrub vegetation than recirculating system; development of nonwetland species.
	Swamp - Cypress/ tupelo community.	Swamp - Cypress/ tupelo community.	Swamp - Cypress/ tupelo community.	Swamp - Cypress/ tupelo community.
Macroinvertebrates	Greater community diversity than in Reach 2; dominated by thermally tolerant species (e.g., oligochaetes and nematodes).	Great increase in diversity and abundance over no action due to temperature reduction; stranding due to variable flows limited to delta area (swamp	Less available habitat but higher quality than with once-through system due to reduced flows; great increase in diversity and abundance over no action; little chance	Less available habitat than recirculating system; similar in abundance and diversity; little chance of stranding due to more stable flows.

BB-3

Table 4-30. Comparison of Potential Environmental Impacts in Reach 3[a] of Pen Branch System (page 2 of 2)

Parameter	Alternative cooling water system: No action	Once-through cooling tower	Recirculating cooling towers	Natural stream[b]
		flow is regulated by Savannah River); no early emergence expected.	of stranding due to more stable flows.	
Fish	Only thermally tolerant species near delta; brief utilization by fish during reactor shut-downs; limited utilization and spawning by anadro-mous species in upper swamp due to high temperatures.	Habitat greatly improved over Reach 2; increased spawning success, utilization, and access by anadromous and riverine species due to reduced temperatures.	Reduced utilization and spawning in delta area due to reduced flows, shallow water depth, and development of dense vegetation, which would limit potential access to upper reaches. Habi-tat for spawning and nursery areas in swamp depends on periodic flooding by Savannah River.	Less available habitat and spawning success than recirculating system due to reduced flow and extensive vegeta-tion in delta area. Swamp utilization similar to that for recirculating system.
Endangered species (wood stork)	Very low utilization due to excessive temperatures and flow.	Very low utilization in delta area due to flows.	Increased utilization for feeding due to reduced flows in delta area; this would decrease as vegeta-tion invades.	Limited utilization due to reduced flows in delta area. Decreased use due to vegetation invasion, which would be more rapid than for re-circulating system.
Waterfowl	High to moderate utilization, particularly below the delta.	High to moderate utilization of all alternatives due to reduced tem-peratures near delta.	Moderate utilization; less than with once-through system due to less available habitat from flow reduction near delta and exten-sive vegetation.	Moderate to low utilization due to less available habitat and less use than with once-through system due to extensive vegetation.

a. Reach 3 comprises approximately 89 percent of the Pen Branch system, as utilized for the HEP analysis (Mackey et al., 1987).
b. Stream system expected within a 15-year period after reactor operations cease.

With the once-through cooling-tower alternative, communities of aquatic and riparian vegetation should develop, but the areal extent, abundance, and species diversity would be limited due to the presence of high and variable cooling water flows. The early emergence of some macroinvertebrate species could occur because of the elevated water temperature; stranding of some macroinvertebrate communities could occur as a result of reactor-induced variations in flow. The fishery community would be limited in size and dominated by species with high flow tolerance (i.e., minnows, suckers, and darters). Spawning by fish would be extremely limited due to fast flow, high stream gradient, and channelized banks. The utilization of Reach 1 by anadromous and riverine species would be limited due to its distance (6 to 8 kilometers) from the Savannah River.

With the recirculating cooling-tower alternative, an increase in the areal extent and diversity of riparian vegetation would occur in comparison with those for the once-through system. An increase in the areal extent of aquatic macrophytes also would occur, but, because of the reduced water flows to be experienced with this alternative, the total available habitat would be reduced. Less habitat would be available for macroinvertebrate communities, but the abundance per unit area would be comparable to that for the once-through system. Species diversity would be greater and the potential for early emergence of macroinvertebrate species would be reduced over that for the once-through system because of reduced temperatures. The more stable water flows would produce little chance of stranding of macroinvertebrates. The reduced flow associated with this system would limit the areal extent of available habitat for fish; however, this habitat would be of higher quality than that for any of the alternatives. This alternative would provide the highest potential standing crop of fish of the alternatives; higher spawning BB-3
per unit area should occur than with the once-through system. However, access to this region by anadromous or riverine fish species from Reaches 2 and 3 is unlikely due to reduced flows, shallow water depth, and development of dense stands of aquatic vegetation.

The complete cessation of reactor operations (i.e., a return to natural stream conditions) would provide less available habitat for aquatic vegetation and macroinvertebrates than the recirculating cooling-tower alternative due to a further reduction in water flows. Riparian areas would be colonized by some nonwetland vegetation. However, the species diversity of these communities would be the highest of all identified alternatives. No potential would exist for the early emergence of any macroinvertebrate species. Less habitat would be available for fish, and spawning success would be less than that for the recirculating system due to lower flows. In addition, access to this region by fish from downstream Reaches 2 and 3 would be unlikely due to reduced flows, shallow water depths, and the expected development of dense stands of aquatic vegetation.

