APPENDIX F

FLOODPLAIN/WETLANDS ASSESSMENT

F.1 INTRODUCTION

Executive Orders 11988 (Floodplains Management) and 11990 (Protection of Wetlands) and U.S. Department of Energy (DOE) regulation "Compliance with Floodplain/Wetlands Environmental Review Requirements" (10 CFR 1022) specify the requirements for a floodplain/wetlands assessment. Pursuant to these requirements, DOE issued a floodplain/wetlands notice on the construction and operation of alternative cooling water systems for the K- and C-Reactors and the D-Area coal-fired powerhouse on March 28, 1986 (51 FR 10654). BC-19

The proposed action and cooling water alternatives discussed in this EIS, except the D-Area direct discharge alternative, do not occur within the base floodplain or wetlands. Consequently, the practicability test for identifying and evaluating alternatives outside the base floodplain is not required except the D-Area direct discharge alternative which is discussed in Section F.4.2. However, the implementation of the cooling water alternatives for K- and C-Reactors and the D-Area powerhouse could potentially impact the base floodplain and wetlands. These impacts are identified and assessed in Chapter 4. The impact identification and assessment requirements for the EIS are applicable and equivalent to the requirements for floodplain/wetlands protection.

This appendix references the EIS wherever possible and addresses only those impacts of the alternative cooling water systems that could affect the base floodplain and wetlands.

One of the primary concerns of the floodplain/wetlands Executive Orders is the protection of lives and properties. Access to the Savannah River Plant (SRP) is strictly controlled. No dwellings, hospitals, schools, nursing homes, or other structures are located within the base floodplain. Therefore, neither individuals nor private property would be affected if the cooling water alternatives were implemented.

Another concern in the floodplain/wetlands Executive Orders is the impact on floodplain values. The cooling water alternatives would have little or no impact on cultural resources, agricultural, aquacultural, or forestry resources as related to floodplain values. Archaeological and historic resource surveys, which are discussed in Appendix E, identified no significant sites requiring impact mitigation. Because of the controlled access to SRP, no agricultural or aquacultural practices exist, and none would be affected by implementation of any of the cooling water alternatives. The implementation of any of the alternatives, except the no-action alternative for K- and C-Reactors, would enhance native plant communities. BC-19

The cooling water alternatives will, however, impact water and biological resources. This appendix discusses positive and negative, direct (concentrated) and indirect (dispersed), and short-term and long-term impacts associated with the construction and operation of the alternatives for each of the floodplain/wetland areas as related to both water and biological resources.

Short-term impacts are temporary changes during and immediately following
BC-23 implementation of an alternative. Impacts related to construction activities
such as site clearing and sedimentation runoff are examples of short-term
impacts. Long-term impacts can persist for a considerable time, and might
TE continue indefinitely. Loss of mature swamp forest trees because of thermal
effluents discharge is an example of a long-term impact. Direct impacts, as
used in this EIS, are concentrated at or near the site of the action; indirect
impacts occur at a site remote from the action. Impacts can be beneficial
(i.e., positive) or harmful (i.e., negative). The alternative cooling water
systems for K- and C-Reactors include the construction and operation of
once-through cooling towers (gravity feed and natural draft), recirculating
TE cooling towers, and the continuation of direct discharge, or no action. The
alternatives considered for the D-Area coal-fired powerhouse include increased
flow with mixing, direct discharge to the Savannah River, and continuation of
TE the present operation, or no action. The proposed action and alternatives are
discussed in Chapter 2.

F.2 PEN BRANCH (K-REACTOR)

F.2.1 ONCE-THROUGH COOLING TOWER (PREFERRED ALTERNATIVE)

F.2.1.1 Construction Impacts

Water Resources

The principal direct impact to water resources in the Pen Branch floodplain/
wetlands during construction would be on water quality. A negative impact of
BC-19 construction activities would be a temporary increase in suspended solids
because of runoff erosion. Temporary measures such as berms, drainage
ditches, drains, sedimentation basins, grassing, and mulching would control
TE runoff until permanent erosion-control measures could be implemented.
Construction activities would have no measurable effect on groundwater
recharge or the ability of the floodplain/wetlands to moderate floods. Water
quality impacts are discussed in Chapter 4.

Biological Resources

Construction activities would occur on upland sites and would not directly
TE affect the floodplain/wetlands. The principal indirect impact would be from
sediment loading on fish and macroinvertebrates. This short-term impact would
be minimal because Pen Branch, in the vicinity of the proposed construction,
is uninhabitable by aquatic and semiaquatic biota because of the high water
temperatures from reactor operations.

F.2.1.2 Operational Impacts

Water Resources

The principal direct impact to water resources in Pen Branch floodplain/
wetlands during operation would be on water quality. A positive impact would
BC-4 be that water temperatures at the outfall would be reduced from a maximum of
75°C to 30°C in the summer, only 3°C above projected ambient
temperatures. In the winter, the discharge temperature would decrease even

more to approximately 26°C (12°C above ambient creek temperature). Lower water temperatures would improve water quality by increasing the dissolved oxygen concentration.

Operation of the once-through cooling tower would reduce both suspended solids and the sedimentation rates of the delta, a positive impact. Some erosion and sedimentation would occur. However, the sedimentation rates of the delta should decrease as plant growth becomes reestablished along the stream banks. This would be a positive impact because of the prevention of further vegetative loss caused by thermal effluents. Operations would have no measurable impact on the ability of the floodplain/wetlands to moderate floods or groundwater recharge. Stream flow would be reduced slightly from 11.3 to about 10.5 cubic meters per second, and should cause a slight reduction in suspended solids concentrations, a positive impact. Water quality and hydrology impacts are discussed in Chapter 4. BC-10 BC-19

Biological Resources

The most significant positive ecological impact would be the enhancement of wetland habitat because of diminished thermal effects of the discharges. Vegetation would become reestablished on portions of the 670 acres of affected wetlands. The vegetation loss rate in the swamp of 26 acres per year because of thermal impacts would be reduced (see Chapter 4). The reduction in stream flow could contribute to a slight reduction in canopy loss from flooding and increased sedimentation, another positive impact. BC-19

Implementation of this alternative should enhance the diversity of plant and animal life over present conditions, a positive impact. Spawning conditions for indigenous and migratory fish species would be greatly improved. Operation of the cooling tower would meet the requirements stipulated for Maximum Weekly Average Temperature (MWAT) for fish survival during a winter shutdown (EPA, 1977; Muhlbaier, 1986); this would be a positive impact. TE

Two species at SRP would be affected positively by this alternative. Because the water temperature would be well below the thermal maximum temperature tolerance of the threatened American alligator (*Alligator mississippiensis*; classified as "threatened due to similarity of appearance"), additional habitat for it and other aquatic species would be created. TC

Reducing the temperature below the thermal maximum for fish would allow fish to recolonize Pen Branch, a positive impact. The fluctuating water levels could concentrate fish, the principal prey of the endangered wood stork (*Mycteria americana*). This would be a positive impact because loss of foraging habitat has contributed to the decline of the wood stork (Du Pont, 1985). TE

Based on formal consultation between the U.S. Fish and Wildlife Service (FWS) and DOE on the American alligator, red-cockaded woodpecker, and wood stork, FWS has issued a biological opinion of "no effect" if DOE implements the preferred alternatives (Parker, 1986). TC

Because this alternative would not require any changes in the cooling water intake structures or flow rates, there would be no change in the entrainment or impingement impacts. Consultation between DOE and the National Marine

TE Fisheries Service has determined that SRP operations would have no adverse impacts on the endangered shortnose sturgeon, <u>Acipenser</u> <u>brevirostrum</u> (Oravetz, 1983). Biological impacts are discussed in Chapter 4.

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

TE Tolerances and susceptibility to salt deposition are highly variable, depending on the plant species and other conditions in the environment. Vegetative studies indicated that thresholds for development of visible salt stress symptoms on the most sensitive species were approximately 83 kilograms (183 pounds) per acre per year of sodium chloride salt (INTERA, 1980). Studies indicate that at sodium chloride deposition rates of about 41 kilograms (90 pounds) per acre per year, agricultural productivity can be reduced (Mulchi and Armbruster, 1981).

TE The drift composition is equivalent to that of the circulating water. The concentration of substances in the circulating water for this alternative is shown in Table 3-3. The substance of particular interest with regard to its potential for damage is the chloride ion. The other constituents in the table are at low concentrations and considered negligible or are potentially beneficial.

TC The implementation of this alternative would result in an estimated total solids deposition of 0.5 kilogram (1.1 pounds) per acre per year within 2 kilometers of the cooling tower. The sodium chloride deposition rates from the cooling tower are much less than the critical values reported by Mulchi and Armbruster (1981), INTERA (1980), and NRC (1979) that can cause reduced productivity of plant species. Therefore, no significant impacts on vegetation are expected with this alternative.

F.2.2 RECIRCULATING COOLING TOWERS

F.2.2.1 <u>Construction Impacts</u>

<u>Water Resources</u>

BC The principal impacts to water resources in the Pen Branch floodplain/wetlands during construction would be similar to those for described the once-through cooling-tower alternative in Section F.2.1.1. Suspended solids because of runoff erosion should be slightly lower, and a projected 50 acres of upland habitat would be disturbed versus 25 acres for the once-through cooling-tower alternative during construction activities.

Biological Resources

Biological resource impacts would be similar to those associated with the construction of the once-through cooling tower (see Section F.2.1.1). TE

F.2.2.2 Operational Impacts

Water Resources

Implementation of this alternative would primarily affect water quality. As with the once-through cooling tower alternative, effluent temperatures would closely duplicate ambient temperatures, a positive impact. Under winter conditions, the average discharge temperature would be about 15°C, about 5°C to 7°C above the ambient stream temperature. BC-14 Dissolved oxygen levels would improve if this alternative were implemented and would comply with State Class B water classification standards throughout the year, a positive impact. Nutrient concentrations would increase at the tower outfall under this alternative, but total loading (quantity) of nutrients and other chemicals transported to the swamp/river system would not increase.

Water consumption from the Savannah River would be reduced from about 11.3 cubic meters per second to about 1.7 cubic meters per second, a positive impact.

The implementation of this action would result in greater reductions in TE suspended solids and the sedimentation rates of the delta than the once-through alternative. The most significant reduction in sedimentation and delta growth rate impacts would be from the reduction in stream flow rates, a TE positive impact. Under this alternative, discharge flows would decrease from 11.3 cubic meters per second to about 0.6 cubic meter per second, and stream channel depth and width would be reduced substantially. Operations would have no measurable impact on the ability of the floodplain/wetlands to moderate floods or groundwater recharge.

Biological Impacts

The most significant ecological impact would be the enhancement of wetland habitat because of the reduced flow and thermal effects, a positive impact. Vegetation would become reestablished on about 500 acres of the thermally BC-19 impacted 670 acres of wetlands and the vegetation loss rate associated with the delta growth (26 acres per year, average 1974-1984) would be substantially reduced.

Stream flows and temperatures would more closely follow ambient conditions and would facilitate plant and animal diversity over present conditions, a positive impact. Spawning conditions for indigenous and migratory fish species would be greatly improved. With discharge temperatures similar to ambient temperature, there would be no potential for cold shock during a winter reactor shutdown. Changes in flow volumes, when they occur, would be smaller than with other alternatives and would tend to minimize changes in stream morphology. This should stabilize aquatic and wetland habitats.

Two species at SRP would be affected by this alternative. The impact on the American alligator which is classified as "threatened due to similarity of appearance" should be positive (i.e., increased habitat). The decrease in water flow would allow vegetation to become reestablished over a larger area than the once-through alternative.

Fish and other vertebrates would be able to inhabit the stream channel, providing potential foraging habitat for the endangered wood stork. Fluctuations in water levels would decrease compared to those from the once-through alternative. Consequently, the potential for fish populations becoming concentrated in small pools, providing foraging habitat for the wood stork, would decrease.

Through natural vegetative succession, a large area of the impacted floodplain/wetlands should eventually return to a closed-canopy forest, thereby providing food and cover for numerous species of wildlife.

Because the rate of entrainment for fish eggs and larvae is directly proportional to the water intake flow rate, entrainment losses would be proportionally reduced (approximately 85 percent). Estimated impingement losses would also be reduced by a similar amount. Biological impacts are discussed in Chapter 4.

TC

Implementation of this alternative would result in an estimated total solids deposition of about 22.7 kilograms (50 pounds) per acre per year within 0.5 kilometers. At 2 kilometers, the predicted solids deposition is calculated to be about 2.2 kilograms (5.0 pounds) per acre per year. Because the deposition rates at 2 kilometers are much less than the critical values reported (see Chapter 4), no significant impacts on vegetation are expected at or beyond this distance with this alternative.

F.2.3 NO ACTION - EXISTING SYSTEM

F.2.3.1 Operational Impacts

Water Resources

The impacts on water resources of the No-Action alternative are mostly negative. The annual average flow in Pen Branch below the K-Reactor cooling water discharge point would continue to be about 11.8 cubic meters per second, 11.3 cubic meters per second above natural stream flow. The thermal maximum temperature tolerance for most aquatic and terrestrial species would continue to be exceeded. The dissolved oxygen levels would continue to fall below minimum South Carolina water classification standards during the summer. Suspended solids and sedimentation rates for delta expansion would continue. Stream morphology has been permanently altered because of approximately 30 years of discharge at 11.3 cubic meters per second. Because of this alteration, continued operations would have little impact on the ability of the Pen Branch floodplain/wetlands to moderate floods. Continued operations would have little impact on the ability of the swamp floodplain/wetlands adjacent to Pen Branch to moderate floods because this is controlled by the Savannah River (483 cubic meters per second of flow during flood stage). Groundwater recharge in this area is primarily controlled by the Savannah River. Water quality and hydrology impacts are discussed in Chapter 4.

Biological Resources

The impacts on biological resources of the no-action alternative are negative. The flora along the creek would continue to be sparse, reflecting the harsh temperature regime. Most aquatic invertebrates would remain absent from the creek. Fish would not be able to inhabit the creek where their thermal maximum temperature tolerance is exceeded, and the fish fauna above the thermal discharge point would continue to be depauperate in number and diversity. Limited use by threatened and endangered species in Pen Branch would continue under existing conditions. Entrainment and impingement rates would remain at the present level. Biological impacts are discussed in more detail in Chapter 4.

F.3 FOUR MILE CREEK (C-REACTOR)

F.3.1 ONCE-THROUGH COOLING TOWER (PREFERRED ALTERNATIVE)

F.3.1.1 Construction Impacts

Water Resources

The types of construction impacts of the once-through cooling tower for C-Reactor on water resources and biological resources in Four Mile Creek would be similar to those described for K-Reactor on Pen Branch (see Section F.2.1.1 and Chapter 4).

F.3.1.2 Operational Impacts

Water Resources

The operational impacts of the once-through cooling tower for C-Reactor on water resources would be similar to those described for K-Reactor on Pen Branch (see Section F.2.1.2 and Chapter 4).

The cooling effect would be the same as that projected for Pen Branch in that temperatures would meet the 32.2°C Class B water classification standard, but would be 10°C to 13°C above ambient creek temperature at the point of discharge during the winter. BC-14

Biological Resources

Operational impacts of the once-through cooling tower for C-Reactor on biological resources would be similar to those described for K-Reactor (see Section F.2.1.2 and Chapter 4). Vegetation would become reestablished on portions of the 1147 acres of affected wetlands, and the vegetation loss rate in the swamp of 28 acres per year due to thermal impacts would be reduced, a positive impact. BC-19 The implementation of this alternative would further enhance foraging habitat for wood storks, a positive impact. The cooling tower would be designed and operated to meet the requirements stipulated for MWAT for fish survival during a winter shutdown (EPA, 1977; Muhlbaier, 1986); this would be a positive impact.

Deposition of cooling tower drift would be similar to that projected for the once-through cooling tower alternative for K-Reactor [i.e., 0.5 kilogram (1.1 pounds) per acre per year within 2 kilometers]. Because these deposition rates are much less than the critical values (see Chapter 4), there would be no impacts on vegetation with this alternative.

F.3.2 RECIRCULATING COOLING TOWERS

F.3.2.1 Construction Impacts

Water Resources

The construction impacts of recirculating cooling towers for C-Reactor on water resources and biological resources would be similar to those described for K-Reactor on Pen Branch (see Section F.2.3.1). Sedimentation runoff
BC-19 impacts should be similar (short-term) because projected disturbances (60 acres) approximate those for the K-Reactor recirculating cooling tower (50 acres).

F.3.2.2 Operational Impacts

The operational impacts of recirculating cooling towers for C-Reactor on water resources and biological resources would be similar to those described for
BC-19 K-Reactor on Pen Branch (see Section F.2.2.2 and Chapter 4). It is estimated that approximately 1000 acres of the thermally impacted 1147 acres of wetland vegetation would become reestablished, a positive impact.

The implementation of this alternative would result in an estimated total sol-
TC ids deposition of 2.2 kilograms (4.8 pounds) per acre per year within 2.0 kilometers of the cooling towers. Because this rate at 2 kilometers is much less than the critical threshold values reported that can cause reduced productivity of plant species (see Section F.2.1.2 and Chapter 4), no significant impacts on vegetation are expected with this alternative.

F.3.3 NO ACTION - EXISTING SYSTEM

F.3.3.1 Operational Impacts

The operational impacts of the no-action alternative on water resources and biological resources are similar to those described for K-Reactor on Pen Branch (see Section F.2.3 and Chapter 4).

F.4 BEAVER DAM CREEK (D-AREA POWERHOUSE)

F.4.1 INCREASED FLOW WITH MIXING (PREFERRED ALTERNATIVE)

F.4.1.1 Construction Impacts

Existing structures would be used for increasing flow. Consequently, there would be no construction or short-term impacts associated with this alternative.

F.4.1.2 Operational Impacts

Water Resources

Water quality monitoring studies have shown that temperature is the only Class B water classification standard not currently being met and that the thermal limits are exceeded only during the late spring and summer months (Du Pont, 1985). During summer extremes, discharges to the creek presently range from 32°C to 34°C. Implementation of this alternative would reduce these effluent temperatures sufficiently to meet State Class B water classification standards. Potential impacts that could occur include small increases in stream suspended solids caused by intermittently increased stream flow (i.e., increases in flow with average increments from 2.7 cubic meters per second to 4.0 cubic meters per second), depending on the number of additional pumps needed to meet temperature requirements (see Chapter 2). Operations under this alternative would have little impact on the ability of the floodplain/wetlands to moderate floods or groundwater recharge, because these activities are predominantly influenced by the Savannah River (Du Pont, 1985).

BC-14

BC-10

Biological Resources

Mean water temperatures at the mouth of Beaver Dam Creek would be about 4°C and 1°C above ambient creek temperatures in the spring and summer, respectively. Water temperatures would be about 7°C above ambient during the winter. Increased flow during the spring and summer months would increase aquatic habitat and should increase the abundance and diversity of fish and macroinvertebrates. However, wildlife habitat would be temporarily reduced during periods of increased pumping.

BC-14

The increased flow would cause temporary increases in stream channel erosion and would increase siltation. This increased siltation would generally occur after peak spawning in May and June. However, during some years increased flow could be required as early as May or June, a potentially negative impact. Any increase in vegetation loss due to delta growth should be minimal and offset by vegetation reestablishment and succession on previously impacted thermal areas. A reversal in the pattern of the canopy loss is already being observed. It is thought this pattern is because of a reduction in effluent temperatures that began in 1978 and has continued (Du Pont, 1985).

The alligator, which is classified as "threatened due to similarity of appearance," and the endangered wood stork could be affected by this alternative. The Beaver Dam Creek area supports a large population of alligators, and the mild thermal effluent during the winter probably enhances the survivability of juvenile alligators. Implementation of this alternative would have no impact on winter thermal effluent. Therefore, it should have no impact on winter alligator populations. Intermittently increased flows during the spring and summer would cause the water level in Beaver Dam Creek to alternately rise and fall 12 to 19 centimeters (see Chapter 4). Water-level increases less than or equal to 35 centimeters are not expected to affect alligator nesting sites (Specht, 1985).

TC

Wood storks frequently forage in the Beaver Dam Creek swamp, although feeding habitat is marginal quality when compared to other areas at SRP (Du Pont, 1985). An increase in water levels of 12 to 19 centimeters could be too deep at times for foraging activities. Conversely, increased water levels could prevent or delay potential foraging areas from drying up during droughts because the Beaver Dam Creek foraging sites are not associated with the more permanent wetlands found along primary and secondary creeks.

BD-5 Entrainment losses would be approximately 2.0×10^6 fish eggs and larvae if this alternative were implemented. Entrainment of the eggs and larvae of the endangered shortnose sturgeon should not occur. This is due to the demersal and adhesive nature of their eggs, as well as to the time of year shortnose sturgeon spawn (February-March). Fish impingement on the 5G intake screens would increase by 113 fish per year or to 1831 total fish per year. Biological impacts are discussed in Chapter 4 and Appendix C.

F.4.2 DIRECT DISCHARGE TO SAVANNAH RIVER

F.4.2.1 Direct Impacts to Floodplains/Wetlands and Practicable Alternatives

Implementation of this alternative would temporarily disturb approximately 1 acre of floodplain/wetlands during construction. The overall operational impact would be to return Beaver Dam Creek to its approximate original status as an intermittent stream. Implementing this action would reduce floodplain/wetland values because current operations enhance certain wildlife values (see Section F.4.3.1 and Chapter 4).

An alternative action that would achieve the intended thermal performance standards but would minimize harm to or within the floodplain/wetlands is described in Section F.4.1; the no-action alternative is described in Section F.4.3. Because public access to and use of SRP are strictly controlled, no individual or private property would be affected by this alternative. In addition, no impact would directly or indirectly support floodplain development. Neither would there be an impact on cultural resources, agriculture, aquaculture, nor forestry resources as they relate to floodplain values.

F.4.2.2 Construction Impacts

Water Resources

The principal direct impact to water resources in the Beaver Dam Creek floodplain/wetlands during construction would be on water quality. A pipeline would be constructed parallel to the existing intake pipe. This pipeline would run from the D-Area powerhouse across the Beaver Dam Creek swamp to a discharge point on the Savannah River below the cooling water intake structure. The pipeline would cross approximately 1 acre of floodplain/wetlands. The construction activities would result in a temporary increase in turbidity and suspended solids. Construction impacts would have no measurable effect on groundwater recharge or on the ability of floodplain/wetlands to moderate floods.

Biological Resources

The principal indirect impact would be from sediment loading on fish and
TE micro-invertebrates in Beaver Dam Creek. When construction activities cease, suspended solids levels should return quickly to ambient conditions. Wildlife

might be disturbed by the noise associated with construction activities. This disturbance is short-term and noncumulative. TE

F.4.2.3 Operational Impacts

Water Resources

The principal direct impact to water resources in the Beaver Dam Creek floodplain/wetlands would be to the decrease in stream flow from the present average of 2.7 cubic meters per second to only 0.2 cubic meter per second. Beaver Dam Creek and the adjacent swamp would essentially return to their approximate original conditions, a wetland with an intermittent stream. Periodic flooding would depend entirely on natural flooding from the Savannah River and storm runoff after rains. Based on pump test data (Specht, 1985), any flooding of Beaver Dam Creek because of storm runoff would have a short duration. The water level in Beaver Dam Creek swamp would return to its original level approximately 24 hours after the rainfall stopped.

Biological Resources

The most significant ecological impact would be a loss of nesting and foraging habitat for wildlife. The implementation of this alternative would decrease or eliminate nesting habitat for the American alligator and any thermal refugia that might have existed during the winter months. Foraging habitat for the wood stork would be significantly decreased or eliminated. Beaver Dam Creek would return to its approximate original condition as an intermittent stream (Moyer, 1985), thus negatively impacting aquatic organisms.

Because the thermal effluent would be pumped directly to the Savannah River, there would be a small thermal plume at the outfall structure. Because of the small volume of mildly thermal effluent and the large volume of ambient river water, there would be no thermal impact outside the mixing zone. There would be a large zone of passage for all fish species, including the endangered shortnose sturgeon. There would be no impact on the shortnose sturgeon from entrainment and impingement with implementation of this alternative. TE

F.4.3 NO ACTION - EXISTING SYSTEM

F.4.3.1 Operational Impacts

Water Resources

The flow of 2.7 cubic meters per second would continue. Water temperatures in the creek and delta could reach 34°C under extreme summer conditions. BC-14 Concentrations of dissolved oxygen would be somewhat lower than those in unimpacted streams. Continued operations would have no measurable impact on the ability of the floodplain wetlands to moderate floods or groundwater recharge. Water resource impacts are discussed in Chapter 4.

Biological Resources

The aquatic and terrestrial ecology of the creek would continue to be affected by the thermal effluent but to a much lesser extent than that of Pen Branch or

Four Mile Creek. Portions of Beaver Dam Creek would continue to show evidence of revegetation and succession due to a slight decline in water temperatures that began in the 1970s. The area around the creek would continue to provide habitat for a dense population of alligators and foraging habitat for the wood stork.

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APPENDIX G

RADIATION DOSE CALCULATION METHODS AND ASSUMPTIONS

The operation of alternative cooling water systems for the K- and C-Reactors at the Savannah River Plant (SRP) would change the amount of radioactive materials released to the environment. Cooling alternatives associated with the D-Area would not cause any changes in radioactive releases to the environment. This appendix describes the methods and assumptions used to (1) determine the change in radiological impacts expected to result from the operation of the cooling alternatives, and (2) determine the doses expected from the operation of facilities on or within 80 kilometers of SRP without the implementation of cooling alternatives (no action - existing conditions).

The cooling water alternatives for K- and C-Reactors that are considered in this EIS are existing operation (no action), recirculating cooling towers, and once-through cooling towers. For the once-through alternative, doses were analyzed for gravity-flow, natural-draft cooling towers without holding ponds. For the recirculating alternative, doses were analyzed for gravity-flow, natural-draft cooling towers pumped to mechanical-draft cooling towers without holding ponds.

The implementation of a once-through or recirculating cooling-tower alternative for K- and C-Reactors would change the amount of radionuclides released to the environment. Because of an increase in evaporation from cooling towers, a greater amount of tritium would be released to the atmosphere, resulting in a positive tritium source term. However, for liquid releases the tritium source term would decrease by the same amount and, therefore, would be considered a negative value. Also, the implementation of alternative cooling water systems might cause a change in the rate of remobilization of radionuclides present in creek beds. Remobilization is discussed in Section G.2 and Appendix D.

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

The calculations of radiological doses to members of the public from these various pathways are based on methods recommended by the U.S. Nuclear Regulatory Commission (NRC) for licensing power reactors. However, the dose-conversion factors were taken from ICRP Publication 30 (ICRP, 1979). Estimates of doses are based on detailed analyses of the sources and rates of radioactive releases and the pathways by which people can be exposed to dispersed radioactive materials. The NRC methods are adapted to specific SRP conditions.

In the calculation of doses, the dose-conversion factors for adults presented in ICRP-30 were used. Dose factors for other age groups have not yet been published by the ICRP. However, age-specific usage factors were used to

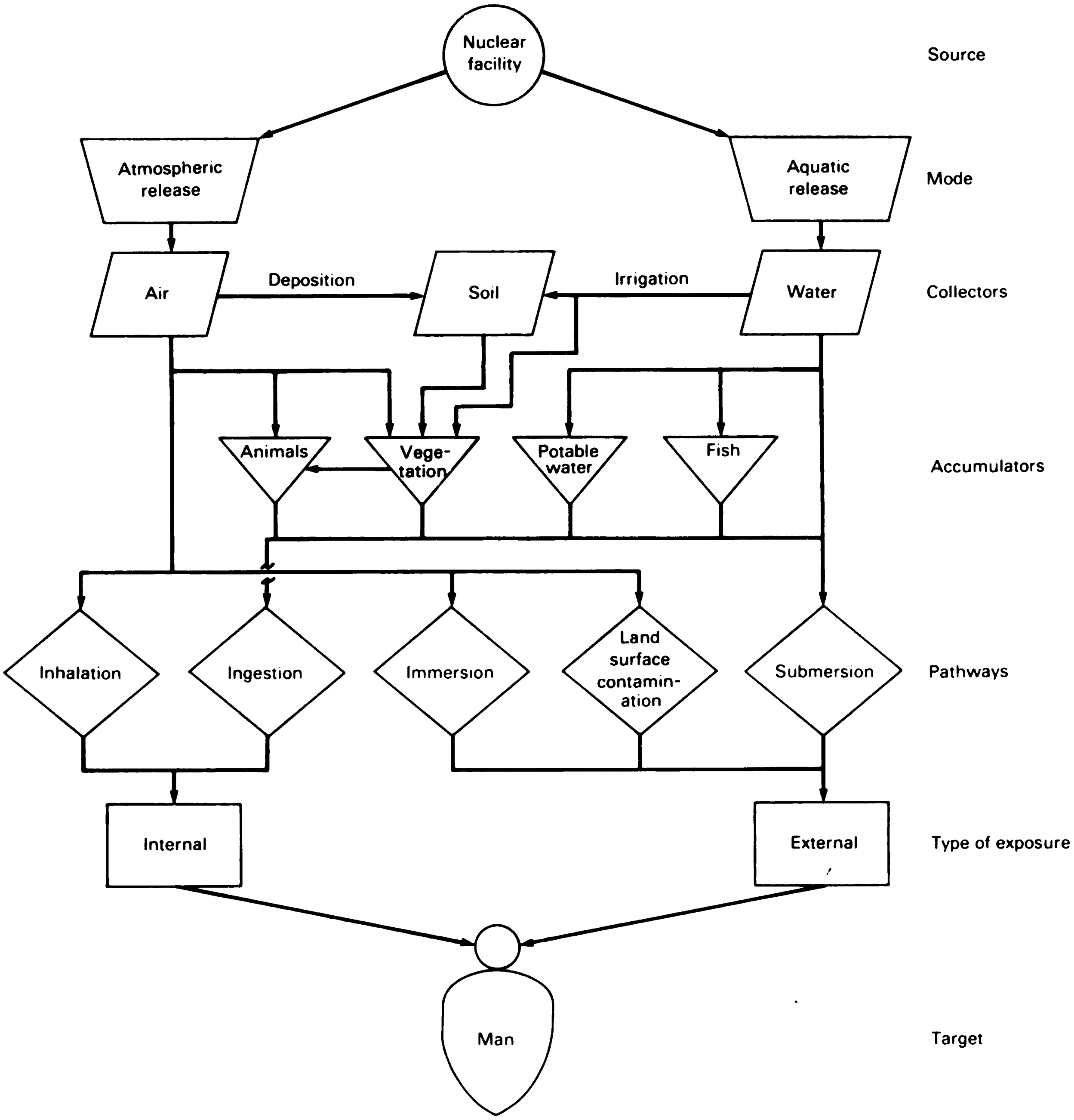

Figure G-1. Exposure Pathways Considered in Radiological Impact Assessments

calculate doses. The age groups considered were infant (0 to 1 year old), child (1 to 11 years old), teen (11-17 years old), and adult (17 years old and older).

Dose-conversion factors are provided in ICRP-30 for many organs. These factors depend on the physical and chemical nature of the radionuclide. The oral- and inhalation-dose conversion factors chosen for tritium presume it to be in the form of tritiated water. Also, to account for tritium absorption through the skin, the inhalation-dose conversion factor is increased by a factor of 0.5. For all radionuclides released to the environment, an effective-whole-body-dose conversion factor was obtained by multiplying the individual-organ-dose conversion factors by the health-risk weighting factors presented in ICRP-30 and summing the results.

Radiation doses are calculated for the maximally exposed individual. In addition, collective radiation doses are calculated for the population within 80 kilometers of the Savannah River Plant and that population served by the Beaufort-Jasper County and Cherokee Hill (Port Wentworth) water-treatment plants.

G.1 ATMOSPHERIC RELEASES

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

The meteorological dispersion parameters obtained by running the XOQDOQ code are used as input to the NRC GASPAR code (Eckerman et al., 1980), which implements the radiological exposure models of Regulatory Guide 1.109, Revision 1 (NRC, 1977), to estimate doses from atmospheric exposure pathways to the effective whole body and various organs. Dose-conversion factors presented in ICRP-30 were input to the GASPAR code. Population distribution data and milk-, meat-, and vegetable-production distribution data (Table G-4) for the 16 wind-direction sectors are also used as input to GASPAR for calculating the collective dose to the regional population; the term "regional population" refers to those individuals residing within 80 kilometers of the Plant. Population data for the year 2000 are used in this analysis.

Source terms that are input to the GASPAR code and used in the calculation of doses to the maximally exposed individual and the regional population are

Table G-1. Joint-Frequency Distribution of Wind: H-Area Tower, 1975-1979

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

Table G-1. Joint-Frequency Distribution of Wind: H-Area Tower, 1975-1979 (continued)

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

Table G-2. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Ground-Level Releases

Direction from site	Distance (km) 0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE X/Q, UNDECAYED AND UNDEPLETED (sec/m^3)					
N	8.254×10^{-7}	2.524×10^{-7}	1.084×10^{-7}	6.403×10^{-8}	4.365×10^{-8}	2.117×10^{-8}	7.908×10^{-9}	3.881×10^{-9}	2.468×10^{-9}	1.769×10^{-9}
NNE	7.390×10^{-7}	2.245×10^{-7}	9.554×10^{-8}	5.606×10^{-8}	3.802×10^{-8}	1.827×10^{-8}	6.741×10^{-9}	3.291×10^{-9}	2.089×10^{-9}	1.495×10^{-9}
NE	9.494×10^{-7}	2.912×10^{-7}	1.251×10^{-7}	7.389×10^{-8}	5.035×10^{-8}	2.434×10^{-8}	9.042×10^{-9}	4.417×10^{-9}	2.800×10^{-9}	2.002×10^{-9}
ENE	9.499×10^{-7}	2.902×10^{-7}	1.241×10^{-7}	7.304×10^{-8}	4.966×10^{-8}	2.397×10^{-8}	8.882×10^{-9}	4.330×10^{-9}	2.742×10^{-9}	1.959×10^{-9}
E	1.227×10^{-6}	3.746×10^{-7}	1.605×10^{-7}	9.473×10^{-8}	6.453×10^{-8}	3.125×10^{-8}	1.167×10^{-8}	5.747×10^{-9}	3.666×10^{-9}	2.634×10^{-9}
ESE	1.156×10^{-6}	3.503×10^{-7}	1.486×10^{-7}	8.699×10^{-8}	5.889×10^{-8}	2.824×10^{-8}	1.039×10^{-8}	5.068×10^{-9}	3.216×10^{-9}	2.302×10^{-9}
SE	9.465×10^{-7}	2.866×10^{-7}	1.213×10^{-7}	7.079×10^{-8}	4.781×10^{-8}	2.282×10^{-8}	8.327×10^{-9}	4.029×10^{-9}	2.544×10^{-9}	1.814×10^{-9}
SSE	6.359×10^{-7}	1.918×10^{-7}	8.127×10^{-8}	4.757×10^{-8}	3.221×10^{-8}	1.548×10^{-8}	5.727×10^{-9}	2.813×10^{-9}	1.793×10^{-9}	1.288×10^{-9}
S	4.705×10^{-7}	1.433×10^{-7}	6.196×10^{-8}	3.681×10^{-8}	2.522×10^{-8}	1.236×10^{-8}	4.709×10^{-9}	2.353×10^{-9}	1.515×10^{-9}	1.095×10^{-9}
SSW	5.057×10^{-7}	1.551×10^{-7}	6.730×10^{-8}	4.009×10^{-8}	2.752×10^{-8}	1.351×10^{-8}	5.156×10^{-9}	2.576×10^{-9}	1.656×10^{-9}	1.197×10^{-9}
SW	9.776×10^{-7}	3.013×10^{-7}	1.313×10^{-7}	7.850×10^{-8}	5.404×10^{-8}	2.666×10^{-8}	1.025×10^{-8}	5.149×10^{-9}	3.322×10^{-9}	2.407×10^{-9}
WSW	8.207×10^{-7}	2.479×10^{-7}	1.048×10^{-7}	6.127×10^{-8}	4.144×10^{-8}	1.984×10^{-8}	7.307×10^{-9}	3.576×10^{-9}	2.276×10^{-9}	1.632×10^{-9}
W	9.536×10^{-7}	2.893×10^{-7}	1.230×10^{-7}	7.213×10^{-8}	4.892×10^{-8}	2.354×10^{-8}	8.718×10^{-9}	4.276×10^{-9}	2.722×10^{-9}	1.953×10^{-9}
WNW	7.890×10^{-7}	2.378×10^{-7}	1.007×10^{-7}	5.889×10^{-8}	3.987×10^{-8}	1.917×10^{-8}	7.106×10^{-9}	3.494×10^{-9}	2.229×10^{-9}	1.603×10^{-9}
NW	1.103×10^{-6}	3.407×10^{-7}	1.484×10^{-7}	8.866×10^{-8}	6.096×10^{-8}	2.997×10^{-8}	1.144×10^{-8}	5.699×10^{-9}	3.657×10^{-9}	2.638×10^{-9}
NNW	7.672×10^{-7}	2.342×10^{-7}	1.003×10^{-7}	5.907×10^{-8}	4.019×10^{-8}	1.939×10^{-8}	7.193×10^{-9}	3.517×10^{-9}	2.233×10^{-9}	1.598×10^{-9}
					ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m^3)					
N	8.235×10^{-7}	2.513×10^{-7}	1.076×10^{-7}	6.334×10^{-8}	4.304×10^{-8}	2.070×10^{-8}	7.557×10^{-9}	3.592×10^{-9}	2.214×10^{-9}	1.538×10^{-9}
NNE	7.375×10^{-7}	2.236×10^{-7}	9.490×10^{-8}	5.553×10^{-8}	3.756×10^{-8}	1.791×10^{-8}	6.477×10^{-9}	3.073×10^{-9}	1.896×10^{-9}	1.320×10^{-9}
NE	9.476×10^{-7}	2.901×10^{-7}	1.243×10^{-7}	7.322×10^{-8}	4.976×10^{-8}	2.388×10^{-8}	8.701×10^{-9}	4.135×10^{-9}	2.552×10^{-9}	1.776×10^{-9}
ENE	9.479×10^{-7}	2.890×10^{-7}	1.232×10^{-7}	7.231×10^{-8}	4.902×10^{-8}	2.347×10^{-8}	8.514×10^{-9}	4.028×10^{-9}	2.477×10^{-9}	1.719×10^{-9}
E	1.224×10^{-6}	3.729×10^{-7}	1.593×10^{-7}	9.367×10^{-8}	6.361×10^{-8}	3.052×10^{-8}	1.113×10^{-8}	5.297×10^{-9}	3.268×10^{-9}	2.271×10^{-9}
ESE	1.154×10^{-6}	3.488×10^{-7}	1.476×10^{-7}	8.613×10^{-8}	5.815×10^{-8}	2.766×10^{-8}	9.970×10^{-9}	4.721×10^{-9}	2.909×10^{-9}	2.023×10^{-9}
SE	9.447×10^{-7}	2.856×10^{-7}	1.205×10^{-7}	7.014×10^{-8}	4.725×10^{-8}	2.238×10^{-8}	8.005×10^{-9}	3.764×10^{-9}	2.310×10^{-9}	1.602×10^{-9}

Table G-2. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Ground-Level Releases (continued)

Direction from site	Distance (km) 0–2	2–3	3–5	5–6	6–8	8–16	16–32	32–48	48–64	64–80
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m^3) (continued)										
SSE	6.345×10^{-7}	1.910×10^{-7}	8.068×10^{-8}	4.708×10^{-8}	3.179×10^{-8}	1.515×10^{-8}	5.484×10^{-9}	2.611×10^{-9}	1.615×10^{-9}	1.125×10^{-9}
S	4.694×10^{-7}	1.427×10^{-7}	6.148×10^{-8}	3.641×10^{-8}	2.487×10^{-8}	1.208×10^{-8}	4.497×10^{-9}	2.175×10^{-9}	1.355×10^{-9}	9.491×10^{-10}
SSW	5.045×10^{-7}	1.544×10^{-7}	6.677×10^{-8}	3.965×10^{-8}	2.713×10^{-8}	1.321×10^{-8}	4.925×10^{-9}	2.382×10^{-9}	1.484×10^{-9}	1.039×10^{-9}
SW	9.755×10^{-7}	2.999×10^{-7}	1.303×10^{-7}	7.768×10^{-8}	5.332×10^{-8}	2.609×10^{-8}	9.816×10^{-9}	4.786×10^{-9}	2.999×10^{-9}	2.110×10^{-9}
WSW	8.191×10^{-7}	2.470×10^{-7}	1.042×10^{-7}	6.072×10^{-8}	4.096×10^{-8}	1.948×10^{-8}	7.038×10^{-9}	3.355×10^{-9}	2.080×10^{-9}	1.454×10^{-9}
W	9.518×10^{-7}	2.882×10^{-7}	1.221×10^{-7}	7.145×10^{-8}	4.833×10^{-8}	2.308×10^{-8}	8.379×10^{-9}	3.996×10^{-9}	2.475×10^{-9}	1.727×10^{-9}
WNW	7.874×10^{-7}	2.368×10^{-7}	9.997×10^{-8}	5.832×10^{-8}	3.937×10^{-8}	1.879×10^{-8}	6.819×10^{-9}	3.255×10^{-9}	2.017×10^{-9}	1.408×10^{-9}
NW	1.101×10^{-6}	3.392×10^{-7}	1.474×10^{-7}	8.774×10^{-8}	6.015×10^{-8}	2.932×10^{-8}	1.094×10^{-8}	5.287×10^{-9}	3.291×10^{-9}	2.303×10^{-9}
NNW	7.657×10^{-7}	2.332×10^{-7}	9.959×10^{-8}	5.851×10^{-8}	3.969×10^{-8}	1.901×10^{-8}	6.910×10^{-9}	3.283×10^{-9}	2.027×10^{-9}	1.411×10^{-9}
ANNUAL AVERAGE X/Q, DECAYED AND DEPLETED (sec/m^3)										
N	7.396×10^{-7}	2.154×10^{-7}	8.784×10^{-8}	4.988×10^{-8}	3.290×10^{-8}	1.496×10^{-8}	4.918×10^{-9}	2.112×10^{-9}	1.212×10^{-9}	7.949×10^{-10}
NNE	6.623×10^{-7}	1.916×10^{-7}	7.745×10^{-8}	4.369×10^{-8}	2.868×10^{-8}	1.293×10^{-8}	4.200×10^{-9}	1.795×10^{-9}	1.029×10^{-9}	6.749×10^{-10}
NE	8.508×10^{-7}	2.485×10^{-7}	1.014×10^{-7}	5.759×10^{-8}	3.798×10^{-8}	1.723×10^{-8}	5.635×10^{-9}	2.411×10^{-9}	1.381×10^{-9}	9.050×10^{-10}
ENE	8.512×10^{-7}	2.476×10^{-7}	1.006×10^{-7}	5.692×10^{-8}	3.744×10^{-8}	1.695×10^{-8}	5.530×10^{-9}	2.360×10^{-9}	1.349×10^{-9}	8.827×10^{-10}
E	1.100×10^{-6}	3.196×10^{-7}	1.301×10^{-7}	7.379×10^{-8}	4.864×10^{-8}	2.208×10^{-8}	7.253×10^{-9}	3.124×10^{-9}	1.796×10^{-9}	1.181×10^{-9}
ESE	1.036×10^{-6}	2.990×10^{-7}	1.204×10^{-7}	6.779×10^{-8}	4.441×10^{-8}	1.997×10^{-8}	6.472×10^{-9}	2.763×10^{-9}	1.583×10^{-9}	1.038×10^{-9}
SE	8.483×10^{-7}	2.447×10^{-7}	9.830×10^{-8}	5.518×10^{-8}	3.607×10^{-8}	1.615×10^{-8}	5.190×10^{-9}	2.199×10^{-9}	1.253×10^{-9}	8.190×10^{-10}
SSE	5.699×10^{-7}	1.637×10^{-7}	6.587×10^{-8}	3.706×10^{-8}	2.429×10^{-8}	1.094×10^{-8}	3.564×10^{-9}	1.532×10^{-9}	8.813×10^{-10}	5.798×10^{-10}
S	4.216×10^{-7}	1.223×10^{-7}	5.021×10^{-8}	2.868×10^{-8}	1.901×10^{-8}	8.734×10^{-9}	2.926×10^{-9}	1.280×10^{-9}	7.429×10^{-10}	4.918×10^{-10}
SSW	4.532×10^{-7}	1.323×10^{-7}	5.453×10^{-8}	3.123×10^{-8}	2.074×10^{-8}	9.548×10^{-9}	3.205×10^{-9}	1.401×10^{-9}	8.128×10^{-10}	5.378×10^{-10}
SW	8.761×10^{-7}	2.570×10^{-7}	1.064×10^{-7}	6.115×10^{-8}	4.074×10^{-8}	1.884×10^{-8}	6.374×10^{-9}	2.805×10^{-9}	1.634×10^{-9}	1.084×10^{-9}
WSW	7.355×10^{-7}	2.116×10^{-7}	8.499×10^{-8}	4.776×10^{-8}	3.126×10^{-8}	1.405×10^{-8}	4.555×10^{-9}	1.953×10^{-9}	1.123×10^{-9}	7.387×10^{-10}
W	8.547×10^{-7}	2.469×10^{-7}	9.967×10^{-8}	5.621×10^{-8}	3.690×10^{-8}	1.665×10^{-8}	5.431×10^{-9}	2.333×10^{-9}	1.341×10^{-9}	8.821×10^{-10}
WNW	7.071×10^{-7}	2.030×10^{-7}	8.159×10^{-8}	4.589×10^{-8}	3.007×10^{-8}	1.356×10^{-8}	4.425×10^{-9}	1.905×10^{-9}	1.097×10^{-9}	7.225×10^{-10}
NW	9.889×10^{-7}	2.907×10^{-7}	1.203×10^{-7}	6.907×10^{-8}	4.596×10^{-8}	2.118×10^{-8}	7.111×10^{-9}	3.103×10^{-9}	1.797×10^{-9}	1.187×10^{-9}
NNW	6.876×10^{-7}	1.999×10^{-7}	8.127×10^{-8}	4.604×10^{-8}	3.031×10^{-8}	1.372×10^{-8}	4.481×10^{-9}	1.919×10^{-9}	1.100×10^{-9}	7.215×10^{-10}

Table G-2. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Ground-Level Releases (continued)

Direction from site	Distance (km) 0–2	2–3	3–5	5–6	6–8	8–16	16–32	32–48	48–64	64–80
					ANNUAL AVERAGE D/Q (m^{-2})					
N	6.024×10^{-9}	1.861×10^{-9}	7.406×10^{-10}	4.047×10^{-10}	2.572×10^{-10}	1.105×10^{-10}	3.426×10^{-11}	1.358×10^{-11}	7.251×10^{-12}	4.488×10^{-12}
NNE	6.351×10^{-9}	1.962×10^{-9}	7.808×10^{-10}	4.267×10^{-10}	2.712×10^{-10}	1.165×10^{-10}	3.612×10^{-11}	1.432×10^{-11}	7.645×10^{-12}	4.732×10^{-12}
NE	7.209×10^{-9}	2.227×10^{-9}	8.863×10^{-10}	4.843×10^{-10}	3.078×10^{-10}	1.322×10^{-10}	4.100×10^{-11}	1.625×10^{-11}	8.678×10^{-12}	5.371×10^{-12}
ENE	7.064×10^{-9}	2.182×10^{-9}	8.684×10^{-10}	4.746×10^{-10}	3.016×10^{-10}	1.296×10^{-10}	4.017×10^{-11}	1.592×10^{-11}	8.503×10^{-12}	5.263×10^{-12}
E	8.791×10^{-9}	2.716×10^{-9}	1.081×10^{-9}	5.906×10^{-10}	3.754×10^{-10}	1.612×10^{-10}	5.000×10^{-11}	1.982×10^{-11}	1.058×10^{-11}	6.550×10^{-12}
ESE	9.561×10^{-9}	2.954×10^{-9}	1.175×10^{-9}	6.423×10^{-10}	4.083×10^{-10}	1.754×10^{-10}	5.438×10^{-11}	2.155×10^{-11}	1.151×10^{-11}	7.124×10^{-12}
SE	8.976×10^{-9}	2.773×10^{-9}	1.104×10^{-9}	6.030×10^{-10}	3.833×10^{-10}	1.646×10^{-10}	5.105×10^{-11}	2.023×10^{-11}	1.080×10^{-11}	6.688×10^{-12}
SSE	5.195×10^{-9}	1.605×10^{-9}	6.387×10^{-10}	3.490×10^{-10}	2.218×10^{-10}	9.528×10^{-11}	2.955×10^{-11}	1.171×10^{-11}	6.254×10^{-12}	3.871×10^{-12}
S	3.199×10^{-9}	9.884×10^{-10}	3.933×10^{-10}	2.149×10^{-10}	1.366×10^{-10}	5.868×10^{-11}	1.820×10^{-11}	7.212×10^{-12}	3.851×10^{-12}	2.384×10^{-12}
SSW	3.072×10^{-9}	9.491×10^{-10}	3.777×10^{-10}	2.064×10^{-10}	1.312×10^{-10}	5.634×10^{-11}	1.747×10^{-11}	6.925×10^{-12}	3.698×10^{-12}	2.289×10^{-12}
SW	5.308×10^{-9}	1.640×10^{-9}	6.525×10^{-10}	3.566×10^{-10}	2.266×10^{-10}	9.735×10^{-11}	3.019×10^{-11}	1.196×10^{-11}	6.389×10^{-12}	3.955×10^{-12}
WSW	6.867×10^{-9}	2.122×10^{-9}	8.443×10^{-10}	4.614×10^{-10}	2.932×10^{-10}	1.260×10^{-10}	3.906×10^{-11}	1.548×10^{-11}	8.267×10^{-12}	5.117×10^{-12}
W	7.555×10^{-9}	2.334×10^{-9}	9.288×10^{-10}	5.075×10^{-10}	3.226×10^{-10}	1.386×10^{-10}	4.297×10^{-11}	1.703×10^{-11}	9.094×10^{-12}	5.629×10^{-12}
WNW	6.595×10^{-9}	2.037×10^{-9}	8.108×10^{-10}	4.430×10^{-10}	2.816×10^{-10}	1.210×10^{-10}	3.751×10^{-11}	1.487×10^{-11}	7.938×10^{-12}	4.914×10^{-12}
NW	6.813×10^{-9}	2.105×10^{-9}	8.376×10^{-10}	4.577×10^{-10}	2.909×10^{-10}	1.250×10^{-10}	3.875×10^{-11}	1.536×10^{-11}	8.201×10^{-12}	5.076×10^{-12}
NNW	5.875×10^{-9}	1.815×10^{-9}	7.223×10^{-10}	3.947×10^{-10}	2.509×10^{-10}	1.078×10^{-10}	3.341×10^{-11}	1.324×10^{-11}	7.072×10^{-12}	4.377×10^{-12}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases

Direction from site	Distance (km) 0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE X/Q, UNDECAYED AND UNDEPLETED (sec/m^3)					
N	1.657×10^{-7}	9.830×10^{-8}	6.035×10^{-8}	4.110×10^{-8}	3.030×10^{-8}	1.617×10^{-8}	6.688×10^{-9}	3.455×10^{-9}	2.246×10^{-9}	1.630×10^{-9}
NNE	1.715×10^{-7}	9.824×10^{-8}	5.792×10^{-8}	3.855×10^{-8}	2.800×10^{-8}	1.461×10^{-8}	5.878×10^{-9}	2.997×10^{-9}	1.938×10^{-9}	1.402×10^{-9}
NE	1.851×10^{-7}	1.140×10^{-7}	7.034×10^{-8}	4.786×10^{-8}	3.523×10^{-8}	1.870×10^{-8}	7.660×10^{-9}	3.931×10^{-9}	2.546×10^{-9}	1.843×10^{-9}
ENE	1.979×10^{-7}	1.186×10^{-7}	7.223×10^{-8}	4.881×10^{-8}	3.578×10^{-8}	1.891×10^{-8}	7.703×10^{-9}	3.936×10^{-9}	2.542×10^{-9}	1.837×10^{-9}
E	2.592×10^{-7}	1.492×10^{-7}	8.848×10^{-8}	5.922×10^{-8}	4.323×10^{-8}	2.278×10^{-8}	9.331×10^{-8}	4.829×10^{-9}	3.150×10^{-9}	2.294×10^{-9}
ESE	2.821×10^{-7}	1.583×10^{-7}	9.177×10^{-8}	6.061×10^{-8}	4.382×10^{-8}	2.274×10^{-8}	9.098×10^{-8}	4.628×10^{-9}	2.990×10^{-9}	2.162×10^{-9}
SE	2.365×10^{-7}	1.357×10^{-7}	7.860×10^{-8}	5.161×10^{-8}	3.711×10^{-8}	1.904×10^{-8}	7.490×10^{-9}	3.757×10^{-9}	2.407×10^{-9}	1.731×10^{-9}
SSE	1.609×10^{-7}	8.715×10^{-8}	5.018×10^{-8}	3.311×10^{-8}	2.394×10^{-8}	1.246×10^{-8}	5.017×10^{-9}	2.571×10^{-9}	1.669×10^{-9}	1.212×10^{-9}
S	9.942×10^{-8}	5.287×10^{-8}	3.174×10^{-8}	2.172×10^{-8}	1.615×10^{-8}	8.804×10^{-9}	3.772×10^{-9}	2.007×10^{-9}	1.329×10^{-9}	9.773×10^{-10}
SSW	9.513×10^{-8}	5.374×10^{-8}	3.282×10^{-8}	2.247×10^{-8}	1.669×10^{-8}	9.063×10^{-9}	3.867×10^{-9}	2.055×10^{-9}	1.360×10^{-9}	1.000×10^{-9}
SW	1.629×10^{-7}	9.250×10^{-8}	5.601×10^{-8}	3.832×10^{-8}	2.850×10^{-8}	1.560×10^{-8}	6.776×10^{-9}	3.661×10^{-9}	2.449×10^{-9}	1.815×10^{-9}
WSW	2.038×10^{-7}	1.107×10^{-7}	6.305×10^{-8}	4.144×10^{-8}	2.991×10^{-8}	1.553×10^{-8}	6.242×10^{-9}	3.200×10^{-9}	2.078×10^{-9}	1.508×10^{-9}
W	2.212×10^{-7}	1.229×10^{-7}	7.136×10^{-8}	4.735×10^{-8}	3.438×10^{-8}	1.800×10^{-8}	7.305×10^{-9}	3.760×10^{-9}	2.445×10^{-9}	1.777×10^{-9}
WNW	2.032×10^{-7}	1.085×10^{-7}	6.167×10^{-8}	4.047×10^{-8}	2.918×10^{-8}	1.515×10^{-8}	6.103×10^{-9}	3.132×10^{-9}	2.036×10^{-9}	1.480×10^{-9}
NW	1.796×10^{-7}	1.080×10^{-7}	6.754×10^{-8}	4.674×10^{-8}	3.492×10^{-8}	1.911×10^{-8}	8.213×10^{-8}	4.375×10^{-9}	2.897×10^{-9}	2.131×10^{-9}
NNW	1.648×10^{-7}	9.680×10^{-8}	5.825×10^{-8}	3.922×10^{-8}	2.870×10^{-8}	1.513×10^{-8}	6.167×10^{-9}	3.163×10^{-9}	2.049×10^{-9}	1.485×10^{-9}
					ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m^3)					
N	1.653×10^{-7}	9.782×10^{-8}	5.987×10^{-8}	4.064×10^{-8}	2.987×10^{-8}	1.580×10^{-8}	6.384×10^{-9}	3.194×10^{-9}	2.012×10^{-9}	1.416×10^{-9}
NNE	1.711×10^{-7}	9.781×10^{-8}	5.751×10^{-8}	3.818×10^{-8}	2.765×10^{-8}	1.431×10^{-8}	5.644×10^{-9}	2.797×10^{-9}	1.758×10^{-9}	1.237×10^{-9}
NE	1.846×10^{-7}	1.135×10^{-7}	6.986×10^{-8}	4.741×10^{-8}	3.481×10^{-8}	1.833×10^{-8}	7.366×10^{-9}	3.679×10^{-9}	2.319×10^{-9}	1.634×10^{-9}
ENE	1.974×10^{-7}	1.181×10^{-7}	7.168×10^{-8}	4.831×10^{-8}	3.530×10^{-8}	1.850×10^{-8}	7.377×10^{-9}	3.658×10^{-9}	2.294×10^{-9}	1.610×10^{-9}
E	2.586×10^{-7}	1.484×10^{-7}	8.779×10^{-8}	5.858×10^{-8}	4.263×10^{-8}	2.227×10^{-8}	8.914×10^{-9}	4.466×10^{-9}	2.822×10^{-9}	1.990×10^{-9}
ESE	2.813×10^{-7}	1.575×10^{-7}	9.108×10^{-8}	5.998×10^{-8}	4.324×10^{-8}	2.225×10^{-8}	8.716×10^{-9}	4.304×10^{-9}	2.700×10^{-9}	1.896×10^{-9}
SE	2.359×10^{-7}	1.351×10^{-7}	7.808×10^{-8}	5.113×10^{-8}	3.666×10^{-8}	1.868×10^{-8}	7.199×10^{-9}	3.511×10^{-9}	2.187×10^{-9}	1.529×10^{-9}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases (continued)

Direction from site	Distance (km) 0–2	2–3	3–5	5–6	6–8	8–16	16–32	32–48	48–64	64–80
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m^3) (continued)										
SSE	1.604×10^{-7}	8.673×10^{-8}	4.979×10^{-8}	3.276×10^{-8}	2.362×10^{-8}	1.218×10^{-8}	4.799×10^{-9}	2.384×10^{-9}	1.501×10^{-9}	1.057×10^{-9}
S	9.914×10^{-8}	5.259×10^{-8}	3.148×10^{-8}	2.147×10^{-8}	1.591×10^{-8}	8.596×10^{-9}	3.597×10^{-9}	1.853×10^{-9}	1.188×10^{-9}	8.459×10^{-10}
SSW	9.486×10^{-8}	5.345×10^{-8}	3.254×10^{-8}	2.221×10^{-8}	1.643×10^{-8}	8.841×10^{-9}	3.683×10^{-9}	1.894×10^{-9}	1.213×10^{-9}	8.643×10^{-10}
SW	1.624×10^{-7}	9.201×10^{-8}	5.553×10^{-8}	3.787×10^{-8}	2.807×10^{-8}	1.523×10^{-8}	6.462×10^{-9}	3.384×10^{-9}	2.195×10^{-9}	1.578×10^{-9}
WSW	2.033×10^{-7}	1.103×10^{-7}	6.261×10^{-8}	4.105×10^{-8}	2.955×10^{-8}	1.523×10^{-8}	6.004×10^{-9}	2.997×10^{-9}	1.895×10^{-9}	1.340×10^{-9}
W	2.207×10^{-7}	1.224×10^{-7}	7.087×10^{-8}	4.690×10^{-8}	3.397×10^{-8}	1.765×10^{-8}	7.021×10^{-9}	3.515×10^{-9}	2.225×10^{-9}	1.573×10^{-9}
WNW	2.027×10^{-7}	1.080×10^{-7}	6.124×10^{-8}	4.008×10^{-8}	2.882×10^{-8}	1.485×10^{-8}	5.856×10^{-9}	2.918×10^{-9}	1.843×10^{-9}	1.301×10^{-9}
NW	1.791×10^{-7}	1.075×10^{-7}	6.703×10^{-8}	4.625×10^{-8}	3.445×10^{-8}	1.869×10^{-8}	7.863×10^{-9}	4.064×10^{-9}	2.612×10^{-9}	1.865×10^{-9}
NNW	1.644×10^{-7}	9.637×10^{-8}	5.783×10^{-8}	3.883×10^{-8}	2.833×10^{-8}	1.482×10^{-8}	5.917×10^{-9}	2.949×10^{-9}	1.857×10^{-9}	1.308×10^{-9}
ANNUAL AVERAGE X/Q, DECAYED AND DEPLETED (sec/m^3)										
N	1.617×10^{-7}	9.484×10^{-8}	5.757×10^{-8}	3.886×10^{-8}	2.845×10^{-8}	1.493×10^{-8}	5.959×10^{-9}	2.962×10^{-9}	1.857×10^{-9}	1.294×10^{-9}
NNE	1.673×10^{-7}	9.451×10^{-8}	5.490×10^{-8}	3.613×10^{-8}	2.600×10^{-8}	1.328×10^{-8}	5.120×10^{-9}	2.494×10^{-9}	1.546×10^{-9}	1.069×10^{-9}
NE	1.807×10^{-7}	1.100×10^{-7}	6.711×10^{-8}	4.524×10^{-8}	3.305×10^{-8}	1.724×10^{-8}	6.824×10^{-9}	3.375×10^{-9}	2.112×10^{-9}	1.472×10^{-9}
ENE	1.931×10^{-7}	1.145×10^{-7}	6.882×10^{-8}	4.606×10^{-8}	3.349×10^{-8}	1.738×10^{-8}	6.820×10^{-9}	3.348×10^{-9}	2.084×10^{-9}	1.446×10^{-9}
E	2.528×10^{-7}	1.435×10^{-7}	8.396×10^{-8}	5.561×10^{-8}	4.024×10^{-8}	2.080×10^{-8}	8.195×10^{-9}	4.068×10^{-9}	2.554×10^{-9}	1.783×10^{-9}
ESE	2.750×10^{-7}	1.520×10^{-7}	8.673×10^{-8}	5.655×10^{-8}	4.046×10^{-8}	2.051×10^{-8}	7.833×10^{-9}	3.791×10^{-9}	2.342×10^{-9}	1.615×10^{-9}
SE	2.308×10^{-7}	1.304×10^{-7}	7.426×10^{-8}	4.809×10^{-8}	3.418×10^{-8}	1.711×10^{-8}	6.395×10^{-9}	3.040×10^{-9}	1.857×10^{-9}	1.270×10^{-9}
SSE	1.567×10^{-7}	8.367×10^{-8}	4.746×10^{-8}	3.095×10^{-8}	2.217×10^{-8}	1.129×10^{-8}	4.344×10^{-9}	2.119×10^{-9}	1.314×10^{-9}	9.085×10^{-10}
S	9.680×10^{-8}	5.077×10^{-8}	3.010×10^{-8}	2.041×10^{-8}	1.506×10^{-8}	8.068×10^{-9}	3.330×10^{-9}	1.702×10^{-9}	1.084×10^{-9}	7.636×10^{-10}
SSW	9.270×10^{-8}	5.176×10^{-8}	3.126×10^{-8}	2.122×10^{-8}	1.565×10^{-8}	8.362×10^{-9}	3.450×10^{-9}	1.767×10^{-9}	1.130×10^{-9}	7.988×10^{-10}
SW	1.587×10^{-7}	8.906×10^{-8}	5.332×10^{-8}	3.619×10^{-8}	2.674×10^{-8}	1.444×10^{-8}	6.092×10^{-9}	3.193×10^{-9}	2.075×10^{-9}	1.487×10^{-9}
WSW	1.985×10^{-7}	1.062×10^{-7}	5.949×10^{-8}	3.862×10^{-8}	2.760×10^{-8}	1.402×10^{-8}	5.392×10^{-9}	2.638×10^{-9}	1.642×10^{-9}	1.139×10^{-9}
W	2.156×10^{-7}	1.181×10^{-7}	6.755×10^{-8}	4.433×10^{-8}	3.190×10^{-8}	1.637×10^{-8}	6.379×10^{-9}	3.144×10^{-9}	1.965×10^{-9}	1.368×10^{-9}
WNW	1.980×10^{-7}	1.041×10^{-7}	5.819×10^{-8}	3.770×10^{-8}	2.690×10^{-8}	1.365×10^{-8}	5.239×10^{-9}	2.555×10^{-9}	1.585×10^{-9}	1.096×10^{-9}
NW	1.752×10^{-7}	1.042×10^{-7}	6.453×10^{-8}	4.431×10^{-8}	3.290×10^{-8}	1.775×10^{-8}	7.415×10^{-9}	3.830×10^{-9}	2.463×10^{-9}	1.751×10^{-9}
NNW	1.608×10^{-7}	9.323×10^{-8}	5.532×10^{-8}	3.684×10^{-8}	2.673×10^{-8}	1.382×10^{-8}	5.410×10^{-9}	2.659×10^{-9}	1.658×10^{-9}	1.151×10^{-9}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases (continued)