The stream gradient and flows of Reach 1 would not provide suitable habitat for the endangered wood stork or for waterfowl with any alternative.

<u>Impacts On Reach 2</u>

Reach 2 extends from SRP Road A to the Pen Branch delta. This reach encompasses approximately 10 percent (110 of 1100 acres) of the Pen Branch system that is influenced by reactor cooling water discharges, as utilized for

The high flows and temperatures expected in Reach 2 (Table 4-29) with the selection of the no-action alternative would allow the occurrence only of isolated communities of riparian vegetation (limited to sandbars and stumps); aquatic vegetation would be limited to thermally tolerant algae. Thermally tolerant macroinvertebrate species would make minimal use of the reach. Only limited improvement in the quality of fish habitat would be expected over the conditions described for Reach 1. Utilization by fish would be limited to brief reactor shutdown periods. No spawning would occur during reactor operations; however, limited spawning could occur during long shutdowns. The high flows and temperatures would preclude the use of this reach by the endangered wood stork and waterfowl.

The once-through cooling-tower alternative would reduce water temperatures below those for no action, but flows would remain high and variable (Table 4-29). The high flows would limit riparian vegetation to isolated communities on sandbars and stumps. Limited macrophyte development would occur in backwater areas of reduced flow; more total habitat would be available than in Reach 1. The macroinvertebrate community would have greater species diversity and abundance in comparison to Reach 1. Only minimal early emergence should occur with some macroinvertebrate species due to elevated temperature; some stranding of portions of the macroinvertebrate community could occur due to reactor-influenced flow variations. A moderate improvement in fish habitat conditions over those in Reach 1 would occur due to downstream reductions in temperature, gradient, depth, and flows; this should provide the greatest occurrence of flow-tolerant species and more moderate spawning activity within the reach. Use of this reach by anadromous species would be limited. The
BB-3 endangered wood stork would not use Reach 2, but limited habitat would probably be available for waterfowl in backwater areas.

With the recirculating cooling-tower alternative, reduced flow and temperature would provide an increase in riparian habitat (i.e., development of a shrub/herb community) and greater species diversity in Reach 2. Reduced flows would also enable greater aquatic macrophyte development to occur in comparison to the once-through alternative; however, less total habitat area would be available. A moderate improvement would occur in habitat available for the macroinvertebrate community, in comparison to that expected in Reach 1 with this alternative and to the once-through alternative, as a result of reductions in temperature and flow. Early emergence of macroinvertebrate species would not occur. The reduced flows and temperatures would also provide moderate improvement of fish habitat in the upper portions of Reach 2; however, the reduced water flows and the increased development of vegetation in the lower portions of the reach probably would cause reduced use and spawning in the shallow areas of the delta. Access by fish to the upper portion of Reach 2 and to Reach 1 could become limited due to reduced flows and dense vegetation development. Limited use of this reach by the endangered wood stork and waterfowl would occur.

With a complete cessation of reactor cooling water flows (natural stream conditions), the reduced water volumes in the stream would cause further reductions in available habitat for aquatic vegetation, macroinvertebrates, and fish in comparison to the recirculating cooling-tower alternative (Table 4-29). However, species diversity of the aquatic and riparian vegetation and macroinvertebrate communities would be greater in areas where habitat is and fish in comparison to the recirculating cooling-tower alternative (Table 4-29). However, species diversity of the aquatic and riparian vegetation and macroinvertebrate communities would be greater in areas where habitat is available. There would be no potential for early emergence of any macroinvertebrate species, and reactor-influenced stranding would not occur. The reduced water volumes would cause the present riparian habitat to be colonized by nonwetland species. The reduced flows and increased density of vegetation would limit fish access to the upper reaches of the stream and, thus, limit overall use and spawning. The endangered wood stork would not use Reach 2, but limited use by waterfowl would occur.

Impacts On Reach 3

Reach 3 of the Pen Branch system, as utilized for the HEP analysis (Mackey et al., 1987) extends from the Pen Branch delta approximately 2 kilometers into the Savannah River swamp; it encompasses approximately 89 percent (988 of 1100 acres) of the Pen Branch system. However, approximately 40 percent of this reach is considered to be part of the Savannah River swamp and, therefore, is not influenced by reactor operations (Mackey et al, 1987). The stream in Reach 3 is highly braided; the gradient is the lowest of all the reaches; sheet flow is prevalent; and water flows are extremely variable, influenced primarily by periodic Savannah River flooding. The following discussions for each alternative consider only the portion of Reach 3 that potentially is influenced by reactor operations.

With the no-action alternative, aquatic vegetation would be limited to thermally tolerant algae and bacteria (Table 4-30). Riparian vegetation in the delta probably would consist of thermally tolerant herbaceous flora; in the swamp, the cypress-tupelo community would predominate. The macroinvertebrate community would be more diverse than that in Reach 2, but it would be dominated by thermally tolerant species (e.g., Oligochaetes and Nematodes). Only thermally tolerant fish species would occur in the delta area. Brief use by some species would occur during reactor shutdowns. In the swamp, high temperatures would limit use and spawning by anadromous species. The endangered wood stork would not use Reach 3 with this alternative; however, extensive use by waterfowl should occur, particularly below the delta.

BB-3

With the once-through cooling-tower alternative, submerged macrophytes should develop, but their distribution would be limited to the edge of the delta and the lower sections of the braided-stream area; in this area, high abundance would occur. Herbaceous marsh should develop in the riparian areas of the delta, while the cypress-tupelo community would predominate in the swamp. As a result of the large reduction in water temperatures, a substantial increase in macroinvertebrate community diversity and abundance would occur in comparison to the no-action alternative. No early emergence of any species should occur, and stranding due to variable flows would be limited to the delta area because flow in the swamp is influenced strongly by Savannah River flows. Because of lower flows and temperatures, fish habitat should be greatly improved over that present upstream; much greater use and spawning success would occur. Some access to Reach 2 would be available for anadromous and other species. Because of high flows, the endangered wood stork probably would not use this reach for foraging; however, because of lower water temperatures, waterfowl should use the delta area to a greater extent than they would for the no-action alternative.

Less aquatic vegetation habitat would be available with the recirculating cooling-tower system than with the once-through alternative (Table 4-30). However, the reduction in flow and the resultant decrease in water depths would provide greater vegetation abundance in the areas of occurrence. In the delta area, herbaceous marsh should occur but in less abundance than with the once-through alternative; shrub species would also be present and old-field species would occur in the drier areas. In the swamp, the cypress-tupelo community would predominate. Less macroinvertebrate habitat would be available than with the once-through system, but the habitat would be of higher quality because of reduced, stable flows. A substantial increase in macroinvertebrate community diversity and abundance would occur, and there would be little chance of stranding due to the more stable flows. Fish use and spawning would be reduced in the delta area as a result of the reduced flow, shallow water depths, and increased densities of vegetation, all of which could also limit access to the upper stream reaches. In the swamp, a high-quality habitat for spawning and nursery functions would occur as a result of the influence of the Savannah River on water levels. Use of the delta area by the endangered wood stork would increase as a result of reduced flows; however, this eventually would decrease as revegetation of the area
BB-3 proceeds. Less habitat would be available in the delta for waterfowl in comparison to the once-through alternative because of flow reduction and the related revegetation of the area.

With a complete cessation of reactor cooling water discharge (natural stream conditions), less habitat would be available for aquatic vegetation than with the recirculating cooling-tower alternative. However, in the available areas, dense concentrations should occur. In the riparian areas of the delta, there would be greater development of an old-field community, with less marsh and shrub vegetation than with the recirculating alternative. In the swamp, the cypress-tupelo community would predominate. Less macroinvertebrate habitat would be available, but community diversity and abundance should be similar to those for the recirculating alternative. There should be little chance of macroinvertebrate stranding due to more stable flows. In the delta area, less fish habitat would be available and spawning success should be less because of reduced flow and revegetation effects that reduce aquatic habitat. However, in the swamp, fish use should be similar to that with the recirculating system. Limited use of the delta area by the endangered wood stork should occur; this would decrease at a more rapid rate than with the recirculating alternative due to revegetation. There would be less use by waterfowl because revegetation would cause less available habitat.

The present worth cost of the once-through cooling-tower system for both
AD-1 reactors would be approximately $93 million less than that for recirculating
BC-6 cooling towers. However, recirculating cooling towers would cost approximately $4 million less to operate each year. In addition, recirculating cooling towers would require approximately 6 months longer to construct. The implementation of recirculating cooling towers could reduce reactor power by 3.7 percent, compared to only 0.2 percent with the
TC once-through system (both systems were compared to the No-Action alternative). Costs to conduct a Section 316(a) Demonstration study would be the same for either alternative, about $1.25 million.

4.6.1.1 Once-Through Cooling Tower

The estimated present worth for the once-through natural-draft cooling tower with gravity feed at K-Reactor would be approximately $43 million, including production losses ($41.4 million without production losses). Estimated annual operating costs would be $6.4 million. Preliminary design studies suggest a 0.2-percent annual average loss of reactor power attributable to the operation of a once-through tower system in comparison to the No-Action alternative. Construction would require about 36 months, after a 9-month lead design period. AD-1 BC-6

The implementation of this alternative would reduce the thermal effects in Pen Branch 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 operations. Fluctuating water levels and flow rate could inundate the eggs, nests, and hibernation sites of the American alligator. The availability of foraging habitat for the wood stork would be limited due to water depth and flow. Air quality impacts, including fogging and icing, elevated visible plumes, and total-solids (drift) deposition would be insignificant. BC-10 BC-14