Direction from site	Distance (km) 0–2	2–3	3–5	5–6	6–8	8–16	16–32	32–48	48–64	64–80
					ANNUAL AVERAGE D/Q (m^{-2})					
N	2.473×10^{-9}	9.109×10^{-10}	4.045×10^{-10}	2.331×10^{-10}	1.539×10^{-10}	6.845×10^{-11}	2.264×10^{-11}	1.049×10^{-11}	6.614×10^{-12}	4.729×10^{-12}
NNE	2.697×10^{-9}	1.011×10^{-9}	4.511×10^{-10}	2.602×10^{-10}	1.717×10^{-10}	7.626×10^{-11}	2.506×10^{-11}	1.151×10^{-11}	7.194×10^{-12}	5.100×10^{-12}
NE	2.740×10^{-9}	1.038×10^{-9}	4.647×10^{-10}	2.682×10^{-10}	1.770×10^{-10}	7.851×10^{-11}	2.569×10^{-11}	1.179×10^{-11}	7.421×10^{-12}	5.323×10^{-12}
ENE	2.811×10^{-9}	1.059×10^{-9}	4.737×10^{-10}	2.733×10^{-10}	1.804×10^{-10}	8.005×10^{-11}	2.625×10^{-11}	1.205×10^{-11}	7.565×10^{-12}	5.399×10^{-12}
E	3.650×10^{-9}	1.369×10^{-9}	6.114×10^{-10}	3.527×10^{-10}	2.327×10^{-10}	1.033×10^{-10}	3.394×10^{-11}	1.559×10^{-11}	9.764×10^{-12}	6.939×10^{-12}
ESE	4.124×10^{-9}	1.582×10^{-9}	7.110×10^{-10}	4.104×10^{-10}	2.708×10^{-10}	1.200×10^{-10}	3.908×10^{-11}	1.776×10^{-11}	1.100×10^{-11}	7.739×10^{-12}
SE	4.028×10^{-9}	1.575×10^{-9}	7.119×10^{-10}	4.113×10^{-10}	2.714×10^{-10}	1.200×10^{-10}	3.880×10^{-11}	1.747×10^{-11}	1.072×10^{-11}	7.461×10^{-12}
SSE	2.366×10^{-9}	8.707×10^{-10}	3.865×10^{-10}	2.228×10^{-10}	1.470×10^{-10}	6.541×10^{-11}	2.164×10^{-11}	9.996×10^{-12}	6.248×10^{-12}	4.412×10^{-12}
S	1.385×10^{-9}	4.897×10^{-10}	2.146×10^{-10}	1.235×10^{-10}	8.152×10^{-11}	3.642×10^{-11}	1.224×10^{-11}	5.765×10^{-12}	3.666×10^{-12}	2.621×10^{-12}
SSW	1.251×10^{-9}	4.481×10^{-10}	1.972×10^{-10}	1.136×10^{-10}	7.496×10^{-11}	3.344×10^{-11}	1.118×10^{-11}	5.246×10^{-12}	3.340×10^{-12}	2.407×10^{-12}
SW	1.979×10^{-9}	7.211×10^{-10}	3.191×10^{-10}	1.839×10^{-10}	1.213×10^{-10}	5.404×10^{-11}	1.796×10^{-11}	8.384×10^{-12}	5.355×10^{-12}	3.888×10^{-12}
WSW	3.024×10^{-9}	1.120×10^{-9}	4.979×10^{-10}	2.870×10^{-10}	1.894×10^{-10}	8.423×10^{-11}	2.780×10^{-11}	1.282×10^{-11}	8.021×10^{-12}	5.678×10^{-12}
W	3.342×10^{-9}	1.228×10^{-9}	5.447×10^{-10}	3.139×10^{-10}	2.072×10^{-10}	9.220×10^{-11}	3.052×10^{-11}	1.412×10^{-11}	8.852×10^{-12}	6.275×10^{-12}
WNW	3.053×10^{-9}	1.120×10^{-9}	4.969×10^{-10}	2.864×10^{-10}	1.890×10^{-10}	8.411×10^{-11}	2.785×10^{-11}	1.288×10^{-11}	8.043×10^{-12}	5.673×10^{-12}
NW	2.555×10^{-9}	9.364×10^{-10}	4.152×10^{-10}	2.393×10^{-10}	1.579×10^{-10}	7.028×10^{-11}	2.330×10^{-11}	1.085×10^{-11}	6.912×10^{-12}	5.008×10^{-12}
NNW	2.415×10^{-9}	9.062×10^{-10}	4.047×10^{-10}	2.334×10^{-10}	1.540×10^{-10}	6.840×10^{-11}	2.246×10^{-11}	1.032×10^{-11}	6.468×10^{-12}	4.602×10^{-12}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases (continued)

Direction from site	Distance (km) 0–2	2–3	3–5	5–6	6–8	8–16	16–32	32–48	48–64	64–80
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m^3) (continued)										
SSE	1.604×10^{-7}	8.673×10^{-8}	4.979×10^{-8}	3.276×10^{-8}	2.362×10^{-8}	1.218×10^{-8}	4.799×10^{-9}	2.384×10^{-9}	1.501×10^{-9}	1.057×10^{-9}
S	9.914×10^{-8}	5.259×10^{-8}	3.148×10^{-8}	2.147×10^{-8}	1.591×10^{-8}	8.596×10^{-9}	3.597×10^{-9}	1.853×10^{-9}	1.188×10^{-9}	8.459×10^{-10}
SSW	9.486×10^{-8}	5.345×10^{-8}	3.254×10^{-8}	2.221×10^{-8}	1.643×10^{-8}	8.841×10^{-9}	3.683×10^{-9}	1.894×10^{-9}	1.213×10^{-9}	8.643×10^{-10}
SW	1.624×10^{-7}	9.201×10^{-8}	5.553×10^{-8}	3.787×10^{-8}	2.807×10^{-8}	1.523×10^{-8}	6.462×10^{-9}	3.384×10^{-9}	2.195×10^{-9}	1.578×10^{-9}
WSW	2.033×10^{-7}	1.103×10^{-7}	6.261×10^{-8}	4.105×10^{-8}	2.955×10^{-8}	1.523×10^{-8}	6.004×10^{-9}	2.997×10^{-9}	1.895×10^{-9}	1.340×10^{-9}
W	2.207×10^{-7}	1.224×10^{-7}	7.087×10^{-8}	4.690×10^{-8}	3.397×10^{-8}	1.765×10^{-8}	7.021×10^{-9}	3.515×10^{-9}	2.225×10^{-9}	1.573×10^{-9}
WNW	2.027×10^{-7}	1.080×10^{-7}	6.124×10^{-8}	4.008×10^{-8}	2.882×10^{-8}	1.485×10^{-8}	5.856×10^{-9}	2.918×10^{-9}	1.843×10^{-9}	1.301×10^{-9}
NW	1.791×10^{-7}	1.075×10^{-7}	6.703×10^{-8}	4.625×10^{-8}	3.445×10^{-8}	1.869×10^{-8}	7.863×10^{-9}	4.064×10^{-9}	2.612×10^{-9}	1.865×10^{-9}
NNW	1.644×10^{-7}	9.637×10^{-8}	5.783×10^{-8}	3.883×10^{-8}	2.833×10^{-8}	1.482×10^{-8}	5.917×10^{-9}	2.949×10^{-9}	1.857×10^{-9}	1.308×10^{-9}
ANNUAL AVERAGE X/Q, DECAYED AND DEPLETED (sec/m^3)										
N	1.617×10^{-7}	9.484×10^{-8}	5.757×10^{-8}	3.886×10^{-8}	2.845×10^{-8}	1.493×10^{-8}	5.959×10^{-9}	2.962×10^{-9}	1.857×10^{-9}	1.294×10^{-9}
NNE	1.673×10^{-7}	9.451×10^{-8}	5.490×10^{-8}	3.613×10^{-8}	2.600×10^{-8}	1.328×10^{-8}	5.120×10^{-9}	2.494×10^{-9}	1.546×10^{-9}	1.069×10^{-9}
NE	1.807×10^{-7}	1.100×10^{-7}	6.711×10^{-8}	4.524×10^{-8}	3.305×10^{-8}	1.724×10^{-8}	6.824×10^{-9}	3.375×10^{-9}	2.112×10^{-9}	1.472×10^{-9}
ENE	1.931×10^{-7}	1.145×10^{-7}	6.882×10^{-8}	4.606×10^{-8}	3.349×10^{-8}	1.738×10^{-8}	6.820×10^{-9}	3.348×10^{-9}	2.084×10^{-9}	1.446×10^{-9}
E	2.528×10^{-7}	1.435×10^{-7}	8.396×10^{-8}	5.561×10^{-8}	4.024×10^{-8}	2.080×10^{-8}	8.195×10^{-9}	4.068×10^{-9}	2.554×10^{-9}	1.783×10^{-9}
ESE	2.750×10^{-7}	1.520×10^{-7}	8.673×10^{-8}	5.655×10^{-8}	4.046×10^{-8}	2.051×10^{-8}	7.833×10^{-9}	3.791×10^{-9}	2.342×10^{-9}	1.615×10^{-9}
SE	2.308×10^{-7}	1.304×10^{-7}	7.426×10^{-8}	4.809×10^{-8}	3.418×10^{-8}	1.711×10^{-8}	6.395×10^{-9}	3.040×10^{-9}	1.857×10^{-9}	1.270×10^{-9}
SSE	1.567×10^{-7}	8.367×10^{-8}	4.746×10^{-8}	3.095×10^{-8}	2.217×10^{-8}	1.129×10^{-8}	4.344×10^{-9}	2.119×10^{-9}	1.314×10^{-9}	9.085×10^{-10}
S	9.680×10^{-8}	5.077×10^{-8}	3.010×10^{-8}	2.041×10^{-8}	1.506×10^{-8}	8.068×10^{-9}	3.330×10^{-9}	1.702×10^{-9}	1.084×10^{-9}	7.636×10^{-10}
SSW	9.270×10^{-8}	5.176×10^{-8}	3.126×10^{-8}	2.122×10^{-8}	1.565×10^{-8}	8.362×10^{-9}	3.450×10^{-9}	1.767×10^{-9}	1.130×10^{-9}	7.988×10^{-10}
SW	1.587×10^{-7}	8.906×10^{-8}	5.332×10^{-8}	3.619×10^{-8}	2.674×10^{-8}	1.444×10^{-8}	6.092×10^{-9}	3.193×10^{-9}	2.075×10^{-9}	1.487×10^{-9}
WSW	1.985×10^{-7}	1.062×10^{-7}	5.949×10^{-8}	3.862×10^{-8}	2.760×10^{-8}	1.402×10^{-8}	5.392×10^{-9}	2.638×10^{-9}	1.642×10^{-9}	1.139×10^{-9}
W	2.156×10^{-7}	1.181×10^{-7}	6.755×10^{-8}	4.433×10^{-8}	3.190×10^{-8}	1.637×10^{-8}	6.379×10^{-9}	3.144×10^{-9}	1.965×10^{-9}	1.368×10^{-9}
WNW	1.980×10^{-7}	1.041×10^{-7}	5.819×10^{-8}	3.770×10^{-8}	2.690×10^{-8}	1.365×10^{-8}	5.239×10^{-9}	2.555×10^{-9}	1.585×10^{-9}	1.096×10^{-9}
NW	1.752×10^{-7}	1.042×10^{-7}	6.453×10^{-8}	4.431×10^{-8}	3.290×10^{-8}	1.775×10^{-8}	7.415×10^{-9}	3.830×10^{-9}	2.463×10^{-9}	1.751×10^{-9}
NNW	1.608×10^{-7}	9.323×10^{-8}	5.532×10^{-8}	3.684×10^{-8}	2.673×10^{-8}	1.382×10^{-8}	5.410×10^{-9}	2.659×10^{-9}	1.658×10^{-9}	1.151×10^{-9}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases (continued)

Direction from site	Distance (km) 0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
					ANNUAL AVERAGE D/Q (m^{-2})					
N	2.473 x 10^{-9}	9.109 x 10^{-10}	4.045 x 10^{-10}	2.331 x 10^{-10}	1.539 x 10^{-10}	6.845 x 10^{-11}	2.264 x 10^{-11}	1.049 x 10^{-11}	6.614 x 10^{-12}	4.729 x 10^{-12}
NNE	2.697 x 10^{-9}	1.011 x 10^{-9}	4.511 x 10^{-10}	2.602 x 10^{-10}	1.717 x 10^{-10}	7.626 x 10^{-11}	2.506 x 10^{-11}	1.151 x 10^{-11}	7.194 x 10^{-12}	5.100 x 10^{-12}
NE	2.740 x 10^{-9}	1.038 x 10^{-9}	4.647 x 10^{-10}	2.682 x 10^{-10}	1.770 x 10^{-10}	7.851 x 10^{-11}	2.569 x 10^{-11}	1.179 x 10^{-11}	7.421 x 10^{-12}	5.323 x 10^{-12}
ENE	2.811 x 10^{-9}	1.059 x 10^{-9}	4.737 x 10^{-10}	2.733 x 10^{-10}	1.804 x 10^{-10}	8.005 x 10^{-11}	2.625 x 10^{-11}	1.205 x 10^{-11}	7.565 x 10^{-12}	5.399 x 10^{-12}
E	3.650 x 10^{-9}	1.369 x 10^{-9}	6.114 x 10^{-10}	3.527 x 10^{-10}	2.327 x 10^{-10}	1.033 x 10^{-10}	3.394 x 10^{-11}	1.559 x 10^{-11}	9.764 x 10^{-12}	6.939 x 10^{-12}
ESE	4.124 x 10^{-9}	1.582 x 10^{-9}	7.110 x 10^{-10}	4.104 x 10^{-10}	2.708 x 10^{-10}	1.200 x 10^{-10}	3.908 x 10^{-11}	1.776 x 10^{-11}	1.100 x 10^{-11}	7.739 x 10^{-12}
SE	4.028 x 10^{-9}	1.575 x 10^{-9}	7.119 x 10^{-10}	4.113 x 10^{-10}	2.714 x 10^{-10}	1.200 x 10^{-10}	3.880 x 10^{-11}	1.747 x 10^{-11}	1.072 x 10^{-11}	7.461 x 10^{-12}
SSE	2.366 x 10^{-9}	8.707 x 10^{-10}	3.865 x 10^{-10}	2.228 x 10^{-10}	1.470 x 10^{-10}	6.541 x 10^{-11}	2.164 x 10^{-11}	9.996 x 10^{-12}	6.248 x 10^{-12}	4.412 x 10^{-12}
S	1.385 x 10^{-9}	4.897 x 10^{-10}	2.146 x 10^{-10}	1.235 x 10^{-10}	8.152 x 10^{-11}	3.642 x 10^{-11}	1.224 x 10^{-11}	5.765 x 10^{-12}	3.666 x 10^{-12}	2.621 x 10^{-12}
SSW	1.251 x 10^{-9}	4.481 x 10^{-10}	1.972 x 10^{-10}	1.136 x 10^{-10}	7.496 x 10^{-11}	3.344 x 10^{-11}	1.118 x 10^{-11}	5.246 x 10^{-12}	3.340 x 10^{-12}	2.407 x 10^{-12}
SW	1.979 x 10^{-9}	7.211 x 10^{-10}	3.191 x 10^{-10}	1.839 x 10^{-10}	1.213 x 10^{-10}	5.404 x 10^{-11}	1.796 x 10^{-11}	8.384 x 10^{-12}	5.355 x 10^{-12}	3.888 x 10^{-12}
WSW	3.024 x 10^{-9}	1.120 x 10^{-9}	4.979 x 10^{-10}	2.870 x 10^{-10}	1.894 x 10^{-10}	8.423 x 10^{-11}	2.780 x 10^{-11}	1.282 x 10^{-11}	8.021 x 10^{-12}	5.678 x 10^{-12}
W	3.342 x 10^{-9}	1.228 x 10^{-9}	5.447 x 10^{-10}	3.139 x 10^{-10}	2.072 x 10^{-10}	9.220 x 10^{-11}	3.052 x 10^{-11}	1.412 x 10^{-11}	8.852 x 10^{-12}	6.275 x 10^{-12}
WNW	3.053 x 10^{-9}	1.120 x 10^{-9}	4.969 x 10^{-10}	2.864 x 10^{-10}	1.890 x 10^{-10}	8.411 x 10^{-11}	2.785 x 10^{-11}	1.288 x 10^{-11}	8.043 x 10^{-12}	5.673 x 10^{-12}
NW	2.555 x 10^{-9}	9.364 x 10^{-10}	4.152 x 10^{-10}	2.393 x 10^{-10}	1.579 x 10^{-10}	7.028 x 10^{-11}	2.330 x 10^{-11}	1.085 x 10^{-11}	6.912 x 10^{-12}	5.008 x 10^{-12}
NNW	2.415 x 10^{-9}	9.062 x 10^{-10}	4.047 x 10^{-10}	2.334 x 10^{-10}	1.540 x 10^{-10}	6.840 x 10^{-11}	2.246 x 10^{-11}	1.032 x 10^{-11}	6.468 x 10^{-12}	4.602 x 10^{-12}

Table G-4. Population and Annual Food Production Within 80 Kilometers of the SRP Center[a]

Direction	Distance (km) 0-8	8-16	16-32	32-48	48-64	64-80	0-80
				POPULATION			
N	0	1,507	5,589	7,411	8,541	20,725	43,774
NNE	0	70	1,118	2,952	4,899	17,585	26,623
NE	0	283	1,218	5,213	9,295	12,435	28,443
ENE	0	25	6,783	5,150	8,039	44,590	64,586
E	0	0	3,203	11,430	6,029	9,672	30,334
ESE	0	0	5,778	4,899	4,208	4,333	19,218
SE	0	0	452	7,285	5,652	9,797	23,187
SSE	0	0	766	1,143	565	5,087	7,561
S	0	0	1,080	1,570	7,034	3,957	13,641
SSW	0	0	264	2,387	6,908	3,454	13,013
SW	0	0	553	3,894	2,261	3,140	9,847
WSW	0	0	496	5,652	1,821	7,662	15,632
W	0	440	2,575	9,420	3,705	12,435	28,575
WNW	0	4,019	5,778	247,443	84,156	15,701	357,096
NW	0	1,118	15,701	64,059	5,778	2,512	89,167
NNW	0	4,208	40,822	16,957	14,445	4,899	81,330
Total[b]	0	11,670	92,176	396,863	173,336	177,983	852,027
				MILK PRODUCTION (liters/yr)			
N	0	1.64×10^4	1.03×10^5	1.72×10^5	1.41×10^6	5.57×10^6	7.28×10^6
NNE	0	1.31×10^4	1.03×10^5	1.72×10^5	3.68×10^5	6.06×10^5	1.26×10^6
NE	0	5.73×10^3	1.22×10^5	1.33×10^6	2.15×10^6	1.39×10^6	4.99×10^6
ENE	0	1.58×10^3	1.80×10^5	1.92×10^6	4.82×10^6	5.46×10^6	1.24×10^7
E	0	1.85×10^3	1.80×10^5	1.74×10^6	4.15×10^6	5.76×10^6	1.18×10^7
ESE	0	4.51×10^1	1.80×10^5	9.31×10^5	2.84×10^6	1.46×10^6	5.41×10^6
SE	0	--	1.21×10^5	4.52×10^4	1.80×10^5	4.00×10^5	7.46×10^5
SSE	0	--	9.38×10^4	2.41×10^5	3.52×10^5	5.64×10^5	1.25×10^6
S	0	--	3.31×10^5	5.74×10^5	7.70×10^5	9.97×10^5	2.67×10^6
SSW	0	--	3.58×10^5	1.89×10^6	6.40×10^6	7.61×10^6	1.63×10^7
SW	0	7.65×10^3	3.87×10^5	6.71×10^5	3.07×10^6	2.84×10^6	6.97×10^6
WSW	0	2.47×10^3	3.53×10^5	6.68×10^5	1.05×10^6	2.40×10^6	4.47×10^6
W	0	1.16×10^4	1.81×10^5	3.79×10^5	1.01×10^6	1.77×10^6	3.36×10^6
WNW	0	1.38×10^4	1.79×10^5	3.46×10^5	6.13×10^5	8.55×10^5	2.01×10^6
NW	0	1.75×10^4	1.03×10^5	4.24×10^5	1.16×10^6	7.81×10^5	2.49×10^6
NNW	0	1.79×10^4	1.03×10^5	2.95×10^5	1.48×10^6	3.14×10^6	5.04×10^6
Total[b]	0	1.10×10^5	3.08×10^6	1.18×10^7	3.18×10^7	4.16×10^7	8.84×10^7

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Table G-4. Population and Annual Food Production Within 80 Kilometers of the SRP Center[a] (continued)

Direction	Distance (km) 0–8	8–16	16–32	32–48	48–64	64–80	0–80	
				MEAT PRODUCTION (kg/yr)				
N	0	8.32×10^4	5.24×10^5	8.73×10^5	1.41×10^6	3.15×10^6	6.05×10^6	
NNE	0	6.63×10^4	5.24×10^5	8.73×10^5	2.29×10^6	4.06×10^6	7.81×10^6	
NE	0	2.37×10^4	4.71×10^5	7.80×10^5	1.71×10^6	3.01×10^6	5.99×10^6	
ENE	0	2.65×10^3	3.02×10^5	5.50×10^5	8.87×10^5	1.06×10^6	2.80×10^6	BC-22
E	0	3.10×10^3	3.02×10^5	4.74×10^5	6.89×10^5	1.03×10^6	2.50×10^6	
ESE	0	7.56×10^1	3.02×10^5	4.66×10^5	6.14×10^5	7.10×10^5	2.09×10^6	
SE	0	—	2.74×10^5	3.82×10^5	6.56×10^5	1.00×10^6	2.31×10^6	
SSE	0	—	2.35×10^5	4.35×10^5	6.19×10^5	9.88×10^5	2.28×10^6	
S	0	—	1.75×10^5	4.58×10^5	7.32×10^5	1.02×10^6	2.39×10^6	
SSW	0	—	1.57×10^5	3.93×10^5	1.13×10^6	1.58×10^6	3.26×10^6	
SW	0	2.29×10^3	1.33×10^5	2.01×10^5	5.76×10^5	7.57×10^5	1.67×10^6	
WSW	0	1.06×10^4	1.75×10^5	2.00×10^5	3.09×10^5	6.65×10^5	1.36×10^6	
W	0	5.90×10^4	1.66×10^5	1.19×10^5	2.91×10^5	5.11×10^5	1.15×10^6	
WNW	0	7.01×10^4	1.75×10^5	1.09×10^5	1.76×10^5	2.45×10^5	7.75×10^5	
NW	0	8.86×10^4	5.24×10^5	6.98×10^5	5.83×10^5	7.01×10^5	2.60×10^6	
NNW	0	9.11×10^4	5.24×10^5	8.20×10^5	7.14×10^5	1.45×10^6	3.60×10^6	BC-22
Total[b]	0	5.01×10^5	4.96×10^6	7.83×10^6	1.34×10^7	2.20×10^7	4.86×10^7	
				VEGETABLE PRODUCTION (kg/yr)				
N	0	7.39×10^4	4.65×10^5	7.75×10^5	2.16×10^6	3.11×10^6	6.58×10^6	
NNE	0	5.89×10^4	4.65×10^5	7.75×10^5	1.18×10^6	1.61×10^6	4.09×10^6	
NE	0	4.13×10^4	9.71×10^5	1.08×10^6	1.59×10^6	1.93×10^6	5.61×10^6	
ENE	0	2.25×10^4	2.57×10^6	2.89×10^6	2.21×10^6	2.78×10^6	1.05×10^7	
E	0	2.64×10^4	2.57×10^6	3.01×10^6	2.72×10^6	3.03×10^6	1.14×10^7	
ESE	0	6.44×10^2	2.57×10^6	3.82×10^6	3.44×10^6	9.66×10^5	1.08×10^7	
SE	0	—	2.73×10^6	4.97×10^6	4.70×10^6	2.89×10^6	1.53×10^7	
SSE	0	—	2.65×10^6	3.71×10^6	5.01×10^6	3.16×10^6	1.45×10^7	
S	0	—	1.36×10^6	1.69×10^6	2.50×10^6	3.27×10^6	8.82×10^6	
SSW	0	—	1.15×10^6	1.33×10^6	1.86×10^6	2.55×10^6	6.89×10^6	
SW	0	1.51×10^4	9.20×10^5	1.33×10^6	1.81×10^6	1.97×10^6	6.04×10^6	
WSW	0	1.01×10^4	7.21×10^5	1.31×10^6	1.86×10^6	2.41×10^6	6.31×10^6	
W	0	5.23×10^4	1.86×10^5	3.17×10^5	1.18×10^6	2.77×10^6	4.51×10^6	
WNW	0	6.22×10^4	1.94×10^5	1.70×10^5	4.89×10^4	1.36×10^6	1.83×10^6	
NW	0	7.86×10^4	4.65×10^5	1.59×10^6	4.20×10^6	2.27×10^6	8.59×10^6	
NNW	0	8.08×10^4	4.65×10^5	1.25×10^6	5.70×10^6	6.38×10^6	1.39×10^7	
Total[b]	0	5.23×10^5	2.05×10^7	3.00×10^7	4.22×10^7	4.24×10^7	1.36×10^8	

a. Adapted from Du Pont, 1981, 1982.
b. Reflects rounding.

given in Chapter 4 for each of the cooling alternatives. For facilities on or within 80 kilometers of SRP, the source terms were taken from supporting documentation referenced in Section G.3.

To calculate collective doses to the regional population within 80 kilometers, compass-sector average values of χ/Q and D/Q are used. All atmospheric releases are assumed to occur at the center of the site; the population and agricultural production distributions were centered at the same points. These are reasonable assumptions, given the absence of high population densities near the release points. Collective doses for each year of operation were calculated as the sum of the doses received during that year of operation, plus residual doses for the next 100 years from radioactivity released during that same year. The calculated collective dose is referred to as a 100-year environmental dose commitment (EDC) per year of operation. (The EDC concept is discussed later in this appendix.) The collective dose received by the exposed offsite population is calculated by adding the individual dose commitments in the population. Parameters used in calculating the collective dose to the 80-kilometer radius population are summarized in Table G-5.

The maximally exposed individual is assumed to reside continuously at the location on the Plant boundary with the highest potential exposure. This is true for both current operating conditions and operations associated with the implementation of cooling alternatives. For the latter, the reference release points of radioactivity to the atmosphere are at the midpoint between the two cooling alternative locations selected for each reactor (K and C). The shortest distance from each of the reference release points to the Plant boundary was calculated for each of the 16 cardinal directions. This method was used to determine the highest boundary χ/Q value, thus identifying the location at which a member of the public would receive the highest dose.

All individual doses are 50-year dose commitments. Parameters used in calculating doses to maximally exposed individuals are summarized in Table G-6.

The following exposure pathways were considered for the atmospheric dose assessment:

1. <u>Plume</u> - External dose from radioactive materials transported through the atmosphere

2. <u>Ground</u> - External dose from radioactive materials deposited on the ground

3. <u>Inhalation</u> - Internal dose from inhalation of radioactive materials transported through the atmosphere

4. <u>Vegetation</u> - Internal dose from consumption of crops that have been contaminated by radioactive deposits from the atmosphere

5. <u>Milk</u> - Internal dose from consumption of milk from cows that consume vegetation contaminated by radioactive deposits from the atmosphere

6. <u>Meat</u> - Internal dose from consumption of meat products from beef cattle that consume vegetation contaminated by radioactive deposits from the atmosphere

Table G-5. Parameters and Demographic Data Used in Calculating Collective Dose to the 80-Kilometer Population

Average individual parameters[a]	Child	Teen	Adult
Inhalation (m^3/yr)	3700	8000	8000
Ingestion[b]			
Cow's milk (liter/yr)	170	200	110
Meat (kg/yr)	37	59	95
Leafy vegetables (kg/yr)[c]	10	20	30
Fruits, vegetables, and grains (kg/yr)	200	240	190
External exposure			
Transmission factor for shielding by residential structures	0.5	0.5	0.5
Demographic data, CY 2000[d]			
80-kilometer residential population (852,000) age-group distribution	20.8	11.8	67.4

a. Data are recommended values from Regulatory Guide 1.109 (NRC, 1977).
b. Foodstuff obtained at large from the 80-kilometer agricultural production of man's foods; any insufficiency is assumed to be imported (uncontaminated). Crop yield and animal feeding data for the 80-kilometer vicinity are presented in Du Pont (1981).
c. Data from Eckerman et al. (1980).
d. 1970 census data projected to the assumed midpoint of operations.

The dose to the maximally exposed individual and collective doses to the population within 80 kilometers of SRP from atmospheric radioactive releases from once-through and recirculating cooling towers for K- and C-Reactors are presented in Tables G-7 through G-14. Section G.3 discusses doses from facilities on or within 80 kilometers of the Plant.

G.2 LIQUID RELEASES

The LADTAP II computer code (Simpson and McGill, 1980) was used to calculate radiation exposures due to liquid releases; LADTAP II implements the dose models recommended in NRC Regulatory Guide 1.109, Revision 1 (NRC, 1977). Both maximum-individual and collective doses were calculated as functions of age group and pathway for various body organs. An effective whole-body dose was also calculated.

During operation of the reactors and associated facilities at SRP (existing operations), liquids are released that ultimately discharge into the Savannah River. Included in these releases are radionuclides from reactors and support facilities, and from remobilization from stream beds. The primary radionuclides remobilized is cesium-137 (DOE, 1984b). (Refer to Appendix D.) BC-22

Table G-6. Parameters Used in Calculating Dose to Maximally Exposed Individuals[a]

Parameter	Infant	Child	Teen	Adult
Inhalation (m^3/yr)	1400	3700	8000	8000
Ingestion[b]				
Cow's milk (liter/yr)	330	330	400	310
Meat (kg/yr)	0	41	65	110
Leafy vegetables (kg/yr)[c]	0	26	42	64
Fruits, vegetables, and grains (kg/yr)[d]	0	520	630	520
External exposure				
Transmission factor for shielding from buildings	0.7	0.7	0.7	0.7

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

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

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

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

The routine operation of cooling water systems for K- and C-Reactors would result in either no change or a decrease in the remobilization of radionuclides to the Savannah River. This is because flow rates in Four Mile Creek and Indian Grave/Pen Branch would remain essentially unchanged if once-through cooling towers were implemented, and would decrease if recirculating cooling towers were implemented. The routine operation of the cooling water alternative systems for D-Area would produce an insignificant increase in remobilization of radionuclides from Beaver Dam Creek because the creek bed contains insignificant amounts of radionuclides.