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 effective whole-body dose of 1.1×10^{-4} millirem per year. The total collective effective whole-body dose would decrease by 2.8×10^{-2} person-rem per year. These dose changes are very small in comparison to 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 for cooling-tower construction. TE

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. The present-worth value of this alternative would be $47 million less than that for recirculating towers. TC

The principal environmental benefit of this alternatives over the no-action alternative would be the reduction of thermal effects in Indian Grave Branch and Pen Branch and the delta and an associated increase in dissolved oxygen levels. TE

4.6.1.2 Recirculating Cooling Towers

The estimated present worth of this alternative would be approximately $90 million including production losses ($58 million without production losses). Estimated annual operating costs would be $4.4 million. Preliminary design criteria suggest a 3.7-percent annual average loss of reactor power attributable to the operation of a recirculating cooling-tower system, in comparison to the no-action alternative. Construction would require about 42 months, after a 9-month lead design time. AD-1 BC-6

This alternative would reduce water temperatures in Pen Branch and its delta, but would also greatly reduce the flows in these areas. Approximately 0.6 cubic meters per second would be discharged as a result of this alternative, in contrast to the present discharge rate of 10.5 cubic meters per second.
BC-1 The reduction in thermal effects would allow recolonization by fishes and
BC-19 other organisms but would greatly reduce the habitat area. Losses of wetlands
BD-5 would essentially cease, and an estimated 500 acres should become re-established through the process of natural plant succession. There should be no impacts associated with cold shock during the winter. Total annual entrainment (eggs and larvae) would be reduced from 13.4×10^6 to 2.0×10^6, while total annual impingement would be reduced from approximately 2942 to 427 fish. Habitat quality for the American alligator would be improved;
BB-3 the inundation of eggs, nests, and hibernation sites would be improbable. The availability of foraging habitat for the endangered wood stork would be enhanced.

Impacts to air quality would be similar to those expected for a once-through tower and, although salt deposition would be higher than that for the once-through tower, levels would be far below those that would cause vegetative stress.

The operation of this alternative would reduce flows in Pen Branch, resulting in a decrease in the cesium-137 release to the Savannah River of 0.12 curie per year. About 425 additional curies of tritium would be released per year to the atmospheric pathway, and 425 fewer curies of tritium would be released per year to the liquid pathway. The reduction in cesium-137 and the change in
BB-3 the release of tritium would result in a decrease in the maximum individual effective whole-body dose of about 7.0×10^{-2} millirem per year. The collective effective whole-body dose would decrease by about 4.8×10^{-1} person-rem per year. The dose to onsite construction personnel due to slightly elevated background levels of radiation produced by SRP facilities would be 20 millirem per year, based on 2000 hours for 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 major advantage over the no-action alternative would be the improvement in water quality in Pen Branch and its delta by the reduction of temperatures and flows 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 to Pen Branch and its delta. The high-water temperatures
BB-4 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 26 acres per year would continue. Entrainment and impingement losses would be

maintained at current levels. Habitat value for the American alligator, which has been classified as "threatened due to similarity of appearance," and endangered wood stork would remain low. There would be no impacts on air quality, noise, or archaeological sites with this alternative. BB-4

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. There would be a considerable savings in construction (a minimum of $41.4 million) and operating (a minimum of $4.4 million per year) costs over those for the implementation of either cooling-tower system. AD-1 BC-6

4.6.2 ALTERNATIVES FOR C-REACTOR

The comparison of impacts of the two cooling-tower alternatives for C-Reactor are similar to those associated with K-Reactor described in Section 4.6.1. TC

4.6.2.1 Once-Through Cooling Tower

The estimated present worth for the once-through, natural-draft, gravity-feed cooling tower at C-Reactor would be approximately $44 million, including production losses ($42.4 million without production losses). The estimated annual operating costs would be $6.4 million. The construction would require 36 months following a 9-month design phase. Reactor power should drop by 1 percent due to the operation of the once-through system, compared to the No-Action alternative. As with K-Reactor, C-Reactor would require an additional $1.25 million for a 316(a) Demonstration study. AD-1 BC-6

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 operations. Fluctuating water levels and flow rate could inundate the eggs, nests, and hibernation sites of the American alligator. The availability of foraging habitat for the wood stork would be limited due to water depth and flow. 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. BB-3

About 50 additional curies of tritium would be released per year to the atmospheric pathway, and about 50 curies less would be released per year to the liquid pathway for this alternative. This would result in a reduction of the maximum individual effective whole-body dose of 1.1×10^{-4} millirem per year. The total collective effective whole-body dose would decrease by 2.8×10^{-2} person-rem per year. These dose changes are very small in comparison to 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 for cooling-tower construction.

An advantage of the once-through tower over recirculating towers would be the maintenance of existing flow levels in the creek and delta, thereby providing more potential habitat for fish and other organisms. BC-6 The present-worth value of this alternative would be approximately $46 million less than that for recirculating 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 Four Mile Creek.

4.6.2.2 <u>Recirculating Cooling Towers</u>

The estimated present worth of this alternative would be approximately $90 million including production losses ($58 million without production losses). Estimated annual operating costs are $4.4 million. In addition to these BC-6 costs, the estimated cost to conduct a Section 316(a) Demonstration study would be $1.25 million. Preliminary design criteria suggest a 4-percent annual average loss of reactor power attributable to the operation of a recirculating cooling-tower system, compared to the no-action alternative. Construction would require about 42 months, after a 9-month lead design time.

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 BB-3 associated with cold shock during the winter. Total annual entrainment (eggs BD-5 and larvae) would be reduced from 13.4×10^6 to 2.0×10^6, while total annual impingement would be reduced from approximately 2942 to 427 fish. Habitat quality for the American alligator would be improved; the inundation of eggs, nests, and hibernation sites is unlikely. The availability of foraging habitat for the endangered wood stork would be enhanced. 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 cause reduced vegetative productivity. The same BB-3 prehistoric site that would be disturbed by construction of the once-through system would be impacted by this alternative.

This alternative would result in a decrease of 0.21 curie per year of cesium-137 released to the Savannah River. The radiological releases for C-Reactor would be similar to those described for K-Reactor in Section BC-22 4.6.1.2, except the total decrease in the maximum individual effective whole-body dose and the collective effective whole-body dose due to cesium and tritium releases would be 1.2×10^{-1} millirem per year and 6.6×10^{-1} person-rem per year, respectively. The dose to onsite construction personnel due to slightly elevated background levels of radiation produced by SRP facilities would be 20 millirem per year, based on 2000 hours for cooling-tower construction.

The principal environmental benefits of this system over a once-through tower would be the successional re-establishment of a greater amount of wetlands and the reduction of losses due to entrainment and impingement.

4.6.2.3 No Action

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

This alternative would not comply with South Carolina's Class B water classification standards. Radiological releases would be approximately the same as those described in Section 4.6.1.3 for K-Reactor, except cesium-137 releases from creek sediments would be slightly lower. There would be a considerable construction cost savings (more than $90 million) over the other two systems.

4.6.3 COMPARISONS FOR D-AREA

4.6.3.1 Increased Flow with Mixing

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 extreme summer temperatures 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 are few adults and spawning in the vicinity of the intake during the summer. Temporary wetland losses would only total about 4 acres during periods when pumping was necessary. American alligator habitat would not be affected, but some decrease of wood stork habitat in the area could result from greater water depths during periods when extra pumping would be required to meet Class B water classification standards. There would be no impacts to air quality, noise, release of radionuclides, or archaeological resources due to the 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 American alligator BB-5 (threatened due to "similarity of appearance") and endangered wood stork. In addition, 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 reduction of thermal effects in the creek during periods of high summer temperatures.

4.6.3.2 Direct Discharge

Construction of the discharge pipeline would require a capital cost of approximately $14 million and 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

This alternative would require no costs or delays. 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. TC The existing habitat for the American alligators ("threatened due to similarity of appearance") and marginal foraging habitat for the endangered wood stork would be unchanged.

An 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 American alligator and the wood TC 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 $140,000 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 K- and C-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 have been taken to satisfy these requirements. Table 5-1 lists the permits and other environmental approvals needed to implement the cooling water alternatives and the status of each. | TC

In addition to securing these permits and complying with applicable standards, the U.S. Department of Energy (DOE) is required to comply with several separate environmental requirements, such as the National Environmental Policy Act (NEPA) and floodplain/wetlands review. 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 to 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 September 30, 1988, subject to the appropriation of funds by Congress	TC
	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, Division of Water Quality	Requested by COE as as part of the dredge and fill permit process	TC
	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	
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 cooling water system	TE
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	

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

Activity/facility	Requirement(s)	Agency	Status
Endangered species	Consultation/ biological assessment	U.S. Fish and Wildlife Service	Consultations with FWS completed
Fish and Wildlife Coordination Act	Consultation/ consideration of fish and wild-life resources	U.S. Fish and Wildlife Service	Consultations with FWS completed
Migratory Bird Treaty Act	Consultation with FWS	U.S. Fish and Wildlife Service	Consultation with FWS completed
Anadromous Fish Conservation Act	Consultation with FWS	U.S. Fish and Wildlife Service	Consultation with FWS completed
Historic preservation	Archaeological survey and assessment	South Carolina Historic Preservation Officer	Surveys and assess-ments completed; consultation with SHPO completed
Floodplains/wetlands[c]	Assessment and determination	U.S. Department of Energy	Notice published in Federal Register (51 FR 10654) con-currently with Notice of Avail-ability of the draft EIS on March 28, 1986; determination published after completion of FEIS.

a. Applicable to the D-Area coal-fired powerhouse direct discharge alternative.
b. Applicable to once-through cooling-tower alternatives for K- and C-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 that government agencies 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) to establish DOE compliance procedures for 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, with jurisdiction over any property or facility that might result in air pollutant discharges, 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 construction, alteration, or addition to a source of air emissions. Consequently, 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 new construction or any modification of a major source that will result in a significant increase in the emission rate. EPA has promulgated final regulations for airborne radiation limits at DOE facilities (40 CFR 61; 50 FR 5190).