The following exposure pathways were considered in the liquid-dose assessments:

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

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

Table G-7. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.28×10^{-5}	4.49×10^{-5}
Meat ingestion	7.86×10^{-6}	6.68×10^{-6}
Milk ingestion	1.85×10^{-5}	1.57×10^{-5}
Inhalation	4.43×10^{-5}	3.77×10^{-5}
Total	1.23×10^{-4}	1.05×10^{-4}
	TEEN	
Plume immersion 0.0	0.0	
Ground plane	0.0	0.0
Vegetation ingestion	6.08×10^{-5}	5.17×10^{-5}
Meat ingestion	4.65×10^{-6}	3.95×10^{-6}
Milk ingestion	2.38×10^{-5}	2.02×10^{-5}
Inhalation	4.43×10^{-5}	3.77×10^{-5}
Total	1.34×10^{-4}	1.14×10^{-4}
	CHILD	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.94×10^{-5}	4.20×10^{-5}
Meat ingestion	2.93×10^{-6}	2.49×10^{-6}
Milk ingestion	1.97×10^{-5}	1.67×10^{-5}
Inhalation	2.04×10^{-5}	1.74×10^{-5}
Total	9.24×10^{-5}	7.86×10^{-5}
	INFANT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	1.97×10^{-5}	1.67×10^{-5}
Inhalation	7.74×10^{-6}	6.59×10^{-6}
Total	2.74×10^{-5}	2.33×10^{-5}

Table G-8. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.44×10^{-5}	4.62×10^{-5}
Meat ingestion	8.10×10^{-6}	6.89×10^{-6}
Milk ingestion	1.90×10^{-5}	1.62×10^{-5}
Inhalation	4.56×10^{-5}	3.87×10^{-5}
Total	1.27×10^{-4}	1.08×10^{-4}
	TEEN	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	6.26×10^{-5}	5.32×10^{-5}
Meat ingestion	4.78×10^{-6}	4.06×10^{-6}
Milk ingestion	2.45×10^{-5}	2.08×10^{-5}
Inhalation	4.56×10^{-5}	3.87×10^{-5}
Total	1.37×10^{-4}	1.17×10^{-4}
	CHILD	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.09×10^{-5}	4.33×10^{-5}
Meat ingestion	3.02×10^{-6}	2.57×10^{-6}
Milk ingestion	2.02×10^{-5}	1.72×10^{-5}
Inhalation	2.10×10^{-5}	1.79×10^{-5}
Total	9.51×10^{-5}	8.09×10^{-5}
	INFANT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	2.02×10^{-5}	1.72×10^{-5}
Inhalation	7.97×10^{-6}	6.77×10^{-6}
Total	2.82×10^{-5}	2.40×10^{-5}

Table G-9. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.48×10^{-4}	3.80×10^{-4}
Meat ingestion	6.68×10^{-5}	5.67×10^{-5}
Milk ingestion	1.57×10^{-4}	1.33×10^{-4}
Inhalation	3.77×10^{-4}	3.21×10^{-4}
Total	1.05×10^{-3}	8.92×10^{-4}
	TEEN	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.15×10^{-4}	4.39×10^{-4}
Meat ingestion	3.93×10^{-5}	3.35×10^{-5}
Milk ingestion	2.02×10^{-4}	1.72×10^{-4}
Inhalation	3.77×10^{-4}	3.21×10^{-4}
Total	1.13×10^{-3}	9.65×10^{-4}
	CHILD	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.20×10^{-4}	3.58×10^{-4}
Meat ingestion	2.48×10^{-5}	2.11×10^{-5}
Milk ingestion	1.67×10^{-4}	1.42×10^{-4}
Inhalation	1.74×10^{-4}	1.48×10^{-4}
Total	7.87×10^{-4}	6.69×10^{-4}
	INFANT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	1.67×10^{-4}	1.42×10^{-4}
Inhalation	6.56×10^{-5}	5.57×10^{-5}
Total	2.32×10^{-4}	1.98×10^{-4}

Table G-10. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.62×10^{-4}	3.93×10^{-4}
Meat ingestion	6.88×10^{-5}	5.84×10^{-5}
Milk ingestion	1.62×10^{-4}	1.37×10^{-4}
Inhalation	3.86×10^{-4}	3.27×10^{-4}
Total	1.08×10^{-3}	9.15×10^{-4}
	TEEN	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.33×10^{-4}	4.51×10^{-4}
Meat ingestion	4.06×10^{-5}	3.46×10^{-5}
Milk ingestion	2.09×10^{-4}	1.78×10^{-4}
Inhalation	3.86×10^{-4}	3.27×10^{-4}
Total	1.17×10^{-3}	9.91×10^{-4}
	CHILD	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.33×10^{-4}	3.68×10^{-4}
Meat ingestion	2.57×10^{-5}	2.17×10^{-5}
Milk ingestion	1.72×10^{-4}	1.46×10^{-4}
Inhalation	1.79×10^{-4}	1.52×10^{-4}
Total	8.09×10^{-4}	6.87×10^{-4}
	INFANT	
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	1.72×10^{-4}	1.46×10^{-4}
Inhalation	6.77×10^{-5}	5.75×10^{-5}
Total	2.40×10^{-4}	2.03×10^{-4}

Table G-11. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.59×10^{-3}	1.35×10^{-3}
Meat ingestion	3.03×10^{-4}	2.58×10^{-4}
Milk ingestion	3.85×10^{-4}	3.27×10^{-4}
Inhalation	3.57×10^{-3}	3.03×10^{-3}
Total	5.85×10^{-3}	4.97×10^{-3}

Table G-12. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.59×10^{-3}	1.35×10^{-3}
Meat ingestion	3.03×10^{-4}	2.58×10^{-4}
Milk ingestion	3.85×10^{-4}	3.27×10^{-4}
Inhalation	3.57×10^{-3}	3.03×10^{-3}
Total	5.85×10^{-3}	4.97×10^{-3}

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

4. Recreation - External dose from recreational activities on or along the Savannah River shoreline

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

Individual and site parameters used in the calculations are summarized in Tables G-15 and G-16. The data on fish consumption are based on data from the region.

Table G-13. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.35×10^{-2}	1.15×10^{-2}
Meat ingestion	2.57×10^{-3}	2.18×10^{-3}
Milk ingestion	3.28×10^{-3}	2.78×10^{-3}
Inhalation	3.03×10^{-2}	2.59×10^{-2}
Total	4.98×10^{-2}	4.22×10^{-2}

Table G-14. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.35×10^{-2}	1.15×10^{-2}
Meat ingestion	2.57×10^{-3}	2.18×10^{-3}
Milk ingestion	3.28×10^{-3}	2.78×10^{-3}
Inhalation	3.03×10^{-2}	2.59×10^{-2}
Total	4.98×10^{-2}	4.22×10^{-2}

TE The individual who would receive the maximum potential dose from liquid releases is assumed to live near the Savannah River downstream from SRP. It is assumed this individual uses river water regularly for drinking, consumes river fish, and receives external exposure from shoreline activities.

TE The collective doses received by the offsite population as a result of liquid releases is estimated by summing the doses to the individuals in the population. The population within an 80-kilometer radius uses no river water for domestic purposes downstream from SRP. It is assumed this population uses the river for recreational purposes and consumes fish and shellfish from the river and its estuary.

There is no known human consumption of Savannah River water up to a distance of about 160 kilometers downstream from SRP. At this distance, Beaufort and Jasper Counties, South Carolina, will pump water from the river for treatment

Table G-15. Individual Parameters Used in Dose Calculations

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

a. For collective dose calculations.
b. Drinking-water consumption for an infant equals 330 liters per year.

Table G-16. Site Parameters Used in Dose Calculations

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

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

and service to about 117,000 people in the year 2000. Several kilometers farther downstream, the Cherokee Hill water-treatment plant draws water from the river to supply a business-industrial complex near Savannah, Georgia. This water is not used for normal domestic service, but it is assumed that about 200,000 people will use this water during the year 2000 (DOE, 1984a). Although these population groups are beyond the 80-kilometer radius, collective doses from drinking-water for these groups have been included in this document. All population doses are 100-year environmental dose commitments.

The doses to the maximally exposed individual and collective dose from liquid radioactive releases from once-through and recirculating cooling-towers for K- and C-Reactors are presented in Tables G-17 through G-28. Section G.3 discusses doses from facilities on or within 80 kilometers of SRP.

G.3 CUMULATIVE EFFECTS

The evaluation of the radiological impacts associated with the implementation of the alternative cooling water systems has also considered the cumulative effects of the operation of all other nuclear facilities in the affected region. This region includes SRP and the area within 80 kilometers of the Plant. These cumulative effects are summarized in Section 4.4.

Impacts for the following nuclear facilities, which represent existing and planned operations, have been considered in the calculation of cumulative effects:

- Four onsite production reactors (L, P, K, and C) using current cooling water systems, and associated support facilities

- The Defense Waste Processing Facility (DWPF) under construction at S-Area on the Plant

- The Fuel Materials Facility (FMF) under construction at F-Area on the Plant

- The Fuel Production Facility (FPF) to be constructed at H-Area on the Plant

- The Vogtle Electric Generating Station (VEGS) under construction across the Savannah River from the southwestern boundary of the site

The maximum individual and collective doses associated with each of these facilities are presented in Tables G-29, G-30, G-31, and G-32. These represent basecase doses. Information necessary for these dose calculations was derived from supporting environmental documentation available for each facility (DOE, 1982a,b; 1984a; Du Pont, 1983; Georgia Power Company, 1985).

To obtain the cumulative impact of the operation of nuclear facilities in the region, including the alternative cooling water systems, the changes in doses associated with operation of the cooling water systems (Tables G-7 through

Table G-17. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Indian Grave/Pen Branch, Millirem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Fish	1.04×10^{-5}	8.84×10^{-6}
Drinking	2.47×10^{-4}	2.10×10^{-4}
Total	2.58×10^{-4}	2.19×10^{-4}
	TEEN	
Fish	7.90×10^{-6}	6.72×10^{-6}
Drinking	1.73×10^{-4}	1.47×10^{-4}
Total	1.81×10^{-4}	1.54×10^{-4}
	CHILD	
Fish	3.42×10^{-6}	2.91×10^{-6}
Drinking	1.73×10^{-4}	1.47×10^{-4}
Total	1.76×10^{-4}	1.50×10^{-4}
	INFANT	
Drinking	1.12×10^{-4}	9.52×10^{-5}
Total	1.12×10^{-4}	9.52×10^{-5}

G-14 and G-17 through G-28) must be combined with the existing doses. These cumulative doses are presented in Tables G-33 through G-38.

G.4 ENVIRONMENTAL DOSE COMMITMENT CONCEPT

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

Table G-18. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Four Mile Creek, Millirem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Fish	1.04×10^{-5}	8.84×10^{-6}
Drinking	2.47×10^{-4}	2.10×10^{-4}
Total	2.58×10^{-4}	2.19×10^{-4}
	TEEN	
Fish	7.90×10^{-6}	6.72×10^{-6}
Drinking	1.73×10^{-4}	1.47×10^{-4}
Total	1.81×10^{-4}	1.54×10^{-4}
	CHILD	
Fish	3.42×10^{-6}	2.91×10^{-6}
Drinking	1.73×10^{-4}	1.47×10^{-4}
Total	1.76×10^{-4}	1.50×10^{-4}
	INFANT	
Drinking	1.12×10^{-4}	9.52×10^{-5}
Total	1.12×10^{-4}	9.52×10^{-5}

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

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

Table G-19. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Indian Grave/Pen Branch, Millirem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Fish	8.81×10^{-5}	7.48×10^{-5}
Drinking	2.09×10^{-3}	1.78×10^{-3}
Total	2.18×10^{-3}	1.85×10^{-3}
	TEEN	
Fish	6.72×10^{-5}	5.70×10^{-5}
Drinking	1.47×10^{-3}	1.25×10^{-3}
Total	1.53×10^{-3}	1.31×10^{-3}
	CHILD	
Fish	2.90×10^{-5}	2.47×10^{-5}
Drinking	1.47×10^{-3}	1.25×10^{-3}
Total	1.50×10^{-3}	1.27×10^{-3}
	INFANT	
Drinking	9.48×10^{-4}	8.06×10^{-4}
Total	9.48×10^{-4}	8.06×10^{-4}

This analysis uses the 100-year integrating period. All collective dose calculations include an accounting of collective dose resulting from environmental radioactivity levels for 100 years following each year's release. The 100-year period provides meaningful results by accounting for impacts over a period of time about equal to the maximum lifetime of an individual; thus, it provides a measure of risk to an individual. Longer integrating periods or an infinite time integral would require extremely speculative predictions.

For all EDC calculations, no attempt was made to predict changes in environmental characteristics. Population size and distribution were based on estimates for the year 2000. Historical meteorological patterns and conditions were assumed to continue, and food production and consumption patterns were assumed to be static.

Table G-20. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Four Mile Creek, Millirem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
	ADULT	
Fish	8.81×10^{-5}	7.48×10^{-5}
Drinking	2.09×10^{-3}	1.78×10^{-3}
Total	2.18×10^{-3}	1.85×10^{-3}
	TEEN	
Fish	6.72×10^{-5}	5.70×10^{-5}
Drinking	1.47×10^{-3}	1.25×10^{-3}
Total	1.53×10^{-3}	1.31×10^{-3}
	CHILD	
Fish	2.90×10^{-5}	2.47×10^{-5}
Drinking	1.47×10^{-3}	1.25×10^{-3}
Total	1.50×10^{-3}	1.27×10^{-3}
	INFANT	
Drinking	9.48×10^{-4}	8.06×10^{-4}
Total	9.48×10^{-4}	8.06×10^{-4}

G.5 RADIATION-INDUCED HEALTH EFFECTS

Radiation can affect human health by causing cancer, genetic disorders, and other health problems. The Committee on the Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences has published a detailed review of available data on radiation-induced health effects (BEIR, 1980). This report (BEIR III) uses a variety of methods and data to quantify the health impacts of low levels of radiation. Its estimates of health risk associated with radiation exposure have been used to quantify the possible changes in radiation-induced health effects that might be caused by operation of the cooling water systems. These potential health effects are discussed in Chapter 4.

The International Commission on Radiological Protection provides risk estimates for radiation exposure in ICRP Publication 26 (ICRP, 1977). These risk estimates for cancer mortality are generally consistent with BEIR III.

Table G-21. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Remobilization of Radiocesium from Indian Grave/Pen Branch Stream Bed, Millirem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
					ADULT					
Fish	6.82×10^{-2}	5.85×10^{-2}	6.33×10^{-2}	6.33×10^{-2}	6.33×10^{-2}	6.33×10^{-2}	6.82×10^{-2}	6.82×10^{-2}	6.82×10^{-2}	6.82×10^{-2}
Drinking	4.88×10^{-4}	4.18×10^{-4}	4.53×10^{-4}	4.53×10^{-4}	4.53×10^{-4}	4.53×10^{-4}	4.88×10^{-4}	4.88×10^{-4}	4.88×10^{-4}	4.88×10^{-4}
Shoreline	1.26×10^{-4}	1.14×10^{-4}	9.56×10^{-5}	9.42×10^{-5}	1.18×10^{-4}	1.07×10^{-4}	7.84×10^{-5}	9.22×10^{-5}	8.53×10^{-5}	1.06×10^{-4}
Total	6.88×10^{-2}	5.90×10^{-2}	6.38×10^{-2}	6.38×10^{-2}	6.39×10^{-2}	6.39×10^{-2}	6.88×10^{-2}	6.88×10^{-2}	6.88×10^{-2}	6.88×10^{-2}
					TEEN					
Fish	5.20×10^{-2}	4.45×10^{-2}	4.82×10^{-2}	4.82×10^{-2}	4.82×10^{-2}	4.82×10^{-2}	5.20×10^{-2}	5.20×10^{-2}	5.20×10^{-2}	5.20×10^{-2}
Drinking	3.41×10^{-4}	2.92×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}
Shoreline	4.22×10^{-4}	3.83×10^{-4}	3.20×10^{-4}	3.16×10^{-4}	3.96×10^{-4}	3.57×10^{-4}	2.63×10^{-4}	3.09×10^{-4}	2.86×10^{-4}	3.55×10^{-4}
Total	5.28×10^{-2}	4.52×10^{-2}	4.88×10^{-2}	4.88×10^{-2}	4.89×10^{-2}	4.89×10^{-2}	5.26×10^{-2}	5.26×10^{-2}	5.26×10^{-2}	5.27×10^{-2}
					CHILD					
Fish	2.25×10^{-2}	1.93×10^{-2}	2.09×10^{-2}	2.09×10^{-2}	2.09×10^{-2}	2.09×10^{-2}	2.25×10^{-2}	2.25×10^{-2}	2.25×10^{-2}	2.25×10^{-2}
Drinking	3.41×10^{-4}	2.92×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}
Shoreline	8.81×10^{-5}	7.99×10^{-5}	6.69×10^{-5}	6.60×10^{-5}	8.28×10^{-5}	7.46×10^{-5}	5.49×10^{-5}	6.45×10^{-5}	5.97×10^{-5}	7.42×10^{-5}
Total	2.29×10^{-2}	1.97×10^{-2}	2.13×10^{-2}	2.13×10^{-2}	2.13×10^{-2}	2.13×10^{-2}	2.29×10^{-2}	2.29×10^{-2}	2.29×10^{-2}	2.29×10^{-2}
					INFANT					
Drinking	2.21×10^{-4}	1.89×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}
Total	2.21×10^{-4}	1.89×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}

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Table G-22. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Remobilization of Radiocesium from Four Mile Creek Stream Bed, Millirem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
ADULT										
Fish	1.19×10^{-1}	1.02×10^{-1}	1.11×10^{-1}	1.11×10^{-1}	1.11×10^{-1}	1.11×10^{-1}	1.19×10^{-1}	1.19×10^{-1}	1.19×10^{-1}	1.19×10^{-1}
Drinking	8.54×10^{-4}	7.32×10^{-4}	7.93×10^{-4}	7.93×10^{-4}	7.93×10^{-4}	7.93×10^{-4}	8.54×10^{-4}	8.54×10^{-4}	8.54×10^{-4}	8.54×10^{-4}
Shoreline	2.20×10^{-4}	2.00×10^{-4}	1.67×10^{-4}	1.65×10^{-4}	2.07×10^{-4}	1.87×10^{-4}	1.37×10^{-4}	1.61×10^{-4}	1.49×10^{-4}	1.85×10^{-4}
Total	1.20×10^{-1}	1.03×10^{-1}	1.12×10^{-1}	1.12×10^{-1}	1.12×10^{-1}	1.12×10^{-1}	1.20×10^{-1}	1.20×10^{-1}	1.20×10^{-1}	1.20×10^{-1}
TEEN										
Fish	9.09×10^{-2}	7.79×10^{-2}	8.44×10^{-2}	8.44×10^{-2}	8.44×10^{-2}	8.44×10^{-2}	9.09×10^{-2}	9.09×10^{-2}	9.09×10^{-2}	9.09×10^{-2}
Drinking	5.97×10^{-4}	5.12×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}
Shoreline	7.38×10^{-4}	6.69×10^{-4}	5.61×10^{-4}	5.53×10^{-4}	6.94×10^{-4}	6.25×10^{-4}	4.60×10^{-4}	5.40×10^{-4}	5.00×10^{-4}	6.21×10^{-4}
Total	9.22×10^{-2}	7.91×10^{-2}	8.55×10^{-2}	8.55×10^{-2}	8.56×10^{-2}	8.56×10^{-2}	9.20×10^{-2}	9.20×10^{-2}	9.20×10^{-2}	9.21×10^{-2}
CHILD										
Fish	3.93×10^{-2}	3.37×10^{-2}	3.65×10^{-2}	3.65×10^{-2}	3.65×10^{-2}	3.65×10^{-2}	3.93×10^{-2}	3.93×10^{-2}	3.93×10^{-2}	3.93×10^{-2}
Drinking	5.97×10^{-4}	5.12×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}
Shoreline	1.54×10^{-4}	1.40×10^{-4}	1.17×10^{-4}	1.15×10^{-4}	1.45×10^{-4}	1.31×10^{-4}	9.61×10^{-5}	1.13×10^{-4}	1.04×10^{-4}	1.30×10^{-4}
Total	4.01×10^{-2}	3.44×10^{-2}	3.72×10^{-2}	3.72×10^{-2}	3.72×10^{-2}	3.72×10^{-2}	4.00×10^{-2}	4.00×10^{-2}	4.00×10^{-2}	4.00×10^{-2}
INFANT										
Drinking	3.86×10^{-4}	3.31×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}
Total	3.86×10^{-4}	3.31×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}

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Table G-23. Decrease in Collective Dose from Reduced Tritium Release to Indian Grave/Pen Branch, Person-Rem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.33×10^{-2}	1.13×10^{-2}
Port Wentworth	2.51×10^{-2}	2.13×10^{-2}
Total	3.84×10^{-2}	3.26×10^{-2}
Sport fish	2.72×10^{-5}	2.31×10^{-5}
Commercial fish	1.73×10^{-6}	1.47×10^{-6}
Shellfish	5.32×10^{-8}	4.52×10^{-8}
Total	2.90×10^{-5}	2.46×10^{-5}
Grand total	3.84×10^{-2}	3.26×10^{-2}

Table G-24. Decrease in Collective Dose from Reduced Tritium Release to Four Mile Creek, Person-Rem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.33×10^{-2}	1.13×10^{-2}
Port Wentworth	2.51×10^{-2}	2.13×10^{-2}
Total	3.84×10^{-2}	3.26×10^{-2}
Sport fish	2.72×10^{-5}	2.31×10^{-5}
Commercial fish	1.73×10^{-6}	1.47×10^{-6}
Shellfish	5.32×10^{-8}	4.52×10^{-8}
Total	2.90×10^{-5}	2.46×10^{-5}
Grand total	3.84×10^{-2}	3.26×10^{-2}

Table G-25. Decrease in Collective Dose from Reduced Tritium Release to Indian Grave/Pen Branch, Person-Rem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.13×10^{-1}	9.58×10^{-2}
Port Wentworth	2.14×10^{-1}	1.82×10^{-1}
Total	3.27×10^{-1}	2.78×10^{-1}
Sport fish	2.30×10^{-4}	1.96×10^{-4}
Commercial fish	1.47×10^{-5}	1.25×10^{-5}
Shellfish	4.52×10^{-7}	3.84×10^{-7}
Total	2.45×10^{-4}	2.09×10^{-4}
Grand total	3.27×10^{-1}	2.78×10^{-1}

Table G-26. Decrease in Collective Dose from Reduced Tritium Release to Four Mile Creek, Person-Rem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.13×10^{-1}	9.58×10^{-2}
Port Wentworth	2.14×10^{-1}	1.82×10^{-1}
Total	3.27×10^{-1}	2.78×10^{-1}
Sport fish	2.30×10^{-4}	1.96×10^{-4}
Commercial fish	1.47×10^{-5}	1.25×10^{-5}
Shellfish	4.52×10^{-7}	3.84×10^{-7}
Total	2.45×10^{-4}	2.09×10^{-4}
Grand total	3.27×10^{-1}	2.78×10^{-1}

The total cancer risk for all organs reported in ICRP-26 is 1.25×10^{-4} per rem, compared to 1.20×10^{-4} reported in BEIR III. However, the genetic risk estimate reported in ICRP-26 is about three times lower than that of BEIR III. BEIR III risk estimates were used in this analysis because (1) BEIR III is a more recent and comprehensive evaluation of radiation-induced health effects and (2) BEIR III results in higher estimates of total risk.

Table G-27. Decrease in Collective Dose from Reduced Remobilization of Radiocesium from Indian Grave/Pen Branch Stream Bed, Person-Rem Per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
Drinking water										
Beaufort-Jasper	1.05×10^{-2}	8.99×10^{-3}	9.74×10^{-3}	9.74×10^{-3}	9.74×10^{-3}	9.74×10^{-3}	1.05×10^{-2}	1.05×10^{-2}	1.05×10^{-2}	1.05×10^{-2}
Port Wentworth	3.81×10^{-2}	3.27×10^{-2}	3.54×10^{-2}	3.54×10^{-2}	3.54×10^{-2}	3.54×10^{-2}	3.81×10^{-2}	3.81×10^{-2}	3.81×10^{-2}	3.81×10^{-2}
Total	4.86×10^{-2}	4.17×10^{-2}	4.51×10^{-2}	4.51×10^{-2}	4.51×10^{-2}	4.51×10^{-2}	4.86×10^{-2}	4.86×10^{-2}	4.86×10^{-2}	4.86×10^{-2}
Sport fish	1.79×10^{-1}	1.53×10^{-1}	1.66×10^{-1}	1.66×10^{-1}	1.66×10^{-1}	1.66×10^{-1}	1.79×10^{-1}	1.79×10^{-1}	1.79×10^{-1}	1.79×10^{-1}
Commercial fish	1.14×10^{-2}	9.74×10^{-3}	1.06×10^{-2}	1.06×10^{-2}	1.06×10^{-2}	1.06×10^{-2}	1.14×10^{-2}	1.14×10^{-2}	1.14×10^{-2}	1.14×10^{-2}
Shellfish	2.83×10^{-6}	2.42×10^{-6}	2.63×10^{-6}	2.63×10^{-6}	2.63×10^{-6}	2.63×10^{-6}	2.83×10^{-6}	2.83×10^{-6}	2.83×10^{-6}	2.83×10^{-6}
Shoreline	1.26×10^{-3}	1.14×10^{-3}	9.56×10^{-4}	9.42×10^{-4}	1.18×10^{-3}	1.07×10^{-3}	7.84×10^{-4}	9.22×10^{-4}	8.53×10^{-4}	1.06×10^{-3}
Total	1.92×10^{-1}	1.64×10^{-1}	1.78×10^{-1}	1.78×10^{-1}	1.78×10^{-1}	1.78×10^{-1}	1.91×10^{-1}	1.91×10^{-1}	1.91×10^{-1}	1.91×10^{-1}
Grand Total	2.40×10^{-1}	2.06×10^{-1}	2.23×10^{-1}	2.23×10^{-1}	2.23×10^{-1}	2.23×10^{-1}	2.40×10^{-1}	2.40×10^{-1}	2.40×10^{-1}	2.40×10^{-1}

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Table G-28. Decrease in Collective Dose from Reduced Remobilization of Radiocesium from Four Mile Creek Stream Bed, Person-Rem Per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
Drinking water										
Beaufort-Jasper	1.83×10^{-2}	1.57×10^{-2}	1.70×10^{-2}	1.70×10^{-2}	1.70×10^{-2}	1.70×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}
Port Wentworth	6.67×10^{-2}	5.71×10^{-2}	6.19×10^{-2}	6.19×10^{-2}	6.19×10^{-2}	6.19×10^{-2}	6.67×10^{-2}	6.67×10^{-2}	6.67×10^{-2}	6.67×10^{-2}
Total	8.50×10^{-2}	7.28×10^{-2}	7.89×10^{-2}	7.89×10^{-2}	7.89×10^{-2}	7.89×10^{-2}	8.50×10^{-2}	8.50×10^{-2}	8.50×10^{-2}	8.50×10^{-2}
Sport fish	3.13×10^{-1}	2.68×10^{-1}	2.91×10^{-1}	2.19×10^{-1}	2.91×10^{-1}	2.91×10^{-1}	3.13×10^{-1}	3.13×10^{-1}	3.13×10^{-1}	3.13×10^{-1}
Commercial fish	1.99×10^{-2}	1.71×10^{-2}	1.85×10^{-2}	1.85×10^{-2}	1.85×10^{-2}	1.85×10^{-2}	1.99×10^{-2}	1.99×10^{-2}	1.99×10^{-2}	1.99×10^{-2}
Shellfish	4.95×10^{-6}	4.24×10^{-6}	4.59×10^{-6}	4.59×10^{-6}	4.59×10^{-6}	4.59×10^{-6}	4.95×10^{-6}	4.95×10^{-6}	4.95×10^{-6}	4.95×10^{-6}
Shoreline	2.20×10^{-3}	2.00×10^{-3}	1.67×10^{-3}	1.65×10^{-3}	2.07×10^{-3}	1.87×10^{-3}	1.37×10^{-3}	1.61×10^{-3}	1.49×10^{-3}	1.85×10^{-3}
Total	3.35×10^{-1}	2.87×10^{-1}	3.11×10^{-1}	3.11×10^{-1}	3.12×10^{-1}	3.11×10^{-1}	3.34×10^{-1}	3.35×10^{-1}	3.34×10^{-1}	3.35×10^{-1}
Grand Total	4.20×10^{-1}	3.60×10^{-1}	3.90×10^{-1}	3.90×10^{-1}	3.90×10^{-1}	3.90×10^{-1}	4.19×10^{-1}	4.20×10^{-1}	4.19×10^{-1}	4.20×10^{-1}

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Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year)

Receptor organ	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
ADULT						
Gonads	5.85×10^{-1}	1.89×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		5.85×10^{-1}
Breast	5.99×10^{-1}	1.68×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		5.99×10^{-1}
R. Marrow	1.85×10^{-1}	1.07×10^{-3}	5.93×10^{-5}	2.49×10^{-7}	5.59×10^{-1}	7.45×10^{-1}
Lungs	6.47×10^{-1}	4.33×10^{-4}	4.53×10^{-2}	1.90×10^{-4}	3.41×10^{-1}	1.03
Thyroid	3.77	6.54×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	9.96×10^{-1}	4.77
Bone Surface	3.59×10^{-1}	2.77×10^{-3}	9.19×10^{-4}	3.77×10^{-6}		3.63×10^{-1}
ST Wall	4.88×10^{-1}	7.59×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		4.88×10^{-1}
SI Wall	4.85×10^{-1}	1.53×10^{-4}	5.58×10^{-8}	5.50×10^{-9}		4.85×10^{-1}
ULI Wall	6.20×10^{-1}	2.72×10^{-4}	3.27×10^{-4}	7.24×10^{-5}		6.21×10^{-1}
LLI Wall	5.62×10^{-1}	4.74×10^{-4}	1.00×10^{-3}	2.06×10^{-4}	3.45×10^{-1}	9.09×10^{-1}
Kidneys	4.37×10^{-1}	7.97×10^{-5}	3.88×10^{-4}	1.59×10^{-6}	4.51×10^{-1}	8.88×10^{-1}
Liver	4.86×10^{-1}	2.29×10^{-4}	7.14×10^{-8}	6.38×10^{-9}	6.44×10^{-1}	1.13
Pancreas	5.30×10^{-1}	6.71×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		5.30×10^{-1}
Spleen	5.44×10^{-1}	7.48×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		5.44×10^{-1}
Thymus	4.44×10^{-1}	8.37×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		4.44×10^{-1}
Uterus	4.32×10^{-1}	6.81×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		4.32×10^{-1}
Adrenals	4.39×10^{-1}	7.95×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		4.39×10^{-1}
Blad. Wall	5.30×10^{-1}	7.70×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		5.30×10^{-1}
Skin	6.23×10^{-1}	1.19×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	4.01×10^{-1}	1.02
Remainder	5.17×10^{-2}	8.98×10^{-5}	0.00	0.00		5.18×10^{-2}
E.W.B.D.	6.38×10^{-1}	7.00×10^{-4}	5.58×10^{-3}	3.98×10^{-5}	5.39×10^{-1}	1.18
TEEN						
Gonads	6.28×10^{-1}	2.04×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		6.28×10^{-1}
Breast	6.42×10^{-1}	1.81×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		6.42×10^{-1}
R. Marrow	1.89×10^{-1}	1.21×10^{-3}	6.82×10^{-5}	2.85×10^{-7}	7.49×10^{-1}	9.39×10^{-1}
Lungs	6.90×10^{-1}	4.47×10^{-4}	4.53×10^{-2}	1.90×10^{-4}	3.65×10^{-1}	1.10
Thyroid	4.31	7.54×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	1.28	5.60