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

Section 316(a) of the Federal Water Pollution Control Act, as amended, authorizes EPA's Regional Administrator to set alternative effluent limitations on the thermal component of discharges if the owner/operator (DOE) demonstrates that the proposed thermal 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." This satisfactory demonstration is to be made to SCDHEC, because it has received the NPDES authority and is the decisionmaker; however program overview is 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. This is to include scientific evidence that a balanced biological community will be maintained; no adverse impacts to threatened and endangered species will occur; no unique or rare habitats will be destroyed; passage zone 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.

<u>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.)</u>

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. The authority to implement these requirements for the discharge of dredged or fill material into the waters of the United States (404 permits) has been given to the U.S. Army Corps of Engineers (COE). SCDHEC has been delegated authority by EPA to regulate wastewater discharges (NPDES permits). Individual (case-by-case) permits issued by COE under Section 404 of the Federal Water Pollution Control Act, as amended, are reviewed by EPA (40 CFR 230). The discharge of dredged and fill material into headwaters of creeks where the natural flow is 0.142 cubic meter per second or less, providing applicable reporting/permitting requirements are met, is covered under a nationwide permit issued by COE. TC

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

The South Carolina Budget and Control Board has a parallel permitting system with COE (permits for construction in navigable waters, Regulation 19-450), that is administered by the South Carolina Water Resources Commission (SCWRC). The permit application submitted to COE also serves as the permit application to SCWRC; a separate permit application is not required.

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 so discharges of dredged and fill material into navigable waters will comply with applicable effluent limitations and water-quality standards. 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)

Under this Act, SCDHEC has authority to require construction permits for the construction of any wastewater treatment facility and any wastewater collection and transmission system. An engineering report and specifications must 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 is jointly administered by the Departments of Commerce and the Interior, and does not require a permit, certification, license, or other formal approval. Section 7 does, however, require consultation to determine whether endangered and
TC threatened species are known to be present or 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 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. 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 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, and bag limits. 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 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 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 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 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 K- and C-Reactors in the Pen Branch and Four Mile Creek areas. During this survey, 65 discrete archaeological resource sites were located and 23 were considered to be significant. The only site that potentially could be affected by proposed alternatives for C-Reactor is

38BR548; however, it 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 (SHPO) has resulted in the opinion that the construction of alternative cooling water systems for K- and C-Reactors will have "no adverse effect" on sites eligible for inclusion in the National Register. DOE, as part of its regular monitoring program of the onsite streams, will monitor flows in Beaver Dam Creek, Four Mile Creek, and Pen Branch. If any erosion that would impact any archaeological site is found, DOE will notify the SHPO, as was requested when the no adverse impact determination was rendered (Lee, 1986).

An extensive archaeological survey was conducted by the SRP 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, because of its specific location, this site would not be affected by erosion or inundation from increased pumping to the raw-water basin alternative. This site has been recommended by DOE to the State Historic Preservation Officer for eligibility for nomination to the National Register of Historic Places. Neither the Advisory Council on Historic Preservation (Klima, 1986) nor the State of South Carolina Historic Preservation Officer (Lee, 1986) object to a determination of "no effect" for archaeological site 38BR450 in relation to increased flows in Beaver Dam Creek (D-Area).

5.3 SOLID WASTE DISPOSAL

The SRP Sanitary Landfill is designed and operated according to SCDHEC guidelines for 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 each Federal agency to ensure that any action it authorizes, funds, or carries out does not jeopardize endangered or threatened species (or those that are proposed as such) or result in the destruction or adverse modification of designated critical habitat. Federal agencies are required to consult with FWS and/or NMFS regarding the implementation of a proposed action. If FWS or NMFS indicates that an endangered or threatened species 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.

Formal consultations were held between DOE and FWS to comply with the Endangered Species Act of 1973. Based on these consultations, FWS issued a biological opinion that the preferred alternative cooling systems should have no effect on the American alligator, red-cockaded woodpecker, wood stork (Parker, 1986), or bald eagle (Henry, 1986). NMFS 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). TC

5.5 WILDLIFE AND FISHERIES

Three regulations grant protection to wildlife and fisheries resources. These are the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, and the Anadromous Fisheries Conservation Act. The Acts do not require application for or acquisition of a permit. However, each requires that DOE consult with FWS about impacts to fish and wildlife.