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

	Facilities					
Receptor organ	SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			TEEN (continued)			
Bone Surface	3.68×10^{-1}	3.07×10^{-3}	1.06×10^{-3}	4.34×10^{-6}		3.72×10^{-1}
ST Wall	5.32×10^{-1}	7.69×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		5.32×10^{-1}
SI Wall	5.28×10^{-1}	1.68×10^{-4}	5.58×10^{-8}	5.50×10^{-9}		5.28×10^{-1}
ULI Wall	6.55×10^{-1}	2.67×10^{-4}	3.77×10^{-4}	5.04×10^{-5}		6.56×10^{-1}
LLI Wall	5.83×10^{-1}	4.33×10^{-4}	1.15×10^{-3}	1.43×10^{-4}	3.61×10^{-1}	9.46×10^{-1}
Kidneys	4.77×10^{-1}	8.07×10^{-5}	4.47×10^{-4}	1.83×10^{-6}	5.26×10^{-1}	1.00
Liver	5.28×10^{-1}	2.31×10^{-4}	7.14×10^{-8}	6.38×10^{-9}	8.47×10^{-1}	1.38
Pancreas	5.71×10^{-1}	6.81×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		5.71×10^{-1}
Spleen	5.85×10^{-1}	7.58×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		5.85×10^{-1}
Thymus	4.85×10^{-1}	8.47×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		4.85×10^{-1}
Uterus	4.73×10^{-1}	6.91×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		4.73×10^{-1}
Adrenals	4.79×10^{-1}	8.05×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		4.79×10^{-1}
Blad. Wall	5.70×10^{-1}	7.80×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		5.70×10^{-1}
Skin	6.63×10^{-1}	1.20×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	4.15×10^{-1}	1.08
Remainder	5.50×10^{-2}	1.05×10^{-4}	0.00	0.00		5.51×10^{-2}
E.W.B.D.	6.87×10^{-1}	7.64×10^{-4}	5.60×10^{-3}	3.47×10^{-5}	5.26×10^{-1}	1.22
			CHILD			
Gonads	4.85×10^{-1}	1.83×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		4.85×10^{-1}
Breast	5.00×10^{-1}	1.62×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		5.00×10^{-1}
R. Marrow	1.71×10^{-1}	9.77×10^{-4}	5.54×10^{-5}	2.34×10^{-7}	1.81	1.98
Lungs	5.19×10^{-1}	2.79×10^{-4}	2.10×10^{-2}	8.77×10^{-5}	4.24×10^{-1}	9.64×10^{-1}
Thyroid	3.47	6.13×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	2.16	5.64
Bone Surface	2.73×10^{-1}	2.27×10^{-3}	8.60×10^{-4}	3.52×10^{-6}		2.76×10^{-1}
ST Wall	3.89×10^{-1}	7.37×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		3.89×10^{-1}
SI Wall	3.86×10^{-1}	1.46×10^{-4}	5.58×10^{-8}	5.50×10^{-9}		3.86×10^{-1}
ULI Wall	5.07×10^{-1}	2.22×10^{-4}	3.05×10^{-4}	3.47×10^{-5}		5.08×10^{-1}

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			CHILD (continued)			
LLI Wall	4.23×10^{-1}	3.43×10^{-4}	9.36×10^{-4}	9.87×10^{-5}	4.15×10^{-1}	8.39×10^{-1}
Kidneys	3.46×10^{-1}	7.75×10^{-5}	3.63×10^{-4}	1.49×10^{-6}	6.91×10^{-1}	1.04
Liver	3.78×10^{-1}	1.47×10^{-4}	7.14×10^{-8}	6.38×10^{-9}	1.25	1.63
Pancreas	4.40×10^{-1}	6.49×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		4.40×10^{-1}
Spleen	4.54×10^{-1}	7.26×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		4.54×10^{-1}
Thymus	3.54×10^{-1}	8.15×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		3.54×10^{-1}
Uterus	3.42×10^{-1}	6.59×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		3.42×10^{-1}
Adrenals	3.48×10^{-1}	7.73×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		3.48×10^{-1}
Bladder Wall	4.39×10^{-1}	7.48×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		4.39×10^{-1}
Skin	5.32×10^{-1}	1.17×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	4.71×10^{-1}	1.00
Remainder	4.38×10^{-2}	8.49×10^{-5}	0.00	0.00		4.39×10^{-2}
E.W.B.D.	5.36×10^{-1}	6.23×10^{-4}	2.64×10^{-3}	1.88×10^{-5}	5.37×10^{-1}	1.08
			INFANT			
Gonads	2.11×10^{-1}	1.19×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		2.11×10^{-1}
Breast	2.26×10^{-1}	1.07×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		2.26×10^{-1}
R. Marrow	1.32×10^{-1}	1.23×10^{-4}	9.28×10^{-7}	1.02×10^{-8}	1.06	1.19
Lungs	2.30×10^{-1}	1.41×10^{-4}	7.93×10^{-3}	3.32×10^{-5}	4.18×10^{-1}	6.56×10^{-1}
Thyroid	6.86×10^{-1}	1.05×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	4.11	4.80
Bone Surface	1.65×10^{-1}	2.68×10^{-4}	1.35×10^{-5}	6.53×10^{-8}		1.65×10^{-1}
ST Wall	1.16×10^{-1}	6.79×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		1.16×10^{-1}
SI Wall	1.12×10^{-1}	8.27×10^{-5}	5.58×10^{-8}	5.50×10^{-9}		1.12×10^{-1}
ULI Wall	2.20×10^{-1}	9.34×10^{-5}	4.81×10^{-6}	2.64×10^{-8}		2.20×10^{-1}
LLI Wall	1.12×10^{-1}	8.93×10^{-5}	1.46×10^{-5}	6.68×10^{-8}	3.38×10^{-1}	4.50×10^{-1}
Kidneys	1.04×10^{-1}	7.17×10^{-5}	5.70×10^{-6}	2.96×10^{-8}	5.49×10^{-1}	6.53×10^{-1}
Liver	1.20×10^{-1}	9.43×10^{-5}	7.14×10^{-8}	6.38×10^{-9}	1.09	1.21

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			INFANT (continued)			
Pancreas	1.97×10^{-1}	5.91×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		1.97×10^{-1}
Spleen	2.11×10^{-1}	6.68×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		2.11×10^{-1}
Thymus	1.11×10^{-1}	7.57×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		1.11×10^{-1}
Uterus	9.91×10^{-2}	6.01×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		9.92×10^{-2}
Adrenals	1.06×10^{-1}	7.15×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		1.06×10^{-1}
Bladder Wall	1.97×10^{-1}	6.90×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		1.97×10^{-1}
Skin	2.90×10^{-1}	1.11×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	3.97×10^{-1}	6.87×10^{-1}
Remainder	1.28×10^{-2}	2.31×10^{-5}	0.00	0.00		1.28×10^{-2}
E.W.B.D.	2.22×10^{-1}	2.27×10^{-4}	9.55×10^{-4}	4.01×10^{-6}	3.92×10^{-1}	6.15×10^{-1}

a. There are no radioactive liquid releases during normal FPF operations.
b. Doses from Georgia Power Company, 1985.

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year)

	Facilities						
Receptor organ	SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities	
			ADULT				
Gonads	1.13	4.38×10^{-3}	3.88×10^{-7}			1.13	
Breast	9.65×10^{-1}	4.38×10^{-3}	1.97×10^{-6}			9.69×10^{-1}	
R. Marrow	9.26×10^{-1}	4.99×10^{-6}	2.76×10^{-4}		6.15×10^{-1}	1.54	BC-22
Lungs	1.01	4.38×10^{-3}	9.54×10^{-8}		3.02×10^{-1}	1.32	
Thyroid	1.01	5.55×10^{-3}	1.27×10^{-7}		6.89×10^{-1}	1.70	
Bone Surface	9.86×10^{-1}	7.37×10^{-6}	4.29×10^{-3}			9.90×10^{-1}	
ST Wall	2.19×10^{-1}	4.73×10^{-3}	6.12×10^{-8}			2.24×10^{-1}	
SI Wall	1.16	4.37×10^{-3}	4.01×10^{-8}			1.16	
ULI Wall	4.84×10^{-1}	4.42×10^{-3}	1.52×10^{-3}			4.90×10^{-1}	
LLI Wall	1.18	4.49×10^{-3}	4.67×10^{-3}		3.22×10^{-1}	1.51	
Kidneys	2.20×10^{-1}	4.40×10^{-3}	1.81×10^{-3}		5.49×10^{-1}	7.75×10^{-1}	
Liver	2.19×10^{-1}	4.39×10^{-3}	5.13×10^{-8}		1.27	1.49	
Pancreas	2.19×10^{-1}	4.38×10^{-3}	6.10×10^{-8}			2.23×10^{-1}	
Spleen	2.19×10^{-1}	4.38×10^{-3}	6.02×10^{-8}			2.23×10^{-1}	
Thymus	2.19×10^{-1}	4.37×10^{-3}	6.49×10^{-8}			2.23×10^{-1}	
Uterus	2.19×10^{-1}	4.37×10^{-3}	3.86×10^{-8}			2.23×10^{-1}	
Adrenals	2.19×10^{-1}	4.37×10^{-3}	9.15×10^{-8}			2.23×10^{-1}	
Blad. Wall	2.19×10^{-1}	4.37×10^{-3}	5.06×10^{-8}			2.23×10^{-1}	
Skin	2.20×10^{-1}	4.37×10^{-3}	3.50×10^{-6}		3.06×10^{-3}	2.27×10^{-1}	
Remainder	9.87×10^{-1}	3.15×10^{-9}				9.87×10^{-1}	BC-22
E.W.B.D.	1.08	3.67×10^{-3}	6.49×10^{-4}		9.85×10^{-1}	2.07	
			TEEN				
Gonads	8.47×10^{-1}	3.07×10^{-3}	1.30×10^{-6}			8.50×10^{-1}	
Breast	7.25×10^{-1}	3.07×10^{-3}	6.60×10^{-6}			7.28×10^{-1}	
R. Marrow	7.05×10^{-1}	3.72×10^{-6}	1.95×10^{-4}		6.59×10^{-1}	1.36	
Lungs	7.61×10^{-1}	3.07×10^{-3}	3.20×10^{-7}		2.82×10^{-1}	1.05	
Thyroid	7.62×10^{-1}	3.92×10^{-3}	4.24×10^{-7}		5.89×10^{-1}	1.35	
Bone Surface	7.47×10^{-1}	5.48×10^{-6}	3.02×10^{-3}			7.50×10^{-1}	

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

	Facilities					
Receptor organ	SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			TEEN (continued)			
ST Wall	1.56×10^{-1}	3.32×10^{-3}	2.05×10^{-7}			1.59×10^{-1}
SI Wall	8.69×10^{-1}	3.07×10^{-3}	1.34×10^{-7}			8.72×10^{-1}
ULI Wall	3.57×10^{-1}	3.10×10^{-3}	1.07×10^{-3}			3.61×10^{-1}
LLI Wall	8.88×10^{-1}	3.15×10^{-3}	3.29×10^{-3}		2.41×10^{-1}	1.14
Kidneys	1.56×10^{-1}	3.09×10^{-3}	1.28×10^{-3}		5.14×10^{-1}	6.74×10^{-1}
Liver	1.56×10^{-1}	3.08×10^{-3}	1.72×10^{-7}		1.25	1.41
Pancreas	1.55×10^{-1}	3.07×10^{-3}	2.04×10^{-7}			1.58×10^{-1}
Spleen	1.56×10^{-1}	3.07×10^{-3}	2.02×10^{-7}			1.59×10^{-1}
Thymus	1.56×10^{-1}	3.07×10^{-3}	2.17×10^{-7}			1.59×10^{-1}
Uterus	1.55×10^{-1}	3.07×10^{-3}	1.29×10^{-7}			1.58×10^{-1}
Adrenals	1.56×10^{-1}	3.07×10^{-3}	3.07×10^{-7}			1.59×10^{-1}
Bladder Wall	1.56×10^{-1}	3.07×10^{-3}	1.70×10^{-7}			1.59×10^{-1}
Skin	1.58×10^{-1}	3.07×10^{-3}	1.17×10^{-5}		1.71×10^{-2}	1.78×10^{-1}
Remainder	7.51×10^{-1}	2.40×10^{-9}				7.51×10^{-1}
E.W.B.D.	8.15×10^{-1}	2.58×10^{-3}	4.58×10^{-4}		6.01×10^{-1}	1.42
			CHILD			
Gonads	4.51×10^{-1}	2.99×10^{-3}	2.72×10^{-7}			4.54×10^{-1}
Breast	3.98×10^{-1}	2.99×10^{-3}	1.38×10^{-6}			4.01×10^{-1}
R. Marrow	3.23×10^{-1}	2.21×10^{-6}	1.84×10^{-4}		8.19×10^{-1}	1.14
Lungs	4.14×10^{-1}	2.99×10^{-3}	6.68×10^{-8}		3.56×10^{-1}	7.73×10^{-1}
Thyroid	4.14×10^{-1}	3.64×10^{-3}	8.87×10^{-8}		1.14	1.56
Bone Surface	3.61×10^{-1}	3.67×10^{-6}	2.86×10^{-3}			3.64×10^{-1}
ST Wall	1.50×10^{-1}	3.18×10^{-3}	4.29×10^{-8}			1.53×10^{-1}
SI Wall	4.61×10^{-1}	2.99×10^{-3}	2.80×10^{-8}			4.64×10^{-1}
ULI Wall	2.40×10^{-1}	3.01×10^{-3}	1.02×10^{-3}			2.44×10^{-1}
LLI Wall	4.76×10^{-1}	3.05×10^{-3}	3.12×10^{-3}		2.84×10^{-1}	7.66×10^{-1}

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			CHILD (continued)			
Kidneys	1.50×10^{-1}	3.00×10^{-3}	1.21×10^{-3}		5.67×10^{-1}	7.21×10^{-1}
Liver	1.50×10^{-1}	3.00×10^{-3}	3.59×10^{-8}		1.23	1.38
Pancreas	1.50×10^{-1}	2.99×10^{-3}	4.27×10^{-8}			1.53×10^{-1}
Spleen	1.50×10^{-1}	2.99×10^{-3}	4.21×10^{-8}			1.53×10^{-1}
Thymus	1.50×10^{-1}	2.99×10^{-3}	4.54×10^{-8}			1.53×10^{-1}
Uterus	1.50×10^{-1}	2.99×10^{-3}	2.71×10^{-8}			1.53×10^{-1}
Adrenals	1.50×10^{-1}	2.99×10^{-3}	6.41×10^{-8}			1.53×10^{-1}
Bladder Wall	1.50×10^{-1}	2.99×10^{-3}	3.55×10^{-8}			1.53×10^{-1}
Skin	1.50×10^{-1}	2.99×10^{-3}	2.45×10^{-6}		3.58×10^{-3}	1.57×10^{-1}
Remainder	3.28×10^{-1}	1.05×10^{-9}				3.28×10^{-1}
E.W.B.D.	4.25×10^{-1}	2.50×10^{-3}	4.33×10^{-4}		4.32×10^{-1}	8.60×10^{-1}
			INFANT			
Gonads	9.76×10^{-2}	1.90×10^{-3}				9.95×10^{-2}
Breast	9.71×10^{-2}	1.90×10^{-3}				4.90×10^{-2}
R. Marrow	2.13×10^{-2}	6.89×10^{-7}	1.14×10^{-4}		3.39×10^{-2}	5.53×10^{-2}
Lungs	9.72×10^{-2}	1.90×10^{-3}			2.39×10^{-1}	3.38×10^{-2}
Thyroid	9.72×10^{-2}	2.21×10^{-3}			1.42	1.52
Bone Surface	4.45×10^{-2}	1.51×10^{-6}	1.77×10^{-3}			4.63×10^{-2}
ST Wall	9.47×10^{-2}	1.99×10^{-3}				9.67×10^{-2}
SI Wall	9.77×10^{-2}	1.90×10^{-3}				9.96×10^{-2}
ULI Wall	9.84×10^{-2}	1.91×10^{-3}	6.31×10^{-4}			1.01×10^{-1}
LLI Wall	1.06×10^{-1}	1.93×10^{-3}	1.93×10^{-3}		2.39×10^{-1}	3.49×10^{-1}
Kidneys	9.49×10^{-2}	1.90×10^{-3}	7.49×10^{-4}		2.51×10^{-1}	3.49×10^{-1}
Liver	9.48×10^{-2}	1.90×10^{-3}			2.82×10^{-1}	3.79×10^{-1}
Pancreas	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Spleen	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}

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Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPF[a]	Vogtle[b]	
INFANT (continued)						
Thymus	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Uterus	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Adrenals	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Bladder Wall	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Skin	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Remainder	3.19×10^{-3}	1.01×10^{-11}				3.19×10^{-3}
E.W.B.D.	8.51×10^{-2}	1.58×10^{-3}	2.68×10^{-4}		2.42×10^{-1}	3.29×10^{-1}

a. There are no radioactive liquid releases during normal FPF operations.
b. Doses from Georgia Power Company, 1985.

Table G-31. Annual Maximum Individual Doses from Combined Atmospheric and Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year)

	Total from all facilities			
Receptor organ	Adult	Teen	Child	Infant
Gonads	1.72	1.48	9.39×10^{-1}	3.11×10^{-1}
Breast	1.57	1.37	9.01×10^{-1}	3.25×10^{-1}
R. Marrow	2.29	2.30	3.21	1.25
Lungs	2.35	2.15	1.74	9.94×10^{-1}
Thyroid	6.48	6.95	7.19	6.32
Bone Surface	1.35	1.12	6.40×10^{-1}	2.12×10^{-1}
ST Wall	7.12×10^{-1}	6.91×10^{-1}	5.42×10^{-1}	2.13×10^{-1}
SI Wall	1.65	1.40	8.50×10^{-1}	2.12×10^{-1}
ULI Wall	1.11	1.02	7.52×10^{-1}	3.21×10^{-1}
LLI Wall	2.42	2.08	1.61	7.99×10^{-1}
Kidneys	1.66	1.68	1.76	1.00
Liver	2.62	2.78	3.01	1.59
Pancreas	7.53×10^{-1}	7.29×10^{-1}	5.93×10^{-1}	2.94×10^{-1}
Spleen	7.67×10^{-1}	7.44×10^{-1}	6.07×10^{-1}	3.08×10^{-1}
Thymus	6.67×10^{-1}	6.44×10^{-1}	5.07×10^{-1}	2.08×10^{-1}
Uterus	6.55×10^{-1}	6.31×10^{-1}	4.95×10^{-1}	1.96×10^{-1}
Adrenals	6.62×10^{-1}	6.38×10^{-1}	5.01×10^{-1}	2.03×10^{-1}
Bladder Wall	7.53×10^{-1}	7.29×10^{-1}	5.92×10^{-1}	2.94×10^{-1}
Skin	1.25	1.26	1.16	7.84×10^{-1}
Remainder	1.04	8.06×10^{-1}	3.72×10^{-1}	1.60×10^{-2}
E.W.B.D.	3.25	2.64	1.94	9.44×10^{-1}

Table G-32. Annual Collective Doses from Atmospheric and Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Person-Rem Per Year)

Receptor organ	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			ATMOSPHERIC			
Gonads	4.12×10^{1}	3.52×10^{-2}	3.77×10^{-4}	7.98×10^{-6}		4.12×10^{1}
Breast	4.12×10^{1}	3.22×10^{-2}	1.91×10^{-3}	1.50×10^{-5}		4.12×10^{1}
R. Marrow	1.04×10^{1}	8.03×10^{-2}	3.02×10^{-3}	1.68×10^{-5}	3.24×10^{-1}	1.08×10^{1}
Lungs	4.87×10^{1}	6.41×10^{-2}	6.14	2.57×10^{-2}	4.82×10^{-1}	5.54×10^{1}
Thyroid	3.58×10^{2}	6.64×10^{-1}	1.23×10^{-4}	6.75×10^{-6}	6.12×10^{-1}	3.59×10^{2}
Bone Surface	3.02×10^{1}	2.26×10^{-1}	4.63×10^{-2}	1.96×10^{-4}		3.05×10^{1}
ST Wall	3.67×10^{1}	2.16×10^{-2}	5.94×10^{-5}	4.43×10^{-6}		3.67×10^{1}
SI Wall	3.62×10^{1}	2.34×10^{-2}	3.89×10^{-5}	3.83×10^{-6}		3.62×10^{1}
ULI Wall	4.25×10^{1}	3.28×10^{-2}	1.65×10^{-2}	4.15×10^{-3}		4.26×10^{1}
LLI Wall	4.07×10^{1}	4.25×10^{-2}	5.03×10^{-2}	1.18×10^{-2}	4.76×10^{-1}	4.13×10^{1}
Kidneys	3.41×10^{1}	2.30×10^{-2}	1.95×10^{-2}	8.42×10^{-5}	4.79×10^{-1}	3.46×10^{1}
Liver	3.91×10^{1}	4.21×10^{-2}	4.97×10^{-5}	4.44×10^{-6}	4.83×10^{-1}	3.96×10^{1}
Pancreas	3.77×10^{1}	1.88×10^{-2}	5.92×10^{-5}	3.81×10^{-6}		3.77×10^{1}
Spleen	3.86×10^{1}	2.13×10^{-2}	5.84×10^{-5}	4.45×10^{-6}		3.86×10^{1}
Thymus	3.42×10^{1}	2.42×10^{-2}	6.29×10^{-5}	5.17×10^{-6}		3.42×10^{1}
Uterus	3.34×10^{1}	1.91×10^{-2}	3.75×10^{-5}	3.89×10^{-6}		3.34×10^{1}
Adrenals	3.41×10^{1}	2.28×10^{-2}	8.88×10^{-5}	4.99×10^{-6}		3.41×10^{1}
Bladder Wall	3.77×10^{1}	2.20×10^{-2}	4.91×10^{-5}	4.45×10^{-6}		3.77×10^{1}
Skin	4.27×10^{1}	3.63×10^{-2}	3.39×10^{-3}	2.13×10^{-5}	7.58×10^{-1}	4.35×10^{1}
Remainder	2.77	4.22×10^{-3}				2.77
E.W.B.D.	4.78×10^{1}	9.37×10^{-2}	7.44×10^{-1}	4.07×10^{-3}	4.80×10^{-1}	4.91×10^{1}
			LIQUID			
Gonads	3.52×10^{1}	6.50×10^{-1}	3.88×10^{-6}			3.59×10^{1}
Breast	3.47×10^{1}	6.50×10^{-1}	1.97×10^{-5}			3.53×10^{1}
R. Marrow	9.02	2.47×10^{-4}	3.93×10^{-2}			9.06
Lungs	3.48×10^{1}	6.50×10^{-1}	9.54×10^{-7}			3.55×10^{1}
Thyroid	3.48×10^{1}	7.60×10^{-1}	1.27×10^{-6}			3.56×10^{1}
Bone Surface	1.71×10^{1}	5.28×10^{-4}	6.10×10^{-1}			1.77×10^{1}

Table G-32. Annual Collective Doses from Atmospheric and Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Person-Rem Per Year) (continued)

Receptor organ	Facilities: SRP	DWPF	FMF	FPF[a]	Vogtle[b]	Total from all facilities
			LIQUID (continued)			
ST Wall	3.24×10^{1}	6.83×10^{-1}	6.12×10^{-7}			3.31×10^{1}
SI Wall	3.53×10^{1}	6.50×10^{-1}	4.01×10^{-7}			3.60×10^{1}
ULI Wall	3.42×10^{1}	6.56×10^{-1}	2.16×10^{-1}			3.51×10^{1}
LLI Wall	3.81×10^{1}	6.62×10^{-1}	6.63×10^{-1}			3.95×10^{1}
Kidneys	3.26×10^{1}	6.52×10^{-1}	2.57×10^{-1}			3.35×10^{1}
Liver	3.24×10^{1}	6.52×10^{-1}	5.13×10^{-7}			3.31×10^{1}
Pancreas	3.24×10^{1}	6.52×10^{-1}	6.10×10^{-7}			3.31×10^{1}
Spleen	3.24×10^{1}	6.52×10^{-1}	6.02×10^{-7}			3.31×10^{1}
Thymus	3.24×10^{1}	6.50×10^{-1}	6.49×10^{-7}			3.31×10^{1}
Uterus	3.24×10^{1}	6.50×10^{-1}	3.86×10^{-7}			3.31×10^{1}
Adrenals	3.24×10^{1}	6.50×10^{-1}	9.15×10^{-7}			3.31×10^{1}
Bladder Wall	3.24×10^{1}	6.50×10^{-1}	5.06×10^{-7}			3.31×10^{1}
Skin	3.24×10^{1}	6.50×10^{-1}	3.05×10^{-5}			3.31×10^{1}
Remainder	2.94	9.41×10^{-9}				2.94
E.W.B.D.	3.09×10^{1}	5.42×10^{-1}	9.21×10^{-2}			3.15×10^{1}
			COMBINED ATMOSPHERIC AND LIQUID			
Gonads						7.71×10^{1}
Breast						7.66×10^{1}
R. Marrow						1.99×10^{1}
Lungs						9.09×10^{1}
Thyroid						3.95×10^{2}
Bone Surface						4.81×10^{1}
ST Wall						6.98×10^{1}
SI Wall						7.22×10^{1}
ULI Wall						7.77×10^{1}
LLI Wall						8.07×10^{1}

Table G-32. Annual Collective Doses from Atmospheric and Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Person-Rem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPF[a]	Vogtle[b]	
COMBINED ATMOSPHERIC AND LIQUID (continued)						
Kidneys						6.82×10^{1}
Liver						7.27×10^{1}
Pancreas						7.08×10^{1}
Spleen						7.17×10^{1}
Thymus						6.73×10^{1}
Uterus						6.65×10^{1}
Adrenals						6.72×10^{1}
Bladder Wall						7.08×10^{1}
Skin						7.66×10^{1}
Remainder						5.72
E.W.B.D.						8.07×10^{1}

a. There are no radioactive liquid releases during normal FPF operations.
b. Doses from Georgia Power Company, 1985; liquid dose is "negligible."

Table G-33. Effective Whole-Body Doses to the Maximally Exposed Individual from Cumulative Atmospheric Releases, Comparison of Cooling Alternatives (Millirem per Year)

Cooling alternative	Adult	Teen	Child	Infant
Present cooling system	1.18	1.22	1.08	6.15×10^{-1}
Once-through cooling towers (K- and C-Reactors)	1.18	1.22	1.08	6.15×10^{-1}
Recirculating cooling towers (K- and C-Reactors)	1.18	1.22	1.08	6.15×10^{-1}

Table G-34. Effective Whole-Body Doses to the Maximally Exposed Individual from Cumulative Liquid Releases to Savannah River, Comparison of Cooling Alternatives (Millirem per Year)

Cooling alternative	Adult	Teen	Child	Infant	
Present cooling system	2.07	1.42	8.60×10^{-1}	3.29×10^{-1}	
Once-through cooling towers (K- and C-Reactors)	2.07	1.42	8.60×10^{-1}	3.29×10^{-1}	
Recirculating cooling towers (K- and C-Reactors)	1.88	1.27	7.95×10^{-1}	3.27×10^{-1}	BC-22

Table G-35. Effective Whole-Body Doses to the Maximally Exposed Individual from Cumulative Atmospheric and Liquid Releases, Comparison of Cooling Alternatives (Millirem per Year)

Cooling alternative	Adult	Teen	Child	Infant	
Present cooling system	3.25	2.64	1.94	9.44×10^{-1}	
Once-through cooling towers (K- and C-Reactors)	3.25	2.64	1.94	9.44×10^{-1}	
Recirculating cooling towers (K- and C-Reactors)	3.06	2.49	1.88	9.42×10^{-1}	BC-22

The BEIR III report identifies three categories of radiation-induced human health effects: (1) cancer, (2) genetic disorders, and (3) somatic effects other than cancer. The committee believes cancer induction is the most important effect of low-dose radiation. In this context, "low dose" refers to

Table G-36. Comparison of 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere with Present Cooling Systems: Once-Through Cooling Towers for K- and C-Reactors and Recirculating Cooling Towers for K- and C-Reactors (Person-Rem per Year)

Cooling alternative	Effective whole body
Present cooling systems (no action)	4.91×10^1
Once-through cooling towers	4.91×10^1
Recirculating cooling towers	4.92×10^1

Table G-37. Comparison of Collective Dose from Reduced Liquid Releases to Savannah River with Present Cooling Systems: Once-Through Cooling Towers for K- and C-Reactors and Recirculating Cooling Towers for K- and C-Reactors (Person-Rem per Year)

Cooling alternative	Effective whole body
Present cooling systems (no action)	3.15×10^1
Once-through cooling towers	3.14×10^1
BC-22 Recirculating cooling towers	3.03×10^1

Table G-38. Comparison of Collective Dose from Increased Atmospheric Releases and Reduced Liquid Releases with Present Cooling Systems: Once-Through Cooling Towers for K- and C-Reactors and Recirculating Cooling Towers for K- and C-Reactors (Person-Rem per Year)

Cooling alternative	Effective whole body
Present cooling systems (no action)	8.07×10^1
Once-through cooling towers	8.05×10^1
BC-22 Recirculating cooling towers	7.96×10^1

doses as high as a few rads per person per year. Natural background radiation ranges from 0.1 to 0.2 rad per person per year. Genetic effects of low-level radiation have been well documented and are addressed in detail in the BEIR III report. Somatic effects other than cancer include cataract induction and fertility impairment. The BEIR III report concludes that low-dose exposure of human populations does not increase the risk of somatic effects other than cancer and developmental changes in unborn children. The report also indicates that developmental changes in unborn children are probably not caused by radiation at or below natural background levels. For these reasons, only cancer and genetic disorders are considered in this analysis.

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

One radiation-induced cancer characteristic is that it takes a long time to develop, known as the latent period. Leukemia has a characteristically short latent period (less than 25 years), while other cancers can have latent periods for as long as the life span of an individual. Because only about 35 years of cancer data have been collected on the survivors of atomic bomb blasts, the data do not account for all the cancers that might develop because of the bombs' radiation. Two projection models have been developed to account for these future cancer deaths: (1) the absolute risk projection model, which assumes that the cancer rate (risk per year) observed since the atomic bomb blasts will continue throughout the life spans of those exposed; and (2) the relative-risk model, which assumes the excess radiation-induced risk is proportional to the natural incidence of cancer with age. The relative-risk model results in cancer-risk estimates greater than those predicted by the absolute model. However, the BEIR III report states that the absolute model is generally more applicable to most forms of cancer. The cancer-risk estimates used represent an average of those calculated using the absolute- and relative-risk models.

Only low-LET radiation is associated with the changes of radioactivity released to the environment resulting from the implementation of the alternative cooling water systems. For existing operations, the contribution of high-LET radiation has been found to be much less than that from low-LET radiation.

Health-effects estimators for low-LET radiation were derived for use in estimating health effects based on an evaluation of the data presented in the BEIR III report. The resulting health-effects estimators used in this document are summarized in Table G-39. They total 120 fatalities per million person-rem. The health-effects estimate for genetic effects used in this document is 257 genetic effects per million person-rem of radiation, received by the gonads.

These health-effects estimators are the best estimate of risk based on present data. The estimators could vary widely, depending on the models used. The low-LET estimators could range from near 0 to as high as 400 per million person-rem. For genetic effects, the risk estimator could range from 60 to 1100 per million person-rem.

Table G-39. Health Effects Estimators Used in the Evaluation of Radiation Health Effects

	Cancer fatalities per million person-rem
Organ/cancer	Low-LET radiation[a,b]
Leukemia and bone cancer[c]	20
Lung	28
Liver	6.5
Kidney and bladder[c]	3.2
Intestinal tract[c]	5.3
Thyroid	6.9
Breast	9.8
Pancreas	7.9
Stomach	11
Other	19
Total	120

a. LET = linear energy transfer.
b. The arithmetic average of the absolute and relative model values has been used. In addition, the linear-quadratic model has been assumed.
c. For multiple organs, the health effects estimators are multiplied by the organ that produces the highest collective organ dose.

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APPENDIX H

SCOPING COMMENTS AND RESPONSES

Pursuant to the National Environmental Policy Act of 1969, the U.S. Department of Energy (DOE) announced its intent to prepare an environmental impact statement (EIS) on cooling water systems for C- and K-Reactors and the D-Area coal-fired powerhouse at the Savannah River Plant (SRP) in the Federal Register on July 29, 1985 (50 FR 145). The Notice of Intent solicited comments and suggestions from interested agencies, organizations, and the general public for consideration in preparing the EIS. Comments were received by mail and at a scoping meeting held in Aiken, South Carolina, on August 19, 1985. Written comments were received until August 31, 1985.

During the public comment period, 12 individuals, agencies, and organizations presented written or oral comments--two individuals provided written comments at one of the public scoping meetings and more detailed written comments following the scoping meetings. Individuals, agencies, and organizations providing comments are listed on Table H-1.

The comments received at the public scoping meeting or in writing during the public comment period are presented in Table H-2. Table H-2 also provides responses to the comments raised by individuals, agencies, and organizations on the scope of the EIS.

Table H-3 provides a summary listing of the topics contained in the comments, with references to the appropriate chapters and sections of the proposed EIS outline.

Copies of the oral statements and scoping letters have been made available for public inspection at the DOE Public Reading Room located at the University Library, 2nd Floor, University of South Carolina, Aiken Campus, University Parkway, Aiken, South Carolina, and the Freedom of Information Reading Room, Room 1E-190, Forrestal Building, 1000 Independence Avenue, SW, Washington, DC.

Table H-1. Index of Agencies, Organizations, and Individuals Submitting Scoping Comments

Designation	Agency, organization, or individual	Page
A	Sheppard N. Moore, Chief of NEPA Review Staff for Region IV, U.S. Environmental Protection Agency	H-3
B	Bart Ruiter, representing the South Carolina Department of Health and Environmental Control	H-5
C	Mr. W. P. Bebbington	H-6
D	Frances Hart, representing the Energy Research Foundation	H-10
E	Mr. Karl Herde	H-12
F	Ms. Dorcas Elledge	H-15
G	Jean Robinson, on behalf of W. F. Lawless	H-16
H	Mr. Sam Schillaci	H-19
I	Mr. William McDaniel	H-20
J	Zoe G. Tsagos, representing the League of Women Voters in Northern Beaufort County	H-24
K	Roger L. Banks, representing the South Carolina Office of the U.S. Department of the Interior, Fish and Wildlife Service	H-26
L	J. W. Morris	H-28

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	STATEMENT OF MR. SHEPPARD MOORE Chief, NEPA Review Staff Environmental Protection Agency Region IV Atlanta, Georgia	
	My name is Sheppard N. Moore. I'm chief of the NEPA Review Staff at Region IV, U.S. Environmental Protection Agency, Atlanta, Georgia. We at EPA are pleased to see that the Department of Energy is preparing an environmental impact statement as part of the decisionmaking process concerning cooling water systems at the Savannah River Plant. EPA has a long history of involvement with environmental matters at SRP, and we look forward to working with DOE and the State of South Carolina during the preparation of this EIS.	
A-1	Relevant to the proposed EIS, EPA believes that the environmental and nonenvironmental issues identified by DOE in their news announcement dated July 29th, 1985, for this EIS are important. Of the issues listed by DOE, EPA is particularly concerned with potential wetland impacts, water quality issues, and radionuclide effects as well as fishery implications, air quality, drinking water quality, and the cumulative effects. Recommended additions to the DOE list are possible floodplain, groundwater, and noise impacts.	A discussion of impacts associated with floodplain/wetlands, groundwater, and noise will be presented in Chapter 4 of the EIS. Appendix F will present a wetlands/floodplains assessment pursuant to Executive Orders 11988 and 11990, and DOE's regulations for compliance with floodplain/wetlands environmental review requirements (10 CFR 1022).
A-2	Since one of our major concerns at EPA is the protection of wetlands, we wish to emphasize that any wetland acreage that may be lost should be quantified and characterized for each action alternative. Avoidance of impacts and mitigation for unavoidable impacts should be addressed for wetlands as well as other areas.	Wetland acreage that will be gained or lost will be quantified and characterized for each cooling water alternative in Chapter 4 and Appendix F of the EIS.
A-3	We appreciate the numerous alternatives considered by DOE for the cooling effluent of C- and K-Reactors and the D-Area coal-fired power plant. In our view, at least two and preferably three feasible action alternatives should be addressed in the EIS in similar detail for each facility so that the EIS will be a decisionmaking document and a final preferred alternative can be selected. Similarly, the no-action alternative should be thoroughly addressed.	Chapter 4 of the EIS will discuss the environmental impacts of the reasonable cooling water alternatives for the C-Reactor, K-Reactor, and the D-Area coal-fired powerhouse. In addition, the no-action alternative will be addressed.
	I appreciate the opportunity to be here. I guess my main purpose is to hear what you and the others have to say. Thank you.	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	ADDITIONAL STATEMENTS OF MR. MOORE EVENING PUBLIC SCOPING MEETING	
	Since I spoke this morning and gave you a copy of my written statement, I won't repeat that. I do want to say for the people that are here this evening that were not here this morning that I appreciate the opportunity to be here. I want to thank you for inviting EPA and the State to participate in this meeting.	
	I would like to add one thing to what Pat had to say about the slide on NEPA. It's true that NEPA requires that the Federal decisionmakers factor the environment into their decision-making process, but I think the really important benefit from NEPA is the public involvement.	
	I'm a little disappointed at the number of people here tonight, and I would like to encourage anyone that is here that has something to say that from experience I can say that government does listen to what people say. That's what NEPA has done for us is provided the mechanism for public involvement and how we, the government, carry out their business.	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	STATEMENT OF MR. BART RUITER SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL	
	My name is Bart Ruiter. I am with the Department of Health and Environmental Control.	
	On January 3, 1984, the South Carolina Department of Health and Environmental Control entered into a Consent Order with the United States Department of Energy Savannah River Plant. This Consent Order allowed the Savannah River Plant temperature requirements in the National Pollutant Discharge Elimination System (NPDES) permit to be temporarily superseded by those requirements contained in the Order. Outfalls affected by this Order are specifically C-Reactor, P-Reactor, K-Reactor, and D-Area powerhouse.	
	In this Consent Order, SRP agreed to, one, complete comprehensive studies on the thermal effects of all operations at the Savannah River Plant upon the waters of the State of South Carolina; two, complete and submit the thermal mitigation studies to DHEC within nine months of the signing of the Consent Order; three, implement the alternative approved by DHEC under a schedule to be established by DHEC in a subsequent order; and four, submit and actively support appropriate funding requests to accomplish any actions resulting from the thermal studies.	
	To date, we are currently near completion in establishing an implementation schedule under an amendment to the Consent Order with SRP which takes into account the National Environmental Policy Act process.	
B-1	As SRP proceeds through this NEPA process and eventually selects a final alternative for the mitigation of thermal restrictions on the above outfalls, the selected alternatives for C-Reactor, K-Reactor, P-Reactor, and D-Area powerhouse must meet the specified limitations of the NPDES permit and/or temperature limits that are consistent with the requirements or intent of the Clean Water Act and the South Carolina Water Classifications and Standards.	The ability of each of the cooling water alternatives considered in the EIS to meet applicable regulatory requirements will be discussed in Chapters 2 and 4.
	Thank you for allowing the Department to express its comments.	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	STATEMENT OF MR. W. P. BEBBINGTON	
	I have submitted a letter containing more specific comments than I intend to make here. I wish, now, to direct the attention of the audience and the other participants to some important general facts regarding the Savannah River Plant and its history.	Comments noted.
	The 200,000-acre site was purchased with taxpayers' money in 1950 to ensure that the public would be adequately protected from possible harm from the nuclear operations within the site and that there would be adequate protection of the operations against incursions.	
	It was recognized at the outset that, while the operators could and would be expected to hold releases of radioactive and other undesirable wastes to levels that were as low as practical, very large amounts of heat would necessarily be discharged from the reactors. The heat would be released as heated water, and the Savannah River had to be protected against biological damage from it. By placing the reactors near the center of the site and allowing the water to flow to the river through the beds of existing small streams, the temperature of the water, when it entered the river, would be low enough to preclude damage.	
	To verify that there was no thermal damage to the river, Dr. Ruth Patrick and her team of limnologists from the Academy of Natural Sciences of Philadelphia were commissioned to determine exactly and comprehensively the condition of the river before plant startup and to monitor it carefully for changes while the plant operated. Dr. Patrick has stated repeatedly and unequivocally that thermal effluents from SRP have had no adverse effects on the river.	
	The streams that carry reactor cooling water to the river are small, rise on the site, and have no significant economic, recreational, or unique ecological values. The hot water has destroyed vegetation and discouraged animal life; but, as was demonstrated in Steel Creek after L-Reactor was shut down, the damage is not permanent.	
	Most of the land of the site is outside the restricted production areas. This land has not been neglected and allowed to deteriorate. Hundreds of millions of trees were planted and	

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	managed as a productive forest. The University of Georgia established there a field laboratory of ecology under the overall direction of Dr. Eugene P. Odum, one of the nation's most revered ecologists. Later, the site was designated as the first National Environmental Research Park. It has attracted students and faculty from many universities for summer and longer residences. A former director of the Savannah River Ecology Laboratory said, "If it hadn't been for AEC support, there wouldn't be a science of ecology." The well-protected site has become an important wildlife refuge.	
	After three decades of plant operation without public harm and with great ecological benefit, the State of South Carolina has intruded with costly, unnecessary, and indeed environmentally detrimental demands that can be met only at great public expense at a time when there is a terribly urgent need to reduce the federal deficit.	
	The cost of the L-Reactor lake project will not be 25 or 40 million dollars but, when delay times and productivity losses are taken into account, in the hundreds of millions of dollars. The reactor will never again operate as efficiently as it once did because the State has demanded that the cooling lake not be treated as such but as a natural recreational lake. This hearing is the beginning of proceedings aimed at applying to C- and K-Reactors and to the D-Area coal-fired powerhouse similarly costly and unnecessary changes.	
	I ask the State of South Carolina, in the interest of responsible concern for the American people, to withdraw its demands and allow SRP to continue its efficient, safe and environmentally benign operations. Failing this, I ask the Department of Energy to take no action as its decision and defend it vigorously up through the courts, if necessary.	
	Thank you very much.	

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	LETTER FROM MR. W. B. BEBBINGTON	
	Thank you for the opportunity to comment on the "Scoping of an Environmental Impact Statement on cooling-water systems at the Savannah River Plant."	Comments noted.
	It should be recognized at the outset that the important issues under consideration, here, are political and bureaucratic <u>not</u> environmental. There is, in the document [6450-01] that defines the purpose of the August 19 public meeting, no reference to past, present or potential future harm to the environment surrounding SRP caused by operations within it. The absence of such harmful effects has been documented in public reports of comprehensive routine and special scientific monitoring over the past quarter century of the plant's existence.	
	In 1950 about 200,000 acres of land was purchased by the United States government on which to build the Savannah River Plant. The large site was acquired to provide isolation of the production facilities and to ensure that those facilities would not harmfully affect surrounding private lands, and most importantly, not damage biologically the Savannah River. Accordingly, the facilities of greatest environmental concern, the reactors and separations plants, were sited near the center of the plant, several miles from the river and the boundary fences. The channels of insignificant streams that rise within the plant, streams that were not then, are not now, will not be in the future of any economic, recreational or unique ecological importance, were used to convey reactor cooling water to the river. The river was seen to be the most important natural resource that might be vulnerable to harm, and the Academy of Natural Sciences of Philadelphia under the direction of the eminent Limnologist, Dr. Ruth Patrick, was commissioned in 1951, years before plant startup, to monitor comprehensively the biological condition of the river. The work of ANSP continues, today, and Dr. Patrick has repeatedly and unequivocally stated that there has been no biological damage from the thermal effluents of SRP. Vegetation in the streambeds was damaged, to be sure, but not irrevocably as was shown by the recovery of Steele Creek during the years that L-Reactor was shut down.	
	The matters with which we are now concerned stem from the actions taken to refurbish and restart L-Reactor at SRP as	

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	authorized by Congress in 1980. Operation of the reactor was declared necessary by October 1983 to met the needs of national defense. The Department of Energy was obliged to meet this goal. The reactor was rehabilitated and brought up to the technological state of the other operating reactors with the intent to operate it as it had operated for fourteen years, previously, and as two other reactors, K and C, were continuing to operate. Near the end of 1982, anti-nuclear activist groups abetted by State officials instigated a succession of delays and ultimately, through a bit of Congressional trickery, the requirement that the cooling water from L-Reactor be passed through a new 1000-acre lake enroute to the Savannah River. Ostensibly, this lake was to forestall damage to "wetlands;" in fact it will permanently inundate most of the area of concern and destroy much productive forest in addition. The direct cost of the lake was to have been $25 million, but has risen to $40 million. The overall addition to the national deficit and cost to the taxpayers, taking into account delays, interest charges and permanent productivity losses will be in the hundreds of millions of dollars, with, on balance, a detrimental environmental effect. If the reactor starts up in October, as is now hoped, it will have been delayed two years. With regard to C and K reactors and the D-Area coal-fired power house, we are now at the point where the L-Reactor fiasco began more than three years ago. No existing environmental harm is alleged, only the need to comply with a "Consent Order" dated January 3, 1984, three decades after the beginning of safe, efficient and environmentally harmless operation of SRP. We taxpayers need to be protected against the squandering of more hundreds of millions of dollars merely to enhance the egos or further the special interests of politicians and activists. It is stated on page 7 of the notice of this meeting that, "As required by the Council on Environmental Quality regulations for implementing the National Environmental Policy Act, the EIS will also consider 'no action'." I urge that "no action" be given first consideration and that the matter be shelved without even the preparation of another redundant, unnecessary and costly Environmental Impact Statement.	

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STATEMENT OF MS. FRANCES HART
ENERGY RESEARCH FOUNDATION

I am Frances Hart, and I represent the Energy Research Foundation. We appreciate the opportunity to address this hearing on the subject of the scope of the proposed environmental impact statement concerning cooling water systems for thermal discharges from the C- and K-Reactors and from the D-Area coal-fired power plant.

The issue of environmental impacts of cooling water systems at SRP was discussed and analyzed at length as part of this NPDES permit reissuance process which began in 1982 and during the L-Reactor EIS process.

A permit demanding compliance of the Clean Water Act requirements was issued by DHEC for SRP's operating reactors in January of 1984, along with the Consent Order allowing the continuation of direct discharge of cooling water for an unspecified time. DOE was required to prepare a comprehensive study of the impacts of thermal discharges and recommend alternative systems which would comply with the Clean Water Act.

Nearly a year ago, in October of 1984, DOE published this report called "Thermal Mitigation Study, Compliance with the Federal and South Carolina Water Quality Standards," which analyzed various cooling water options. We reviewed that report and believe that recirculating mechanical draft cooling towers and once-through mechanical draft cooling towers with holding pond systems -- these are alternatives C-4, C-5, K-5, and K-6 - would be acceptable for C- and K-Reactors. Although DOE is required to analyze all reasonable options during the EIS process, we would urge that any option chosen provide at least as much environmental protection as do these options.

It may not have been clear as early as 1981, when these original NPDES permits for the operating reactors at SRP expired, that new cooling water systems would have to be installed. But this necessity must have become obvious soon thereafter when negotiations with DHEC over new permits began, and South Carolina's Attorney General ruled that SRP's streams were part of the state.

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	It is unfortunate that the EIS process was not begun at that time and that these years have passed without implementation of some sort of mitigation. Beginning the EIS process now has the obvious side effect of delaying still further the long-awaited cooling systems. We believe that complying with the National Environmental Policy Act is a valuable objective and, therefore, that the delay is perhaps warranted, even at this late date.	
D-1	However, because it seems unlikely that substantive new information will be generated during further study of possible alternatives beyond that already offered in the L-Reactor EIS and NPDES comments, we would urge that the preparation of this particular environmental impact statement be expedited as much as is possible within the law, given the substantial information and public comments already generated in these other related processes.	The Department of Energy will expedite the preparation of the EIS to the extent permitted by its regulations for implementing the procedural provisions of the National Environmental Policy Act.
D-2	The EIS is designed to play an integral role in the decision-making process, a role which cannot be very meaningful after the fact. Hopefully, DOE will initiate the EIS process at the beginning of future projects as the law requires, rather than after extensive study has taken place and time has elapsed, to ensure that the process itself can be meaningful and that timely compliance with other legal requirements will be possible.	The preparation and completion of the Thermal Mitigation Study and Comprehensive Cooling Water Study were undertaken by the Department of Energy in fulfillment of and compliance with the Memorandum of Understanding and Consent Order with the State of South Carolina. The Department of Energy is currently undertaking the preparation of the environmental impact statement to fulfill its requirements pursuant to the National Environmental Policy Act--as identified in the current Consent Order with the South Carolina Department of Health and Environmental Control--in attaining compliance with South Carolina's Class B water classification standards.
	Thank you.	

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	STATEMENT OF MR. KARL HERDE	
	I am retired from the Atomic Energy Commission. I retired five years ago. I came here in 1951 as the first environmentalist for the Atomic Energy Commission. I served 23 years in that capacity; and, during that time, the emphasis always with the Atomic Energy Commission was with regard to the taxpayers' dollars.	
	As a guardian of the taxpayers' dollars and a taxpayer myself, along with the few hundred million other taxpayers, I would like to say that we have had enough. The costs are just unjustified.	
	I am also a member of the Antique Automobile Association of America. We have a motto there for antique cars: If they are not broke, don't fix them.	
	Experience has proven that there is nothing wrong with the way the reactors have been operated out there at the Savannah River Plant. I want to completely endorse my friend Mr. Bebbington on what he just said in the second talk ahead of this one.	
	I'm an environmental biologist by training and experience. I started my biological work with the Atomic Energy Commission back actually with Du Pont at the Hanford Plant in the State of Washington. There, I was a group leader in environmental biology for five years before coming here. When I came here, I came by way of Washington, in which they very definitely gave me the indoctrination that we are guardians of the taxpayers' dollars.	
	We are to see that every dollar spent of government money is to get just as much value out of it as if it were our own dollars. That theory still should exist. I'm afraid it doesn't. We are willing to help build up the deficit by requiring costs that are unjustified.	
	Earlier, we built nine big plants and completed the plants roughly in a square-mile area for less than 3 billion dollars. We have not come close to that now. Our liaison negotiations with the contractor, the Du Pont Company, were every thousand dollars that we could save was a thousand dollars earned for the government. Every $100,000 was that much more.	

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	As an environmentalist, we look toward saving dollars. I still think that that should be the utmost concern in the plan and method of our Department of Energy.	
	I have my reservations, but I think I should make this statement. I actually hope that our Congressmen are smart enough that they won't allow this expenditure. I know that the plant needs to go on and I know, from a biology standpoint, we need to be safe; but I'm an environmentalist. I am not a lobbyist. I am not an activist, but I certainly want the environment to be kept intact.	
	Our authority back in the early days was respected authority. The three main authorities we had were the Reactor Safeguard Committee, the National Academy of Science, and the International Commission on Radiation Protection. We met the standards of those three organizations. We were doing a good job. Those three organizations are all made up of men of prestige. There were not would-be environmentalists, self-made environmentalists, in the group. They were all college-trained and college-experienced people, and those three organizations guided our destiny and guided well.	
	Using our minor tributaries and streams was regarded by people who were looking after the taxpayers' dollars as good business, as good logic, as good empirical use of the streams. Our empirical experience over the past 30 years has proven that theory to be right. It's just as right now as it ever was.	
	The streams have adjusted to the higher temperature, and to change them now is rather futile. One thing about the stream, though, a stream has its own capacity to restore itself.	
	It doesn't need the restoration, the decontamination, and so forth that a cooling tower is going to take. A cooling tower can become a sight in the environment.	
	I would like for some of you to take a trip up on the upper part of the Ohio River up in the region of West Virginia and Pennsylvania. Look along that river. There are a bunch of old, rusty monsters, towers, cooling towers, that have been completely abandoned and have been left there to become a part of the environment. I don't like that kind of an environment. I don't want to see that kind of environment on our Savannah River.	

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	I think we know that our streams will clean up themselves and will become fertile and productive biological streams within two or three years. In a very few years, a stream will produce good fishing again without any effort on the part of man. All he has to do is let mother nature take over.	
	I want to say the pond costs us 40 million dollars and is killing off every species, every plant and animal species, of that thousand acres of land to save or maybe better the environment of one or two individual species. If that makes sense, I'm crazy.	
E-1	Now, the cooling towers will be the same thing. You will ruin more of the environment than you will correct by installing the cooling towers.	Chapters 2 and Chapter 4 of the EIS present and discuss both adverse and beneficial impacts of the cooling water alternatives considered.
	So let's hope that our Congress takes the right action on that, and I think it should be up to Congress or a bill to be presented to our courts.	

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	STATEMENT OF MS. DORCAS ELLEDGE	
	I appreciate the opportunity to say a few words to you. I have been to many of the meetings concerning the L-Reactor and read as much as I could understand of the books relating to that.	
	I still compliment the Department of Energy for doing something about the L-Reactor, a better way than putting scalding water in a stream that would have destroyed life. I don't know the best way. I'm not an engineer, as I've said before.	
	I don't know the best way to cool the water and to restore life to these streams that have been killed by the scalding waters from the reactors now in operation. But I do feel that it is an obligation of the Department of Energy and any governmental agency to protect life as we know it on earth.	
	To do less and to do nothing in this case will eventually affect our life, and it might well put South Carolinians and Georgians and anyone else visiting this state on the endangered species list.	
	I do feel that South Carolina citizens and Georgians and all those affected by the operation of the Savannah River Plant deserve protection, equal protection, with all citizens in the United States.	
	I believe we make nuclear weapons to protect our safety. I believe the obligation also in the making of them is paramount with the United States Government.	
F-1	And I do urge you to pick the best solution to the problem that DHEC has required of you. To do nothing doesn't sound like a solution to me, and that is one of the alternatives.	The consideration in the EIS of "No Action" is required pursuant to regulations of the Council on Environmental Quality for implementing the procedural provisions of the National Environmental Policy Act (40 CFR 1500-1508).
	And I thank you very much.	

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	STATEMENT OF MS. JEAN ROBINSON ON BEHALF OF W. F. LAWLESS	
	My name is Jean Robinson. I'm presenting a statement for Professor W. F. Lawless who had to be out of town at this time. Professor Lawless is at Paine College in Augusta, Georgia. The statement is entitled Scoping Comments on SRP Cooling Water Systems EIS.	
	General Comments	
	To proceed with some general comments, the Department of Energy should be commended for asking for public scoping comments on the proposed Savannah River Plant cooling water systems environmental impact statement. Compared to the recent public imbroglio between the South Carolina DHEC and SRP, wherein DHEC had cited SRP for groundwater violations, and as well to past coverups of SRP reports by the Department of Energy, it's always refreshing to have government business conducted in the open. However, as important as this is, it can be significantly improved.	
G-1	The public does not have the technical capability nor the time to adequately explore nor keep track of the rather abstruse scientific studies of the environmental interactions and alternatives explored in this new environmental impact statement. That the public knows of, there are two such SRP environmental impact statements now underway.	As required by the regulations of the Council on Environmental Quality (40 CFR 1502.19), copies of the draft EIS will be provided to Federal and State agencies having special expertise with respect to any environmental impact that might be involved.
	A publicly funded peer review committee should be created, using regional scientific and political talent, as a means of safeguarding the public's interest. Both DHEC and DOE, by their nature as political bureaucratic institutions, have more than enough administrative chores to worry about as it is, and an independent peer review panel would appropriately monitor scientific reports and construction projects with the rigor that escapes bureaucracies. If a peer review panel prevents the necessity of another 60-million-dollar clean-up similar to that now being spent to clean up the M-Area seepage basin fiasco, such a peer review panel could easily afford to attract talented participants.	
	The public deserves more than playing DHEC against DOE to protect its interests and the environment. As the technological stakes increase, an independent scientific peer review panel	

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	for the Savannah River Plant will add flexibility, improve technological solutions, and reduce the opportunity for environmental impacts, mistakes, and ineptitude. This technique has worked well with the NASA bureaucracy, and landed Americans on the moon. On the other hand, without peer review panels, the SRP has given us not only the M-Area seepage basin, but 67 other seepage basins at the Plant as well.	
	<u>Specific Comments</u>	
G-2	1. The DOE has not yet responded to information provided at the last Public Scoping Meeting on the reported statistically significant differences between strontium-90 concentrations found in milk around the SRP plant compared to the Southeastern average concentration of strontium-90 in milk.	Responses to comments received during the scoping period for the preparation of the environmental impact statement on waste management activities for groundwater protection will be included in that environmental impact statement.
G-3	2. The new EIS should consider treatment of the cooling water before it is released back to the environment.	The effluent from the cooling systems considered in the EIS will meet the State of South Carolina's Class B water classification standards. The effluent is expected to be similar to the water quality of the Savannah River, and other than for reduction of temperature, treatment of the cooling water will not be required.
G-4	3. Water quality analyses of water released into the environment from C- and K-Reactors and the D-Area coal-fired power plant should be published and compared to EPA drinking water standards. The D-Area basin overflow and outfall water quality characteristics should also be provided.	Water quality impacts of the alternatives will be assessed in Chapter 4 of the EIS.
G-5	4. The D-Area power plant air quality at the release point from its cooling tower should be included in the new EIS.	Air quality impacts of the alternatives for the D-Area powerhouse will be described in Chapter 4 of the EIS.
G-6	5. P-Reactor effluent, that is, thermal, water quality, air stream quality characteristics should be included in the new EIS. Also, a biological community comparison to Par Pond with a comparable sized pond to Par Pond should be made and included. An aquifer water quality analysis of water under Par Pond should be made and included in the proposed EIS.	A discussion of P-Reactor effluent and Par Pond is not within the scope of this EIS, as discussed in the <u>Federal Register</u> notice announcing the preparation of the EIS.
G-7	6. The South Carolina DHEC and DOE March 1985 agreement suggests the continued use of a raw water basin at the D-Area power plant. The advantages of having a lined basin and an unlined basin, as well as RCRA compliance, should be discussed in the new EIS for this basin and for the ponds at C- and K-Reactors.	The use of the raw water basin at the D-Area powerhouse does not involve hazardous waste; therefore, a discussion of having lined basins and compliance with RCRA is not an appropriate topic for inclusion in the EIS.

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G-8	7. Water quality characteristics of the cooling water at its source should be provided. Coolant waste system diagrams and effluent system diagrams should be provided. Well construction and closure information as necessary should be provided.	Chapter 3 of the EIS will describe the existing surface-water hydrology and water quality of the streams that would be affected by the alternative cooling water systems. Also see the response to comment G-3. If well closures should be required due to construction of the alternative cooling water systems, the closure wells will be discussed in the EIS.
G-9	8. Cooling water tower effluent characteristics at the release point should be provided.	See the response to comment G-3.
G-10	9. All mathematical models should be detailed, statistical techniques discussed, and validation of all models, equations, or techniques discussed.	Appendix B of the EIS and its referenced documents will discuss the models, assumptions, and validation of models used in the preparation of the EIS.
	Thank you very much. That concludes his statement. And he wanted to let you know that he would be glad to submit a final copy by the 31st but wishes to make you copies of this because of some typographical errors.	
	ADDITIONAL COMMENTS CONTAINED IN LETTER FROM W. F. LAWLESS DATED AUGUST 29, 1985	
G-11	No. 10, Airborne releases, including levels of dioxin, from the Beta-Gamma Incinerator (BGI) at the point of release should be quantified and reported. Provide calculated and actual release data, from the point of release, for each waste category, matching the BGI incinerator burn loads to normalize the predicted with actual data.	A discussion of airborne releases from the Beta-Gamma Incinerator is outside the scope of this EIS.
G-12	No. 11, The two high level radioactive waste (HLW) corrosion pitting reports (L-Reactor EIS, p. M 113-114) did not discuss corrosion pitting in HLW tanks 25-28. These 4 HLW tanks were not treated for corrosion pitting as were HLW tanks 38-51, since HLW tanks 25-28 were already radioactive when the corrosion pitting was discovered in the 14 HLW tanks completed later. Provide a corrosion pitting status report on HLW tanks 25-28 performance, and compare to the last 14 HLW tanks at SRP (tanks 38-51) that went into radioactive waste service after remedial action for corrosion pitting.	A discussion of high-level waste is outside the scope of this EIS.

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	STATEMENT OF MR. SAM SCHILLACI	
	I've been studying the Savannah River Plant for a long time, and I've got a good plan for its survival. I'm a former employee also with ten years of service with the Department of Energy. I had some mental problems because of stress, so the government "retired me." The stress was brought on because I didn't like all the waste, fraud, and abuse out there. But they dumped me in a hurry. For six months after they dumped me I went without a salary or any means of support. I had a lot of time to think, do things I've never done before, drink a lot, write, which I thoroughly enjoy, even though my grammar ain't so hot. Now, my plan for DOE is simple. It's the same (expletive deleted) plan I had. Set all the DOE employees, and hopefully all the government employees, free at a certain, hopefully surprise, moment. They all go home for five months without leave or salary. They could think, read, do anything they want to. They could grind and gnash their teeth if they want to. And at the end of the five-month period -- notice that I give them a little less time than I had; I'm lenient -- the ones that haven't done themselves in could come back and determine if those cooling ponds or whatever is needed out there at SRP. Let them think a little more. Now, if the government employees do that, I think the whole public sector would probably do the same thing. Just think of all the fun that we could have. 1929 all over again. Mr. Herde, you probably remember him. That's probably why he has grayer hair and his voice has a little more common sense in his tone of voice. And just think of all the neat movie stuff of 1929. Back to the future. Anyway, I'm not anti or pro nuclear or anything; I'm just pro myself, pro my God, which is different from your God, and a survivor. I hope more become self-reliant, learn to fight rather than this (expletive deleted) love we have now, and learn that the best plan is no plan. I will also shut up my mouth for a half million dollars, passage to New Zealand, and permanent silence to the Will Rogers Institute. After five months I hope the hot water is used for enemas for anybody who wants it. Thank you.	Comments noted.

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	STATEMENT OF MR. WILLIAM McDANIEL	
	I have no written speech with me, but I do have a part of a tape that I would like to play. Of course, you can have a copy of the tape.	
	I think you are escalating out of control as far as reactors are concerned. This has very little bearing, I realize this, on the coolant system that you have here as far as water going back into the creeks and rivers and so on. I would like to play as much of this tape as I can. I appreciate this opportunity.	
	(Mr. McDaniel began playing the tape.)	
	Forbes, the magazine that calls itself a capitalist tool, last month proclaimed on its cover the failure of the U.S. Nuclear Power program ranked as the largest managerial disaster in business history. Forbes pointed out that we spent more on nuclear power than we did on the space program or the Vietnam War, and the magazine says, "Only the blind or the biased can now think that most of the money has been well spent."	
	Well, that's something that Amory and Hunter Lovins have been saying for years. They are husband and wife who put their energies together to create a vision of a non-nuclear energy future.	
	"Who would have guessed that a beer-drinking, country-music-loving cowboy would team up with a scrawny, four-eyed, physicist?"	
	The physicist and the cowboy, she is also a lawyer and political scientist, were married in 1979. They began traveling around the world, as Amory says, "Cross-pollinating the energy grapevine." They wrote books and consulted for governments and businesses in 15 countries.	
	They contend that the new nuclear plants will turn out more electricity than we really need at a cost no one can afford and that the money the utility companies spend on those plants would be better spent on helping the country become more energy-efficient. In other words, use the money to help make homes, factories, and office buildings do the same work with less energy. Then everybody is a winner. The answer can be as	

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	simple as installing better windows, designing better buildings and appliances. At their home and research institute in Old Snowmass, Colorado, Amory and Hunter Lovins live their state-of-the-art ideas for saving energy. They built a 4,000-square-foot home, office, and indoor farm that takes the simple idea of a solar greenhouse and makes use of it on a grand scale. The 16-inch-thick curving walls provide more insulation than most people's roofs. The Lovins moved into the still-unfinished structure in January 1984. Soon after, they published a visitors' guide. More than 2600 people from around the world have to come to see their house. "This is the space we donate as the headquarters of our non-profit group, Rocky Mountain Institute, where we and about a dozen colleagues try to foster the official use of resources." Amory and Hunter Lovins use electricity for those things it does best. "Using nuclear power to heat a house," Amory Lovins has said, "is like cutting butter with a chain saw." Passive solar design, even at an altitude of 7100 feet in the Rocky Mountains, allows the Lovins to heat with sunlight year-round. "This is the greenhouse?" "No. This is basically the furnace of the house. These windows are, I think, the most advanced in commercial use anywhere. They insulate twice as well as typical shades and cost less. There is an invisibly thin film of plastic with special high-tech coatings on it which let the light in but don't let the heat get out, and then we fill up the space around that heat-mirror form with argon gas which insulates better than air." "Design with nature," say the Lovins, who would have built differently in a different climate; but some of their basic design elements are just common sense. If you insulate more, you have to heat or cool less. "There is about yea much polyurethane foam up on the roof, and there is 4 inches of it in the middle of the walls. Just (knocking sound) like that, and the house is also darn near airtight. We then laid it through what are called air-to-air heat exchangers."	