Consultations have been completed with FWS to ensure that DOE will comply fully with these three Acts. To assist in these consultations, a Habitat Evaluation Procedure (HEP) analysis was conducted which identified the value of habitat to be gained or lost with the potential implementation of the cooling water alternatives (Mackey et al., 1987). BC-3 BD-4

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 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 K- and C-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 wastewater 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 wastewater 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.

TC

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 August 27, 1985, to include an implementation schedule for the selected cooling water systems. Due to extensive comments on the draft Environmental Impact Statement for the alternative cooling water system, additional time was needed by DOE to address the comments, resulting in an August 1987 amendment to 84-4-W which provides a revised schedule. Major requirements contained in the amended Consent Order and their status are summarized below.

TC

Comprehensive Cooling Water Study: Required by NPDES permit as Special Condition Part III, Number 8 - 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 objective is to quantify the environmental effects associated with the large-volume withdrawal and discharge of cooling water on the Plant. The second objective 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) contains historic data pertinent to the study's objectives and new data developed during fiscal year 1984. A final report (Du Pont, 1987) documents additional data collected during fiscal year 1985 and conclusions. This EIS incorporates data from this study. TL

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 K- and C-Reactors and the D-Area coal-fired powerhouse was submitted to SCDHEC on October 3, 1984.

Implementation Schedule - As outlined in the amended 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 September 30, 1988. The Consent Order further provides for the start of construction of the selected cooling water systems for K-Reactor on or before February 28, 1990, with completion of the selected system for K-Reactor on or before December 31, 1992. 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, 1988, and is to become enforceable after approval by SCDHEC. TC 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 ΔT of 2.8°C above ambient temperature requirement.

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 COE. Section 401 certification from SCDHEC will 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 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 K- and C-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

TC A floodplain/wetlands assessment is presented in Appendix F. A notice of this floodplain/wetlands assessment appeared in the Federal Register on March 28, 1986 (51 FR 10654). A floodplain/wetlands determination will appear in the Federal Register after completion of this 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 K- and C-Reactors or the D-Area powerhouse.

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

EPA has retained jurisdiction for the regulation of airborne radionuclides. The 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 5480.1B, "Environmental Protection, Safety, and Health Program for DOE Operations," September 23, 1986
- TC Order 5482.1B, "Environmental, Safety, and Health Appraisal Program," September 23, 1986
- Order 5483.1A, "Occupational Safety and Health Program for a Government Owned Contractor Operated Facility," June 22, 1983
- Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," February 24, 1981
- Order 5700.6B, "Quality Assurance," September 23, 1986

- Order 6430.1, "Department of Energy General Design Criteria Manual," December 12, 1983

- Order 5480.6, "Safety of Department of Energy-Owned Nuclear Reactors," September 23, 1986

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EIS RESPONSIBILITY	Performed technical reviews of hydrology sections in Chapter 3

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EIS RESPONSIBILITY	Performed technical review of Chapter 5

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

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EDUCATION	M.S., Geology, University of Wisconsin B.S., Geology, University of Wisconsin
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EIS RESPONSIBILITY	Assisted in preparation of geology, water quality, and radionuclide transport sections in Chapters 3 and 4 and Appendix D

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

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EXPERIENCE TECHNICAL SPECIALTY	Thirty-eight years. Corporate Technical Director; senior management of site evaluation, safety and environmental assessment, and environmental impact evaluation. Professional Engineer
EIS RESPONSIBILITY	Primary reviewer of draft and final EIS for NUS Corporation

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EDUCATION: M.S., Game Management, Louisiana State University
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EXPERIENCE TECHNICAL SPECIALTY: Fifteen 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

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AFFILIATION: NUS Corporation

EDUCATION: M.S., Geography, University of South Carolina
B.S., Geography, University of South Carolina

EXPERIENCE TECHNICAL SPECIALTY: Three years. Remote sensing and geographic information system studies, regulatory analysis, environmental policy, environmental impact studies, terrestrial ecology, and natural resource management

EIS RESPONSIBILITY: Deputy Principal Investigator for EIS preparation. Prepared geography sections in Chapter 3 and assisted in preparation of endangered species sections of Chapter 3 and Appendix C. Assisted in preparation of Chapters 4 and 5 as well as Appendix E.