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	In all over the house, they have energy-efficient light bulbs.	
	"It's an 18-watt bulb that screws into a regular socket and gives the same amount of light as a regular 75-watt bulb, so it's four times as efficient, lasts about thirteen times as long, and I think gives better light. It isn't a fluorescent folded up in there."	
	The bulbs currently retail for $18 to $25 each. They are just coming onto the American market. Lovins' critics say that the bulbs are too expensive, won't fit in many home lighting fixtures, and are better for commercial lighting because they don't give full light instantly. Lovins also sees the benefits of commercial use, but he is not bothered by the warm-up time. He believes the price will come down and that the fixture problems will be solved.	
	(Mr. McDaniel stopped playing the tape)	
	I'm a member of two different groups, ecology groups. Of course, I'm a public citizen. The point I'm trying to get across is that, as I have stated here when I first came up here, things, in my opinion, are escalating out of proportion. Sometimes I think we should try to go back and erase the board and start all over, but then that cannot be done.	
I-1	I am still opposed to any type of radiation in regards to how high a level or how low a level it is, and I know we have certain amounts of radiation naturally. I think we have 82 percent of the oxygen that comes out of the Amazon Rivers in the New Guinea. But you add radiation onto x-rays that a person has had and nature itself, and then you are doubling and tripling it.	A discussion of the existing radiation environment at and in the Savannah River Plant Region will be presented in Chapter 3 of the EIS. Chapter 4 of the EIS will discuss the radiological impacts of the cooling water alternatives considered.
	The thing that bothers me most, which I see from research, is it's a mortality. You know the group I'm with. This is a research committee. It's a citizens' committee, and now we have taken a survey on mortality and cancer. I was so shocked when it went through my neighborhood. At least one or both people have died from cancer of some sort or the other, and the people around us are dying. I live on 2910 Carolina Avenue. Other members of this same group --	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	(Mr. McDaniel's time for making his presentation expired)	
	Thank you. I appreciate it very much. I will see that you get a copy of the tape.	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	STATEMENT OF ZOE G. TSAGOS LEAGUE OF WOMEN VOTERS OF NORTHERN BEAUFORT COUNTY	
	The League of Women Voters of Northern Beaufort County appreciates this opportunity to participate, by our comments, in the preparation of an EIS on the type of cooling-water systems to be used for the C- and K- Reactors and the D-Area coal-fired power plant at the SRP.	
	It is our understanding that a conditional National Pollutant Discharge Elimination System (NPDES) permit was issued to DOE for SRP by SCDHEC in January 1984. Compliance with NPDES provisions rests upon the issuance of an EIS which will note the environmental impact of thermal discharges from the above mentioned reactors and power plant and will outline the means proposed to mitigate the high temperature flow by the use of cooling systems so that the 90°F required by law can be attained before it reaches the Savannah River.	
J-1	Inasmuch as SCDHEC, according to the DOE statement on page 5 of the "Intent to Prepare an Environmental Impact Statement" document [6450-01] which we have received, has accepted either a cooling water system of "once-through cooling towers for C- and K-Reactors" or "recirculating cooling towers" as satisfying NPDES provisions, we support this SCDHEC position. We hope that DOE and SCDHEC will work towards whatever method is environmentally safest in thermal effluent management. An expedited EIS will help to bring this about with the least loss of time.	See the response to comment D-1.
	We agree with Ms. Frances Hart in her presentation for the Energy Research Foundation at the August 19 DOE hearing in Aiken where she stated that if an alternative method is chosen, it should provide "at least as much environmental protection" as the SCDHEC acceptable cooling methods as presented above.	
J-2	We in Beaufort are as concerned as we have ever been about the quality of our drinking water which has as its source the Savannah River. We shall read with great interest the EIS analysis of "Environmental Issues" (p. 9) numbers: 6. "Radionuclide remobilization" and 9. "Cumulative thermal effects." Both changes can have an impact on the quality of downstream drinking water.	Radionuclide remobilization and cumulative thermal effects will be assessed in Chapter 4 of the EIS for the cooling water alternatives.
	In conclusion, we urge DOE to continue holding hearings in Beaufort as well as Aiken. The number of people attending any	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	one hearing has varied; this is perhaps also true of Aiken. Because the decisions reached and changes made at SRP are of great environmental importance to us here, we must continue to be involved and to actively participate in hearings held in Beaufort. Please include this submission in the Scoping Record.	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	STATEMENT OF ROGER L. BANKS U.S. DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE	
	We have reviewed the above-referenced notice as presented in the Federal Register on July 29, 1985. The following comments are provided to you in accordance with the Fish and Wildlife Coordination Act and are intended to assist you during the preparation of the EIS.	
K-1	The environmental issues identified in the Register that you intend to analyze during the preparation of the EIS appear generally inclusive of the fish and wildlife resource issues of concern to the Service. It appears likely at this early stage in project planning that significant beneficial effects on wetland fish and wildlife resources will likely result from installation of the proposed cooling water alternatives. It also appears probable that significant adverse effects may result from siting of the cooling towers, holding ponds, and ancillary facilities.	The potential environmental effects resulting from the location of cooling water systems and ancillary facilities will be discussed in Chapter 4 of the EIS.
K-2	We would like to see the following issues emphasized and the extent of their probable effects quantified during subsequent studies: 1. The effects of reduced thermal effluents on fish and wildlife resources in the receiving streams and contiguous wetland habitats. 2. A comparison of habitat impacts resultant from alternative facilities siting plans. 3. Impingement and entrainment effects on fishery resources resultant from alternative plans.	Chapter 4 of the EIS will present the environmental consequences of the construction and operation of alternative cooling water systems, including the beneficial and adverse impacts to fish and wildlife resources, wetland habitats, and impingement and entrainment. Also see the response to comment K-1.
K-3	We recommend that the Habitat Evaluation Procedures (HEP) be considered as a means of comparing and quantifying the habitat effects of alternative plans considered in the EIS. Use of the HEP in this case could make economical use of the basic	A HEP study is being conducted to identify the value of habitat to be gained or lost for use in assessing further mitigation. The EIS will discuss the HEP study in Chapter 5.

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	framework of the ongoing L-Reactor HEP Mitigation Study. As a result of the L-Reactor HEP Study you have trained and experienced staff members capable of conducting a study within the time constraints of the EIS. In addition should the need for habitat mitigation be indicated after selection of the preferred alternative, HEP provides a means of mitigation cost-benefit analysis. Finally, the primary benefit of the HEP is in promoting interagency cooperation resulting in balanced planning decisions. If you have any questions regarding our comments contact me at your convenience.	

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	STATEMENT OF J. W. MORRIS	
	Thank you for the opportunity to comment on the scope of the planned Environmental Impact Statement (EIS) on the Savannah River Plant (SRP) Cooling Water Systems.	
	I urge that the EIS deal carefully and thoroughly with a cost-benefit analysis of the construction and operation of the proposed cooling-water systems. Specifically, the following aspects should be considered:	
L-1	1. The complete and continuing cost to the taxpayers of increasing the national debt to pay for a. the proposed construction, b. the operational costs, and c. the increased production costs that will result from the proposed operating limits. 2. The benefits, if any, that can be expected from the proposed changes.	Chapter 2 of the EIS will present the estimated costs associated with the cooling water alternatives considered. Chapter 2 of the EIS will summarize and Chapter 4 will discuss the adverse and beneficial impacts of the construction and operation of the cooling water alternatives.
L-2	I urge also that the EIS review the overall environmental productivity of the SRP site, as a whole, and compare that productivity with the productivity that might have been expected from the SRP area had the project been located elsewhere, and with the incremental effects that may be expected from the proposed cooling-water systems. Such a review will show that the environmental productivity of the SRP site now is very high, and that the incremental benefits of the proposed actions are very low. The long-term costs of the proposed action will be very high to the nation's taxpayers, the benefits will be very small, and none of these benefits will accrue to the public since the SRP site is necessarily closed to the public. The basic intent of the Clean Water Act and of Water Quality Standards is to protect the public and to preserve environmental productivity. At SRP overall the public is presently well protected and environmental productivity is very high.	Chapter 3 of the EIS will discuss the existing environment at the SRP site that will be affected by alternative cooling water systems, and Chapter 4 will discuss the environmental consequences of constructing and operating the systems. Since the cooling water systems will neither affect the entire SRP site nor can the systems be located elsewhere, the comparison of overall productivity as cited is considered outside the scope of the EIS.

Table H-2. Scoping Comments and DOE Responses

Comment number	Comments	Responses
	I urge the Federal government to exercise its responsibility to the total spectrum of U.S. taxpayers, and to pursue all possible means to implement "No Action" in the matter at hand.	

Table H-3. Scoping Topics and EIS Sections

Comment number	Scoping topic	EIS section
A-1	Environmental impacts	Ch. 4, App. F
A-2	Environmental impacts	Ch. 4, App. F
A-3	Cooling water alternatives	Ch. 4
B-1	Regulatory requirements	Ch. 2, Ch. 4
D-1	Regulatory requirements	Ch. 1, Ch. 5
D-2	Regulatory requirements	Ch. 1, Ch. 5
E-1	Environmental impacts	Ch. 2, Ch. 4
F-1	Cooling water alternatives, No-action alternative	Ch. 2, Ch. 4
G-1	Regulatory requirements	Ch. 1
G-2	Scoping comments	Ch. 1
G-3	Water quality impacts	Ch. 4
G-4	Water quality impacts	Ch. 4
G-5	Air quality impacts	Ch. 4
G-6	Regulatory requirements	Ch. 1
G-7	Raw water basin usage - RCRA compliance	Outside the scope of the EIS
G-8	Surface water hydrology and water quality, well closures	Ch. 3, Ch. 4
G-9	Water quality impacts	Ch. 4
G-10	Mathematical models	App. B, App. G
G-11	Beta-Gamma incinerator	Outside the scope of the EIS

Table H-3. Scoping Topics and EIS Sections (continued)

Comment number	Scoping topic	EIS section
G-12	High-level waste	Outside the scope of the EIS
I-1	Radiological releases	Ch. 3, Ch. 4
J-1	Regulatory requirements	Ch. 1, Ch. 5
J-2	Radionuclide remobilization, cumulative thermal effects	Ch. 4
K-1	Facility siting impacts	Ch. 4
K-2	Fish and wildlife resource impacts	Ch. 4
K-3	Habitat impacts	Ch. 4
L-1	Cost of alternatives, impacts of alternatives	Ch. 2, Ch.4
L-2	Affected environment, impacts of alternatives	Ch. 3, Ch. 4

APPENDIX I

POTENTIAL APPLICATIONS FOR UTILIZATION OF WASTE HEAT FROM K- AND C-REACTOR COOLING WATER DISCHARGES

During the public comment period on the draft environmental impact statement (EIS) for alternative cooling water systems at the Savannah River Plant (SRP), the U.S. Department of Energy (DOE) received several comments that requested consideration of other alternatives for use of the cooling water effluents from K- and C-Reactors. These comments did not identify specific alternatives (i.e., concepts with specific functions and features) for the effluents, but rather suggested that DOE consider the use of the cooling water or the contained thermal energy in agricultural or aquacultural applications or in the production of ethanol.

This appendix discusses earlier waste heat utilization studies conducted at the Savannah River Plant, and assesses the general alternatives identified during the public comment period (irrigation, soil warming, greenhouse heating, aquaculture, and ethanol production).

I.1 K- AND C-REACTOR COOLING WATER DISCHARGES

K- and C-Reactor each discharge approximately 11.3 cubic meters of reactor cooling water per second at an average temperature of between 70°C and 77°C. These discharges are not continuous; periods of reactor operation depend on production runs and on required maintenance shutdowns of 1 to 2 months, which generally occur during the summer. The chemical quality of the cooling water is similar to that of the Savannah River; however, the cooling water from both reactors contains tritium, a radioactive isotope of hydrogen, resulting from small process water leaks in the reactor heat exchanger.

I.2 PREVIOUS STUDIES

DOE has funded or performed several studies that evaluated the potential for utilization of waste heat generated at SRP. In 1978, the South Carolina Energy Research Institute (SCERI) prepared a report entitled Low Level Waste Heat Utilization Project, Savannah River Plant, Preliminary Analysis. This study considered a number of potential waste heat utilization projects, including agricultural and aquacultural uses, industrial applications, and direct power generation. It evaluated five agricultural options - soil warming, biomass production, greenhouse heating, anaerobic digestion of animal wastes, and space heating of poultry brooding houses. After the evaluations, the researchers did not consider any of these options to be independently viable as a major user of SRP waste heat. Of the nine aquatic species evaluated for potential commercial culture using SRP waste heat, the report considered the culture of freshwater prawns and channel catfish to offer the most promise as an end user in an energy cascade system. Of the direct power generation options considered, a Rankine cycle system appeared to be the most viable.

In 1982, Clemson University's College of Agricultural Sciences and College of Forest and Recreation Resources prepared a report entitled Feedstock Options for Ethanol Production at the Savannah River Plant (Cross et al., 1982). This report provided DOE with information to judge the short- and long-term potentials for feedstock alternatives for onsite ethanol conversion.

In 1983, Arthur D. Little, Inc. (ADL), under contract to E.I du Pont de Nemours and Company (Du Pont), prepared the SRP Cogeneration Study, which evaluated the feasibility of various methods of cogeneration (i.e., the recovery and utilization of heat from the reactor effluents) as a means of reducing SRP thermal impacts. The ADL investigation utilized the previous studies conducted on this issue with appropriate updates of technologies and costs (ADL, 1983). The cogeneration options evaluated included the generation of electricity using Rankine cycle systems, the generation of process steam for the SRP using heat pumps, onsite industrial applications (direct uses and/or temperature augmentation using heat pumps), onsite agricultural and aquacultural applications, and hot water delivery to offsite users. ADL evaluated each of the applications with respect to technical, economic, institutional, and environmental feasibility. The environmental evaluations included an assessment of the ability of the cogeneration options to meet the proposed 32.2°/2.8°C thermal standard for SRP streams. This standard requires that the temperature of plant effluents entering a natural stream not exceed 32.2°C, and that plant effluents cause no more than a 2.8°C temperature increase above the natural stream temperature.

ADL evaluated the onsite applications both as standalone strategies and as precooler strategies. The standalone evaluations examined the cost/benefit associated with adding a cogeneration system to the existing once-through reactor cooling system. The precooler evaluations assumed that the once-through system would be augmented by mechanical-draft cooling towers, and examined the cost/benefit of using cogeneration to precool the reactor effluent before it enters the cooling towers.

Based on a detailed review of the ADL work and on an independent assessment of cogeneration, the Savannah River Laboratory (Roggenkamp, 1983) concluded that none of the standalone strategies would provide sufficient temperature reduction to satisfy the 32.2°/2.8°C thermal standard for SRP streams year-round. The precooler strategies were not considered feasible for reasons specific to each application, as discussed below.

Technically, Rankine cycle systems could generate as much as 37 to 46 megawatts of electricity at each reactor. However, while the 12°C temperature reduction would permit the use of smaller cooling towers, the delivered electricity costs would be 2 to 3 times higher than the costs for the current system of purchased electricity.

The only technically viable heat pump application identified in the studies would result in a decrease in reactor cooling water effluent temperatures of only 0.6°C. In addition, this application would be uneconomical.

Onsite industrial, agricultural and aquacultural applications, and heated effluent delivery to offsite users would not be feasible because of poor economics and many institutional barriers.

The institutional problems associated with industries locating to the SRP area to obtain low-cost heat from the reactor effluent would be virtually insurmountable. ADL cited the problems encountered by the Tennessee Valley Authority in attracting industries to use the waste heat from its Watts Bar Nuclear Power Plant.

The ADL study concluded that onsite agricultural and aquacultural uses of the waste heat were not feasible. Features of these applications leading to poor economics are the relatively low duty cycle (heat generally not needed except in winter) and the relatively low value of the output. Also, the study determined that, unless very large land areas are employed, these applications would produce little impact in terms of waste heat utilization. The relatively frequent outages of the reactors also would cause difficulties with respect to winter kill unless backup systems were provided. In addition, Federal legislation [21 USC 321(s) and 342(a)(7)] expressly forbids the adulteration of food or food products with any radioactive substance. SRP reactor cooling water contains tritium as a result of small process water leaks in the reactor heat exchangers. While discharges of this radioactive material are well within applicable regulatory limits for water quality, the legislation regarding food and food products sets no lower threshold limit, precluding the use of this water for direct contact use in agriculture or aquaculture.

The study also concluded that it would be uneconomical to pipe reactor cooling water effluent offsite for district heating or industrial applications.

I.3 POTENTIAL AGRICULTURAL APPLICATIONS

I.3.1 IRRIGATION

This potential application for the utilization of SRP waste heat would entail delivery, via a closed pipeline or open canals, of reactor cooling water effluent to offsite users for direct contact irrigation of agricultural crops.

In the six-county area surrounding the SRP, agriculture accounts for approximately 21 percent of the total land use (DOE, 1984). The results of the 1980 census of population (Bureau of the Census 1982a,b) indicate that fewer than 2 percent of the population in the six-county area were employed in the category of agriculture, forestry, and fishing, a 2-percent decrease from 1970. Agricultural land in the six-county area is undergoing a transition from smaller operators to larger consolidated farms, especially in the rural areas of Allendale, Bamberg, and Barnwell Counties (DOE, 1984).

Although the conservation of water resources is considered a national priority and recent drought conditions in the southeastern United States have generally indicated the importance of the availability of adequate water supplies, DOE is not aware of specific agricultural needs or requirements for diversion of existing water resources for use in the irrigation of local crops. No uses of the Savannah River for irrigation have been identified in either South Carolina or Georgia (Du Pont, 1982).

Even if a specific need was identified for local use of the SRP reactor cooling water for irrigation purposes and recognizing the legal barrier for such uses for food crops described above, various environmental, technical, and economic difficulties exist; these are discussed below.

The estimated temperature of the cooling water delivered from K- and C-Reactors to an offsite location would be between 52° and 75°C. Before it could be used for irrigation, this water would have to be cooled to about 32.2°C to avoid damage to crops. In the summer, when irrigation is needed and the ambient Savannah River temperature is approximately 26°C, an estimated 156 cubic meters per second of local water (or seven times the amount of cooling water delivered from K- and C-Reactors) would be required to dilute and thus cool the discharge water from both reactors to 32.2°C. This quantity is equal to the 7-day, 10-year low flow (159 cubic meters per second) of the Savannah River near the SRP. If such quantities of local water were available, the K- and C-Reactor discharges probably would not be needed for irrigation; because this amount of local surface-water use is not considered feasible, a cooling system (i.e., once-through or recirculating cooling tower) would still be necessary to cool reactor cooling water sufficiently for irrigation use. In addition, during those periods when irrigation water would not be required, some alternative mechanism of cooling water disposal (and cooling to meet regulatory requirements) would be necessary.

The offsite agricultural user(s) would be responsible for meeting all construction and operational permit requirements for offsite irrigation systems. Major issues of concern from a regulatory point of view relate to large volume translocation of a riverine water resource to the groundwater table and the potential permit requirements of transporting surface water from one basin to another (for example, interbasin transfer from the Savannah River basin to the Salkehatchie River basin near Allendale, South Carolina).

To deliver heated water from K- and C-Reactors to a potential user(s) at the SRP boundary line, DOE would have to construct either open canals or an underground pipeline. Consideration was given to the use of open cement-lined canals with gravity flow, similar to those constructed to carry cooling water from the P- and R-Reactors to Par Pond. However, this alternative was considered less attractive than the closed pipeline option for both technical and economic reasons. Several stream valleys and ridge lines would have to be crossed between the reactors and the SRP eastern and western boundary lines. Gravity flow canals could only be used from a ridge line to the next stream valley, from which a closed pipeline and a pumping station would be required to move the water to the next ridge line.

Water flow in a canal would be by gravity, whereas the pipeline would be under pressure from the pumps. Therefore, the pipeline could use a shorter, straight path and follow the existing ground elevation to avoid deep excavations and fills. A canal would have to meander along the contours, requiring a longer route and greater expense. The canal would also produce a larger potential area of disturbance than the pipeline and, accordingly, would have a greater potential environmental impact.

A pipeline system would require the following:

- A pumping station at each reactor with underground reinforced concrete pits approximately 20 meters deep, each containing 10 pumps capable of pumping 2.3 cubic meters per second.

- Associated control buildings, valves, electrical substations and switchyards, and access and security facilities.

- Underground pipelines from each reactor area to the SRP boundary. Each pipe would be about 2.5 meters in diameter. Both pipes would be combined into one about 3.7 meters in diameter where the lines converge. The system would have drain and air valves at low and high points in the pipes, similar to those in existing wastewater pipelines.

A pipeline could follow several routes from K- and C-Reactors to the SRP boundary. The closest point on the boundary to either reactor is along the Savannah River. However, no practical use exists for heated water in this area because it consists almost exclusively of wetlands. The route to a usable offsite area with the shortest total length of pipe (Figure I-1) would start at a new K-Reactor pump station and follow the existing 115-kilovolt transmission line and control cable between K- and C-Reactors for about 4.5 kilometers. A 0.5-kilometer pipeline would run from the new C-Reactor pump-house to connect to that pipeline just north of Road 3. From this connection, a larger combined pipe would follow the existing South Carolina Electric and Gas (SCE&G) Company transmission line to the intersection of Roads 2 and C. From this point, the pipe could either continue along the transmission line or run parallel to Road C to the SRP boundary near Jackson, South Carolina. The length of the large pipe would be about 13 kilometers, and the total length of pipe would be about 18 kilometers.

A second possible route (Figure I-2) would have the small pipes run from each reactor to a junction at the intersection of Roads B and C near L-Reactor. From the new pumphouse at C-Reactor, the pipe would follow the C-Area railroad to Road C, and then parallel Road C to the junction; this pipe would be about 8.5 kilometers long. The pipe from K-Reactor would run parallel to Road B for about 5.5 kilometers. From this junction, a larger pipe could follow two routes to the boundary. The shorter route (Route 2-A) would turn south, cross Myers Branch and the Seaboard Coast Line Railroad, and run approximately parallel to the SCE&G transmission line for about 10.5 kilometers to a point on the SRP boundary near the northwest corner of Allendale County. This point is near a ridge line that bisects the area between SRP and Lower Three Runs Creek. The large pipe could also continue (Route 2-B) from the junction 14 kilometers along Road B to the SRP boundary east of Par Pond. This point is near a ridge line that runs south through part of Barnwell County and most of Allendale County between Lower Three Runs Creek and the Salkehatchie River. The total lengths of pipe for Routes 1 and 2 are 24.5 and 28 kilometers, respectively.

Although the route to Jackson is the shortest, the pumps at each reactor would have to be larger than those required for the other routes because the pipe-line would reach its lowest point where it crosses Upper Three Runs Creek; the system would have to pump water upgrade to the boundary. Stream crossings on the other routes are at higher elevations.

Depending on the pipeline route selected, 1200- to 1800-horsepower motors would power the pumps. The rating for each pump would be 1.1 cubic meters per second and the required power supply per pump would range between 0.995 and 1.5 kilowatts. Because each pumping station would require 10 operating and

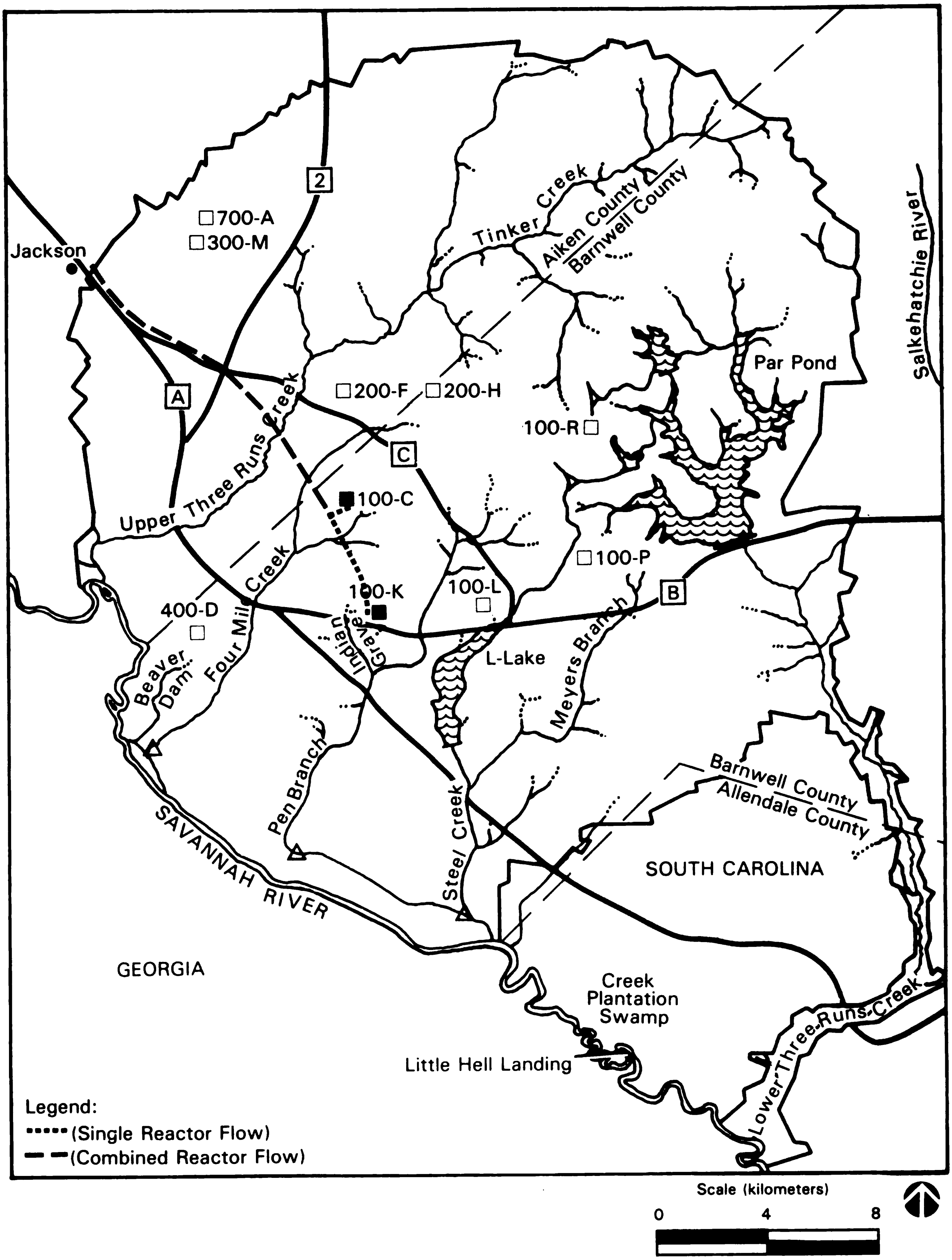

Figure I-1. Proposed Pipeline Route 1 (West)

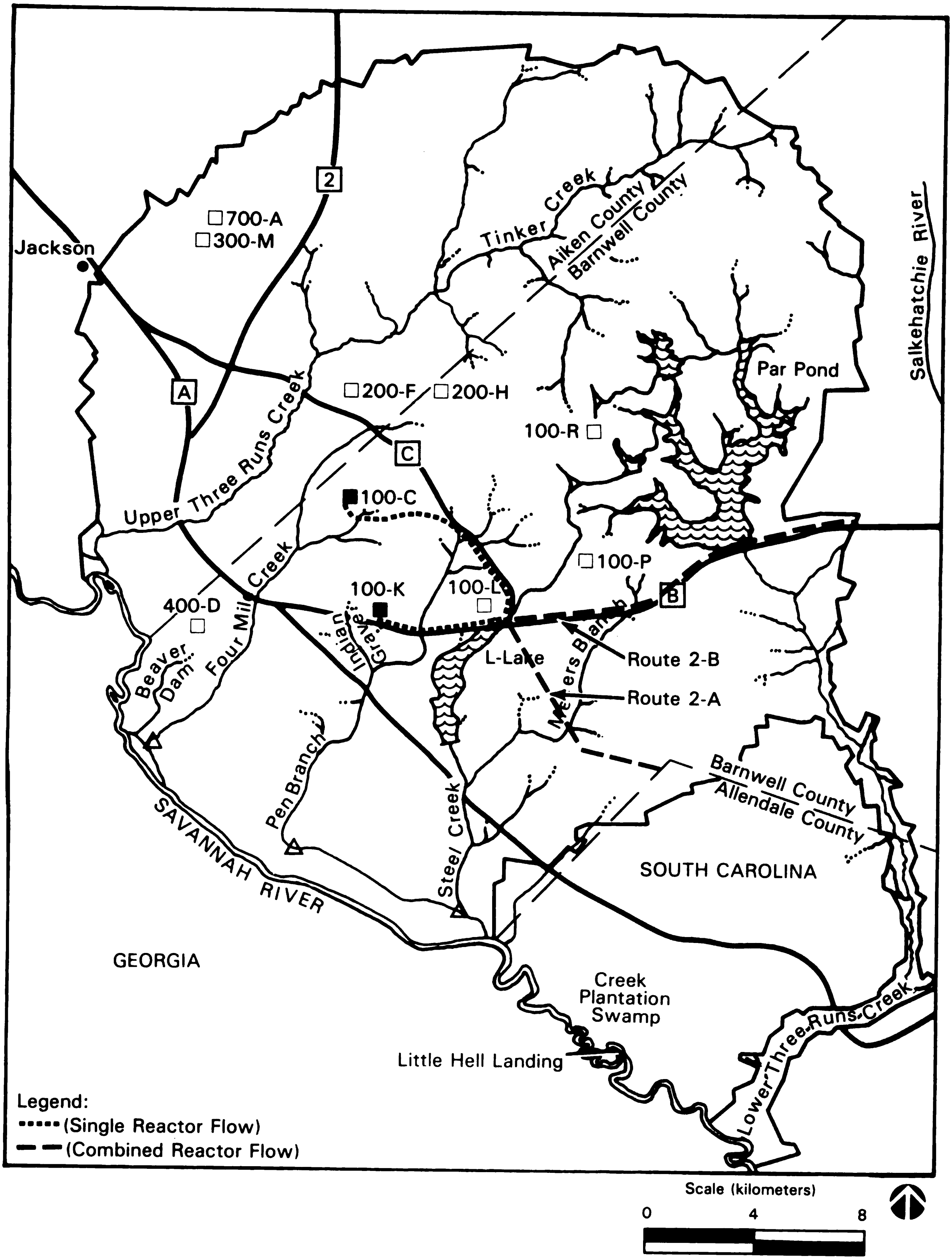

Figure I-2. Proposed Pipeline Route 2 (East)

5 redundant pumps, DOE would have to construct an electrical power substation and special transmission lines. The estimated total DOE construction costs for pumping stations and pipelines range between $188 and $215 million, and the estimated annual operating costs would be approximately $18 million (Table I-1).

Table I-1. Costs for Closed Pipeline to Carry K- and C-Reactor Cooling Water Offsite

Item	West pipeline (Figure I-1)	East pipeline (Figure I-2)
Length of route (kilometers)	24.5	28
Capital costs ($ million)		
Pipeline	44	64
Pumps and accessories, installed	92	92
Contractor operations and profit	27	31
Design	25	28
Total capital costs ($ million)	188	215
Operating costs per year ($ million)		
Power (at $.06/kWh)	13	13
Operations and maintenance	5	5
Total operating costs per year ($ million)	18	18

DOE estimates that it would require about 12 to 15 months to design the pipeline, and about 24 months to construct the shortest system or 32 months to construct the longest route. The workforce is estimated to be 25 personnel for operations and 15 for maintenance.