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AFFILIATION: NUS Corporation

EDUCATION: M.S., Physics, University of Maryland
B.S., Physics, University of Maryland

EXPERIENCE TECHNICAL SPECIALTY: Eighteen 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

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EDUCATION: B.S., Environmental Science, Florida Institute of Technology

EXPERIENCE TECHNICAL SPECIALTY: Four years. Statutory/regulatory analysis, site-specific environmental compliance plans, environmental impact studies

EIS RESPONSIBILITY: Contributed to Chapter 5

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AFFILIATION: NUS Corporation

EDUCATION: B.S., Chemical Engineering, University of Connecticut

EXPERIENCE TECHNICAL SPECIALTY: Eighteen years. Environmental impact studies, radiological dose impacts

EIS RESPONSIBILITY: Performed technical reviews of Appendixes B, D, and G

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EDUCATION: Ph.D. Residency, Geography/Geology, University of Michigan
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B.A., Geography/Botany, University of Michigan

EXPERIENCE TECHNICAL SPECIALTY: Twenty-three 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

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AFFILIATION	NUS Corporation
EDUCATION	M.S., Zoology-Ichthyology, University of Connecticut B.S., Biology, Wake Forest University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-three years. Environmental impact studies, ichthyoplankton and entrainment studies, fisheries and impingement, aquatic ecology, and marine biology
EIS RESPONSIBILITY	Principal Investigator for draft EIS preparation. Assistant Program Manager; principal technical reviewer of draft and final 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 Appendixes C, I, and J.

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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

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

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EXPERIENCE TECHNICAL SPECIALTY Nineteen 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

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B.A., Chemistry, Lehigh University

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

EIS RESPONSIBILITY Prepared subsurface hydrology description for Chapter 3

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

EIS RESPONSIBILITY Deputy Principal Investigator for draft EIS preparation. Principal Investigator for final EIS preparation. Aquatic ecology sections for Chapters 3 and 4 and Appendix C. Completed revision of the Summary and Chapter 1, primary reviewer of all sections FEIS

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EDUCATION	Illinois Institute of Technology University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Thirty-three 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

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EXPERIENCE TECHNICAL SPECIALTY	Sixteen years. Environmental impact statements and assessments, socioeconomic and land-use analyses, transportation studies, water resources and quality
EIS RESPONSIBILITY	Principal technical reviewer of draft EIS for NUS Corporation

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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-one years. Radiological dose assessments, environmental impacts
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NAME	Michael Septoff
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EDUCATION	M.S., Meteorology-Oceanography, New York University B.S., Meteorology, City College of New York
EXPERIENCE TECHNICAL SPECIALTY	Eighteen 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

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EIS RESPONSIBILITY	Technical editor of the EIS

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EDUCATION	Ph.D., Nuclear Physics, Florida State University B.S., Physics, Michigan State University
EXPERIENCE TECHNICAL SPECIALTY	Sixteen years. Environmental impact statements; environmental, safety analysis, and licensing activities
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EDUCATION B.S., Forest Biology, State University of New York

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EIS RESPONSIBILITY Performed technical reviews of geography sections in Chapter 3

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

EXPERIENCE TECHNICAL SPECIALTY Thirteen 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

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EDUCATION Towson State University
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EXPERIENCE TECHNICAL SPECIALTY Nineteen 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

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

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AFFILIATION	NUS Corporation
EDUCATION	M.S., Mechanical Engineering, Tennessee Technological University B.S., Aeronautical Engineering, Embry Riddle Aeronautical University
EXPERIENCE TECHNICAL SPECIALTY	Fourteen 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	William R. Weiss
AFFILIATION	NUS Corporation
EDUCATION	M.S., Marine Science, University of South Florida B.S., Biology, Eastern College
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Aquatic ecology, water quality, environmental impact assessment including thermal and entrainment/impingement effects studies, natural resource management
EIS RESPONSIBILITY	Prepared descriptive sections for chlorination/dechlorination plans in Chapter 2, sections on environmental consequences to aquatic ecology and water quality/hydrology in Chapter 4, modifications/updates to aquatic ecology sections in Appendix C, all of Appendix I, and response to comments in Appendix J

NAME: Robert H. Werth

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EDUCATION: B.A., Physics, Gordon College

EXPERIENCE TECHNICAL SPECIALTY: Twelve 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

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EDUCATION: B.A., Geography, The George Washington University

EXPERIENCE TECHNICAL SPECIALTY: Sixteen 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

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EDUCATION: B.S., Civil Engineering, University of Maine

EXPERIENCE TECHNICAL SPECIALTY: Thirty-eight 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

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AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.B.A., Management, Georgia State University B.S., Chemistry, University of Georgia
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EIS RESPONSIBILITY	Principal reviewer of EIS for DOE

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EDUCATION	M.S., Biology, West Virginia University B.S., Biology, University of Pittsburgh at Johnstown
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EIS RESPONSIBILITY	Prepared descriptive radiological sections for Chapter 3 and Appendix D

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Conservation Foundation

Sierra Club Foundation

Sierra Club

League of Women Voters of the United States

Environmental Defense Fund

National Wildlife Federation

National Audubon Society

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Environmental Policy Center

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Albuquerque Operations Office
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Freedom of Information Public Document Room
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Gregg-Graniteville Library
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Public Reading Room
Chicago Operations Office
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Allendale-Hampton-Jasper Regional Library
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Aiken County Public Library
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Burke County Library
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Warren C. Gibbs Memorial Library
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