I.3.2 SOIL WARMING

Warming of crop soils to higher temperatures during the cooler months has been tested experimentally as a method of increasing agricultural productivity. SCERI (1978), in its assessment of potential applications at SRP, reported on soil warming experiments that produced a variety of effects on growing crops: longer growing seasons, higher quality vegetables, and sometimes significant increases in yields. However, artificial warming of the soil has also been found to cause substantial reductions in yields of some crops. A system using waste heat to provide soil warming would include the following necessary components:

- The availability of land suitable for crop production

- Sufficient labor, management, and equipment to produce a crop

- An extensive system of buried pipelines for the transfer of heat to the soil

- An irrigation system to alleviate the increased evapotranspiration caused by higher soil temperatures

Temperatures higher than 32.2°C have been found to decrease crop growth significantly. Some crops have a critical temperature limit as low as 13°C (Ontario Department of Agriculture and Food, 1978). Thus, the use of K- and C-Reactor discharges for soil warming, given an estimated delivery range between 52°C and 75°C, would require a method to lower the temperature before the cooling water could be used for soil warming.

The SCERI (1978) assessment determined that a volume of 21.5 cubic meters per second of water at a temperature of 32.2°C, distributed through a subsurface pipeline, would warm and maintain the soil temperature of a 1000-acre field during early spring. This would allow an approximate 5.6°C reduction in the temperature of the cooling water. Using a combined reactor cooling water effluent volume of 22.6 cubic meters per second at a maximum discharge temperature of 75°C, an estimated additional 50 cubic meters per second of local ambient surface water (at a March ambient Savannah River temperature of 13°C) would be required to provide 32.2°C effluent water for soil warming. Based on SCERI calculations of water distribution, approximately 3395 acres of agricultural land could be warmed using this method. However, the quantity of additional local surface water required to cool the reactor effluent to meet soil warming needs is approximately one sixth of the average annual Savannah River stream flow (295 cubic meters per second) near the SRP.

Reactor operations at the Savannah River Plant would have a significant effect on the supply of heated water available for soil warming. DOE cannot ensure a continuous supply of heated water due to frequent reloading and maintenance activities at the reactors; thus, system users would have to depend on other means for warming the soil when the supply of cooling water from the reactors was not available.

Because soil warming for agricultural purposes is required only during the coldest portions of the year, this method of heat dissipation would not be feasible during the warm seasons. For this reason and because of the need to cool reactor effluents to levels acceptable to plant growth requirements while using only reasonable volumes of local surface waters, the soil warming application would not preclude the need for cooling towers at the SRP.

Based on its assessment of the soil warming application, SCERI (1978) concluded that the potential limited benefits of soil warming do not justify the costs for such a system. Soil warming is useful for, at most, 6 months per year and the use of SRP waste heat is not replacing (and conserving) another energy source because soil warming is not practiced commercially. Estimated costs to the user for installation of the soil warming equipment are $5000 per acre for what is only an experimental system. The small profit margin for crops that do well on large acreages makes the additional soil warming investment economically unsound for large farms.

In addition to the costs associated with the soil warming equipment and agricultural production, the user would be responsible for all National Pollutant Discharge Elimination System (NPDES) permit requirements for the ultimate disposal of the reactor cooling water effluent after use in the soil warming application.

The estimated costs of the DOE delivery of K- and C-Reactor cooling water to the offsite user location would be the same as those discussed for irrigation. The estimated total construction costs for pumping stations and pipelines for soil warming range between $188 and $215 million, and the estimated annual operating costs for these delivery systems would be approximately $18 million. These costs would be in addition to the DOE costs for construction and operation of the anticipated cooling towers for K- and C-Reactors.

I.3.3 GREENHOUSE HEATING

SCERI (1978) determined that, of the five potential applications it evaluated for the utilization of SRP waste heat, greenhouse heating appeared to be the best prospect. However, as with the other options, SCERI concluded that this application could not be a major use of the waste heat, but it could be incorporated into an industrial/agricultural park as one of the last recipients in an energy cascade. Based on its review of the greenhouse application, ADL (1983) concluded that "some greenhouse operations might be possible and could represent an interesting demonstration activity. However, the presence of low cost heat is not likely to be a sufficient incentive to attract any truly commercial activities."

SCERI (1978) cited a report (Boyd et al., 1977) on an experimental greenhouse facility in Minnesota that used cooling water waste heat from a powerplant of Northern States Power Company for both heating and cooling purposes. This greenhouse has been used for the successful production of tomatoes, lettuce, and roses during the winter.

The Pennsylvania Power and Light Company (PPL) has established a greenhouse complex at its Montour Steam Electric Station (a coal-fired powerplant in east central Pennsylvania) to deliver heat to greenhouse operators (PPL, 1982). PPL uses the discharge from the plant's cooling towers rather than directly from the condensers because the greenhouse operators could not process water warmer than 45°C. Based on a flow rate of 0.022 cubic meter per second of 37.8°C cooling water (annual average) per acre of greenhouse, this system, as presently operating, has the capacity to supply 34 or 17 acres of greenhouses with or without pump assistance, respectively. At the time of the report, 13 greenhouse acres were under cultivation. This application utilizes approximately 1 percent of the plant's cooling water with an approximate 5.6°C reduction (to 32.2°C) in cooling water temperature for return to the plant.

The PPL greenhouses employ an underfloor heating system and an overhead (air heater) system. Each greenhouse operator had to install full-capacity gas- or oil-fired backup heating systems and self-draining pipes to ensure the maintenance of suitable temperatures in the greenhouse during powerplant outages and extremely cold periods.

If the PPL figures are used as a basis for estimating the amount of greenhouse area necessary to lower the temperature of the cooling water discharges from K- and C-Reactors without cooling towers and still meet a discharge temperature of 32.2°C, 30.2 cubic meters per second of local surface water at ambient Savannah River temperature in January (approximately 10°C) for dilution/cooling and 2402 acres (not including associated equipment and access areas) of greenhouses would be required.

PPL estimates that its 34-acre greenhouse cost $35,650 per acre to construct and that the annual heating cost (annual charge for the pipeline) is about $13,290 per acre (PPL, 1982). The SCERI (1978) study at SRP estimated the capital costs of greenhouse construction at $43,560 per acre, with an annual energy cost of $7675 per greenhouse acre.

Based on an estimate of 2402 acres of greenhouses needed to dissipate the waste heat from K- and C-Reactor discharges without a cooling tower and meet a 32.2°C discharge temperature, greenhouse construction costs (excluding costs for the delivery of cooling water from the reactors) would range between $86 and $105 million; annual energy costs would range between $18 and $32 million.

When the heat in the water used for greenhouse heating is not dissipated to required levels, discharge of this water would require a cooling system, such as a cooling tower, to meet South Carolina water-quality standards.

I.4 POTENTIAL AQUACULTURAL APPLICATIONS

I.4.1 PRAWN PRODUCTION

The SCERI (1978) report found that, for biological, technical, and economic reasons, the freshwater prawn (*Macrobrachium rosenbergii*) was the only crustacean with commercial culture potential at the SRP. However, because no commercial prawn farms of the type envisioned exist, the SCERI report concluded that extensive pilot-scale testing and research would be required to determine the extent of this economic potential.

The SCERI study determined that the greatest potential for commercially successful prawn farming in the local area would result from the use of a combination of very intensive indoor and outdoor culture systems. A production plan was proposed for a controlled-environment pilot operation that would utilize indoor tanks for the brood-stock, hatchery, and nursery phases and outdoor ponds for the production phase, during which juvenile prawns would be grown to marketable size. The local climate is such that prawn culture can occur outdoors only during the warmer months of the year. Thus, the cooling water from K- and C-Reactors could contribute heat to an aquaculture operation during the colder months. The low-level waste heat from SRP reactor cooling water could be used to maintain water temperatures in a range favorable to prawn growth (26-30°C), making year-round production possible. However, the presence of tritium in the reactor cooling water precludes direct contact with the prawn culture medium [21 USC 321(s) and 342(a)(7)]; therefore, waste heat could only be used indirectly, through a heat-exchange system, to heat the culture water. This would necessitate the local availability of large volumes of high-quality water (uncontaminated with biocides from agricultural uses, industrial wastes, etc.) for the culture medium. In addition, the commercial feasibility of using SRP waste heat for prawn production would depend on the cost of the heat-exchange system best suited for large-scale production, which could be determined only through pilot-scale testing.

Water temperatures higher than 33°C are detrimental to prawn growth; accordingly, during the warmer periods of the year, the use of outdoor ponds for heat dissipation would be negligible. (Intensive indoor tank culture would allow year-round use, but would require only relatively small volumes of reactor cooling water for tank warming.) Conversely, a continuous supply of heated cooling water would have to be provided to the prawn farm during the colder months. Any significant interruptions in this flow could result in the complete loss of the prawn crop. Therefore, a backup heating system would be required to ensure controlled maintenance of suitable temperatures during periods of reactor shutdown.

The SCERI report concluded that the potentially most feasible and economically successful system for prawn production using SRP waste heat would be with intensive management techniques using small (1/4-acre) ponds and maintaining high densities of individuals in the ponds. The estimated potential production from such intensively managed units ranges from about 6000 to 8100 kilograms of whole prawns per acre per year. The type of system envisioned by the SCERI studies would use 10 to 100 acres of growout ponds plus associated hatchery and nursery facilities. SCERI assumed that circulation of SRP heated water would be required for 8 months of the year. During the coldest periods, SCERI estimated that a maximum volume of 0.022 cubic meter per second of 38°C reactor cooling water effluent (assuming that pond water could be heated 14° to 17°C via the heat exchangers) would be required for heating each 1/4-acre pond. Considering the maximum prawn farm size suggested by SCERI of 100 acres, pond heating during the coldest portion of the year would be able to utilize only 8.8 cubic meters per second (39 percent) of the total cooling water effluent from K- and C-Reactors. Some other form of cooling of the effluent would be required for the remaining volume (13.8 cubic meters per second) to meet regulatory requirements. Also, SCERI determined that additional cooling of the reactor effluent (to reduce the temperature to 38°C) would be required before passage through the culture system heat exchangers for maintenance of suitable temperatures in the ponds.

The use of cooling water from K- and C-Reactors for prawn production would require the delivery of this water via a pipeline to an offsite prawn producer(s). In addition to the costs associated with the delivery of the cooling water (estimated construction costs of between $188 and $215 million and estimated annual operating costs of about $18 million), cooling systems (once-through or recirculating cooling tower) would still be required to meet environmental standards during the warm season when the prawn producer(s) would not need the cooling water from the reactors.

I.4.2 CATFISH PRODUCTION

The SCERI report (1978) examined raising such noncrustacean food organisms as clams, eels, and exotic fish such as tilapia. Due to the lack of literature on the potential environmental impacts for an inadvertent introduction of these species into the South Carolina environment, and due to specific technical difficulties with the culture of each species, SCERI eliminated most of these candidates from further consideration as potential aquaculture products. However, it did consider channel catfish (Ictalurus punctatus) culture as a potential application. Catfish farming is presently centered along the Mississippi River, particularly in Louisiana, Mississippi, and Arkansas, where the major portion of the product market also exists. In comparison to the freshwater prawn, the per pound value of catfish is lower and, while prawns are relatively disease-free, catfish are particularly susceptible to certain bacterial, viral, fungal, and algal diseases that often occur under culture conditions. Because these factors would greatly influence the economic feasibility of a commercial catfish operation using reactor waste heat, SCERI determined that the establishment of a research facility would be required to develop the technology of growing catfish in heated ponds and raceways and to develop strains that would be better able to cope with stressful environments and diseases.

Channel catfish have optimum growth and feed conversion at relatively high temperatures (28.9°-31.1°C). Using SRP waste heat, a catfish culture system could expand what would normally be 7 to 8 months of production in the southeastern United States to year-round production. However, the presence of tritium in the reactor cooling water precludes direct contact with the catfish culture medium [21 USC 321(s) and 342(a)(7)]; therefore, waste heat could only be used indirectly, through a heat-exchange system, to heat the culture water. This would necessitate the local availability of large volumes of high-quality water (uncontaminated with biocides from agricultural uses, industrial wastes, etc.) for the culture medium. In addition, the commercial feasibility of the use of SRP waste heat for catfish production would depend on the cost of the heat-exchange system best suited for large-scale production, which could be determined only through pilot-scale testing.

Optimum catfish production requires culture water temperatures of 28.9° to 31.1°C. Water temperatures must remain above 15.6°C if the fish are to continue to grow throughout the year; at temperatures greater than 32.2°C, the fish do not feed regularly. Accordingly, during the warm periods of the year, the use of outdoor ponds for reactor heat dissipation would be negligible. Conversely, a continual supply of heated cooling water would have to be provided to the catfish farm during the colder months; any significant interruptions in this flow could result in complete loss of the catfish crop. Therefore, a backup heating system would be required to ensure maintenance of suitable temperatures during periods of reactor shutdown.

Open ponds are the most common facilities used in catfish production, and their cost in relation to the volume of fish produced is less than that of other facilities such as cages and raceways. Cage culture accounts for only a small proportion of commercial production, used where the culture water is not readily seined (for collection of grown fish). Additional research is required before cage culture could be adopted on a wide scale. Raceways are generally used when only a small amount of land is available for farming. In pond culture, spawning and fry-rearing ponds are usually 1 acre in size, while the most profitable size for growing ponds appears to be 20 acres.

While the SCERI (1978) study did not quantify potential cooling water use or the degree of heat dissipation possible using a heat-exchange system with catfish production ponds, the limitations for waste heat utilization probably would be similar to those for prawn pond farming; that is, (1) that pond heating could utilize only a fraction of the cooling water available from K- and C-Reactors, and (2) that the volume of cooling water that could be utilized for pond heating would require some precooling prior to passage through the heat-exchange system. As with prawn farming, these limitations would necessitate an additional means of reactor effluent cooling to meet regulatory requirements and to make available a usable source of waste heat.

The SCERI study (1978) estimated that it could cost as much as $20,000 to construct a 20-acre pond. Construction of a 50-acre pond would require an estimated $60,000. Enclosing the hatcheries and brooding tanks could double the costs. In addition, SCERI estimated that annual operational costs could amount to more than $1 million for every 640 acres of ponds.

The use of cooling water from K- and C-Reactors for catfish production would require the delivery of the cooling water via a pipeline to an offsite producer(s). In addition to the costs associated with the delivery of this water (estimated construction costs of between $188 and $215 million and estimated annual operating costs of about $18 million), cooling systems (once-through or recirculating cooling tower) would still be needed to meet South Carolina water classification standards during the summer, when the catfish producer(s) would not need the cooling water from K- and C-Reactors.

I.5 ETHANOL PRODUCTION

The technology for ethanol production is fully established; a considerable amount of development and market research has been completed during the past decade. The largest markets for ethanol would be as fuel for engines or as gasoline blending stock (gasohol). The market for gasohol currently exists. At present, however, this market in the United States cannot compete economically with the price of gasoline.

Even though gasohol marketing efforts during the past 10 years have diminished with the decrease of subsidy support from tax credits and the reduction of economic incentives with the fall in crude oil prices, there is still a potential for ethanol to help offset declining U.S. crude oil production. Due to its strong octane-enhancing properties, a barrel of alcohol displaces more than a barrel of crude oil.

Waste heat from K- and C-Reactors at 77°C could be used economically for ethanol production until it reaches 55°C; technically, it is possible to use this heat to a minimum of 32.2°C. The ethanol production process is a batch activity, during which cooling water must be supplied continuously. Because the production process could not always accept the waste heat, the ethanol facility would require a cooling water system to meet the South Carolina water-quality standards.

The Office of Technology Assessment (OTA) prepared a study to evaluate ethanol production potential (OTA, 1980). A slurry of biomass material (grains are preferred but other crops can be used) would be prepared at ambient temperature; it would be heated to about 90°C to promote enzyme development. The high-temperature enzyme addition accelerates the fermentation process. After fermentation, a mechanical separator would remove the solids, fibers, and particles from the slurry. Depending on the biomass source, the removed solids could be dried, caked, and used as animal feed. This drying operation would start at about 90°C and require a temperature higher than 100°C to be efficient; therefore it would not be a potential application for the waste heat from K- and C-Reactors because the cooling water temperatures are too low.

The use of the available waste heat for the major energy requirement (i.e., the distillation and purification operation) for this process would require a departure from the normal commercial practice - performance of the distillation at a partial vacuum pressure. This would lower the reboiler temperature requirement, but it would add significantly to the required capital costs. Of even greater concern, this departure would remove the process from a well-established commercial practice.

The OTA report (1980) concludes that a 38 to 189-million-liter-per-year process plant was the largest that should be built, due to the requirements for transporting the biomass material to the facility and for transporting the ethanol to market and the byproduct (the dried stillage) to a disposal point or a secondary market. The OTA report states that an acre of corn could produce 640 to 980 liters of ethanol per year in such a process. This report estimates that the ethanol production costs for a 189-million-liter-per-year plant would be about $0.32 per liter and that product delivery costs would be about $0.08 per liter, for a total product cost of $0.40 per liter. OTA further concluded that ethanol as an octane-boosting additive to gasoline would not be economical until crude oil prices ranged from $20 to $30 per barrel (in 1980 dollars). If the SRP waste heat were provided free to the producer, the savings realized would only be about $0.02 per liter, which would not be of great importance in a decision to build such a plant.

A variety of biomass feedstocks could be used in the process. The OTA (1980) and Rogers (1980) studies indicate that the best crops are corn or grain sorghums. Both of these grains produce a solid byproduct that is suitable for processing as an animal feed. Because the Savannah River Plant is not located in a major corn or grain growing area, crop transportation costs would be significant. Also, as indicated above, existing ethanol production facilities are operating at well below full capacity due to depressed crude oil prices.

Clemson University (Cross et al., 1982) studied the feasibility of using waste heat from SRP reactors and root crops such as sweet potatoes and Jerusalem artichokes as feedstock. The estimated production costs of ethanol using these crops ranged from $0.42 to $0.45 per liter, excluding the cost of the feedstock. This study indicated that further study along these lines would not be productive unless a significant cost-reduction breakthrough in harvesting or processing technology is achieved.

I.6 SUMMARY

None of the potential applications for the utilization of SRP waste heat are considered substitutes for cooling water systems because of institutional, technical, and economic problems. Rather, such costs are considered additive to the construction and operation of cooling water systems for K- and C-Reactors. Reactor cooling water cannot be used directly on crops or other food products because of the presence of tritium in the cooling water discharges. This precludes direct contact use for irrigation of crops and as an aquacultural growth medium. Reactor effluent could be used indirectly in agriculture or aquaculture through the warming of crop soils or the heating of greenhouses or prawn or catfish culture ponds, requiring the use of expensive heat-exchange systems. Such agricultural and aquacultural applications are of seasonal value, required only during the coldest months of the year. Even during the period of use, these applications alone would not dissipate sufficient waste heat to meet State temperature discharge requirements. These potential applications, as well as an ethanol production facility, would require significantly greater capital costs (Table I-2) than recirculating or once-through cooling towers and would take several years to implement, even if commercial operators could be identified. For these reasons, the Department of Energy does not consider the agricultural, aquacultural, and ethanol production applications to be reasonable alternatives to the construction and operation of once-through or recirculating cooling towers for K- and C-Reactors.

Table I-2. Costs for Alternative Cooling Systems and Waste Heat Applications for K- and C-Reactors

Alternative/application	Capital cost ($ million)	Annual operating cost ($ million)
Once-through cooling towers	$87	$0.4
Recirculating cooling towers	$190	$2.4
Irrigation[a]	$275-302	$18.4
Soil warming[a]	$275-302	$18.4
Greenhouses[b]	$86-105	$18-32
Aquaculture[a]	$280-324	$4-6
Ethanol production	$NP[c]	$NP

a. Estimated costs include the costs for once-through cooling towers (because cooling water discharge temperatures are too high to be used during summer) and the costs for delivery of cooling water to the SRP boundary; they do not include costs of user irrigation, soil warming, or production systems (ponds).
b. Estimated costs do not include the costs of delivery of cooling water discharges or of the cooling system that might be required for discharge of the warm water from the greenhouse.
c. NP = Technology not practicable unless gasoline prices rise significantly or there is a cost reduction breakthrough in harvesting feedstock or processing technology. (Note: The estimated capital cost of an ethanol production facility would exceed several hundred million dollars).

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APPENDIX J

COMMENTS AND DOE RESPONSES ON DRAFT ENVIRONMENTAL IMPACT STATEMENT ALTERNATIVE COOLING WATER SYSTEMS

During the public comment period from March 28 through May 19, 1986, the U.S. Department of Energy (DOE) received 27 statements and/or comment letters on the draft version of this environmental impact statement (EIS). In addition, three comment letters were received after May 19, 1986. The 30 statements and letters included eight from Federal agencies, seven from agencies and offices of the States of Georgia and South Carolina, five from individuals associated with various colleges and universities, two from members of the United States House of Representatives, and eight from concerned individuals.

This appendix presents the individual statements and/or comment letters and DOE's responses to them. If a comment has led to a text revision in this EIS, the revision is identified with a vertical line in the margin, a comment letter, and a number designation. Table J-1 lists the comments received, and Table J-2 lists the individual comments and DOE responses.

Comments received at the public hearings and during the subsequent comment period dealt with the following issues:

- Alternative uses of cooling water for various agricultural, aquacultural, and power production purposes
- Cost breakdown, present worth analysis, projected lifetime, and thermal performance for cooling towers
- Establishment of an independent review group for all environmental impact statements
- Preference for recirculating cooling towers due to cost and environmental soundness
- Impact of chlorination and corrosion inhibitory compounds upon the aquatic environment
- Incorporation of predictive Section 316(a) type information
- Analysis of entrainment of fish eggs and larvae

DOE has responded to all these issues and has included additional information in some chapters and appendixes as appropriate.

Table J-1. Comments and Statements Received on the Alternative Cooling Water Systems Environmental Impact Statement

Designation	Individual or organization	Page
AA*	Henry D. McMaster	J-3
AB*	Heinz J. Mueller	J-6
AC*	Harry Busbee	J-7
AD*	William N. Wheeler	J-8
AE*	Bart Ruiter	J-10
AF*	Richard Hegg	J-11
AG*	Roger Dale Wensil	J-13
AH*	Richard Dickison	J-16
AI*	Frank Watters	J-18
AJ*	Diane Mahoney	J-19
AK*	Sam Schillaci	J-20
AL*	William F. Lawless	J-23
AM	Ralph F. Cullinan	J-29
AN	Sherman R. Ellis	J-30
AO	Willian D. Anderson, Jr.	J-31
AP	Bruce Rippeteau	J-33
AQ	J. Leonard Ledbetter	J-35
AR	Richard W. Riley	J-37
AS	Richard O. Hegg	J-39
AT	Charles E. Lee	J-42
AU	Danny L. Cromer	J-45
AV	Hilary J. Rauch	J-48
AW	Thomas F. Hartnett	J-49
AX	Butler Derrick	J-51
AY	John C. Villforth	J-54
AZ	Don L. Klima	J-56
BA	Dan M. Mauldin	J-58
BB	James A. Joy, III	J-60
BC	Jack E. Ravan	J-66
BD	Bruce Blanchard	J-91

*Comments or statements received at public hearing held by DOE on the Draft EIS on April 30, 1986.

Table J-2. DOE responses to comments on Draft EIS

Comment number	Comments	Responses
	TESTIMONY OF HENRY D. McMASTER, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
	Thank you, ma'am. I'm very happy to have the opportunity to speak to you today on this issue, and appreciate your taking the time to conduct this hearing. I know the people of this area and of the state are very interested in the Savannah River Plant because it is a very important part of our state.	
AA-1	There are just a few things that I'd like to say, and basically, this deals with the one alternative to the cooling towers, or any other form of cooling the water, and that is the irrigation system. It is a system which has been recommended for study by Clemson University and the Department of Agriculture, and I think as a private citizen, and also one interested in public affairs, I think that this is something that needs to be included in the Environmental Impact Statement, because I believe we must study the issue, here, to see if there aren't ways to put more back into the state; to have some more positive benefits flowing to the state than are presently flowing from the Savannah River Plant, and of course, those benefits now are substantial to the state and to the nation. But, we have a good opportunity, here, I believe, to do something positive for the state, for the State's economy, particularly in terms of the farm industry, the farm, the farmers.	DOE has incorporated a new appendix in this EIS (Appendix I) that addresses the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.
	So those, briefly, that's what I had in mind. I'll say this: I think that instead of treating the huge amount of heated water and potential energy it represents - which is estimated to having a value of about a half a billion dollars a year - as a nuisance, and something we should worry about being	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	disposed of, we should be studying the alternatives for harnessing this for future economic development of this area and the State of South Carolina, because it does provide some tremendous opportunities for us. There are many needs for heated water in various industries. Besides attracting new industries, this heated water could benefit the area farmers if used for inexpensive irrigation or crop drying. The nation's fuel consumers could benefit from the inexpensive production of ethanol this heat could produce, not to mention the area farmers who could produce the raw materials from various row crops, including turnips, rutabagas, parsnips and all sorts of other things, that Clemson University has been talking about.	
	In my opinion, I think what we should do is work to redefine the role of the Savannah River Plant. We would all benefit if the bureaucratic red tape that's in all government, especially the Federal Government it seems, were cut and if the blinders which narrow us to the potential benefits of this plant were taken off. I think that we cannot allow the opportunity that this resource--this hot water--presents to the people of this region, for economic growth, to be thrown away by the construction of very expensive water-cooling towers. Instead, we must look toward ways of using this energy to benefit all of the area's people; and the Savannah River Plant's role should be redefined in that fashion, I believe, so that it can make these additional major contributions to the economy and ecology of South Carolina. But, in a nutshell, this is what could happen: instead of taking this hot water and cooling it for later discharge into the river, we could have all sorts of things to be based upon that. I understand that the water from the present reactors is not hot enough to produce electricity. If a new production	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	reactor were built here--and I understand there's question about that--of course, that water would be hot enough; it could be used in that fashion to produce electricity and could possibly reduce heating bills about $200.00 per family around South Carolina, I am told. But, with the present reactors that we have, the hot water could be used, number one, to create ethanol which, of course, doesn't have the environmental problems associated with it of coal, and the regular gas-burning automobiles. And, also, that after the crops that are used, like parsnips, rutabagas and turnips that have a much higher starch and protein and sugar content than other crops that are used to make those--to make the ethanol--the residue could be used to feed hogs, for example, could be used for feed all around the state. So, you could have a whole industry developing of farmers growing these row crops that they can't grow, now, because it's too expensive to dry them, and they're about ninety percent water, and it's just too expensive to dry them in order to ship them around the country. So, people don't get into that. If we were to use the heat given off by the present system in that fashion, we could build up that farming industry, that part of the farming industry; create new industries for feeding hogs, things of that nature; and then, take the water and run it through, for instance, part of Allendale County. I'm told there are about 300,000 acres that could be irrigated there by the water, and it would be very helpful. As far as the new production reactor goes, which is not a question, here, I believe that if it is constructed, here, when it is constructed, here, it should also be viewed from these same viewpoints, to see if these types of positive benefits could be built into that system to benefit the people of this area.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF HEINZ J. MUELLER, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
AB-1	I'm Heinz Mueller. I'm with US EPA in Atlanta. EPA is currently reviewing the draft Environmental Impact Statements to determine which of the alternatives provide the least impact to the environment. We will be submitting formal comments to DOE by mid-May, and we're primarily here today to listen to any comments and concerns. We appreciate the opportunity to participate. And that's really all we have to say today. Thank you.	Comments noted.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF HARRY BUSBEE, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
	I am Harry Busbee, and I am Assistant to the Commissioner of Agriculture for the State of South Carolina. I am representing Commissioner of Agriculture, Leslie Tindall, here today.	
AC-1	I think you all realize the plight of the South Carolina farmer today, and when we are twelve or fifteen inches less water this year than we were last year, I think that we realize in agriculture how important the waste water at the Savananh River Plant can be to agriculture. We at the South Carolina Department of Agriculture would like to recommend to the Department of Energy and to the Savannah River Plant to consider including in the Environmental Impact Statement the use of irrigation and/or aquacultural use of water as a means of heat abatement. I realize that this is a very complex issue and one not easily resolved. Your consideration in including irrigation and/or aquacultural use of water as a means of heat abatement in the EIS would be greatly appreciated. Thank you.	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF WILLIAM N. WHEELER, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING My name is William N. Wheeler. I am here on my own behalf and I have a statement to make in an effort to get an answer to a question.	
AD-1	Any of the DOE information that I have seen in the past following through with the late investigation in L-Reactor gave cost figures, but they gave no breakdown of those costs; and having been employed as an engineer in the fuel and power industry, I would be very curious as to see the cost breakdown of the estimates as far as the money being expended. It is an extremely large sum of money; and I think the public should be shown how the money should be spent. Thank you.	The cost breakdown for cooling towers varies with the type of tower and the location selected. The following breakdown of costs for cooling tower systems under consideration was developed for planning purposes. These percentages would range between the values presented when the final design has been approved. <u>Mechanical draft, once-through or recirculating towers</u> 1. Cooling tower, tower basin, tower foundations, tower preparation area, (leveling, grading) diversion boxes, pump pits and piping, 79 to 83 percent of the estimated cost. 2. Electrical distribution upgrade, extension of power to tower site, and electrical control building at the tower site, 12 to 17 percent of the estimated cost. 3. Canals, headwalls, clearing and grubbing, access roads, chlorinated and dechlorination systems, including chemical storage, 3 to 6 percent of the estimated cost.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		<u>Gravity-fed, once-through or recirculating towers</u> 1. Cooling tower, tower basin, tower foundations, tower preparation area, (leveling, grading) diversion boxes, pump pits and piping, 71 to 83 percent of the estimated cost. 2. Electrical distribution upgrade, extension of power to tower site, and electrical control building at the tower site, 7 to 19 percent of the estimated cost. 3. Canals, headwalls, clearing and grubbing, access roads, chlorination and dechlorination systems, including chemical storage, 10 to 13 percent of the estimated cost. Also see response to comment BC-6.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF BART RUITER, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
AE-1	I'd just like to say, my name is Bart Ruiter. I'm with the South Carolina Department of Health and Environmental Control. We also are currently reviewing the draft EIS and we should have our comments in by May 19th. That would be it.	Comments noted.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF RICHARD HEGG, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
	PUBLIC HEARING ON HEAT ABATEMENT PLANS FOR THE SRP April 30, 1986 Aiken, SC	
	Richard Hegg, Head, Agricultural Engineering Dept Clemson University, Clemson, SC	
AF-1	I am aware of the proposed plan to construct a heat abatement facility at the Savannah River Plant. The purpose of this statement is to request that one option for this heat abatement should be irrigation on cropland, pastureland, and forest in the area of the Savannah River Plant. I feel this is a technically feasible option; therefore, it should be addressed by DOE and the Savannah River Plant. It is logical to utilize this resource, being a large volume of heated water, rather than building cooling lakes or cooling towers. The option of irrigation would be of benefit to South Carolina agriculture, and would show that the Savannah River Plant is interested in a project that would emphasize utilization of a resource. There are many points that would need to be addressed, such as legal, crops, climatic effects, surface water, ground water, wildlife, off-season use, social, economics, and the overall organization. It would be appropriate that a feasibility study be conducted, and I would be happy to work with those persons preparing an environmental statement, to work on this study of a large-scale irrigation project. There are scientists at Clemson University and professionals with state agencies within the state to adequately provide the necessary technical assistance.	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	And to elaborate a little bit, I've talked with several people at Clemson regarding this, and contacts with other agricultural interests in the state, and I believe this morning a representative of Les Tindall's office, the Commissioner of Agriculture, was here also expressing support of this idea. We feel that, as I pointed out, there may be many potential problems, but it certainly would be something that needs to be addressed. And, I am not aware that this option has been addressed or there will be a response to this question, but I would certainly like to know that. And, I feel that with the volume or the amount of money that would be invested in these cooling towers, that certainly a feasibility study prior to the initiation of that would be beneficial, and if it came out that it would not be practical, would not be feasible, that it would stand on that basis. But it certainly, we feel, would need to be addressed. And I would encourage you to proceed on this, and I guess I would be waiting for a response from the representatives here, if I could be of help or make contacts as would need to be made. So, at that point, that concludes the comments I'd like to make. Thank you for the opportunity.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF ROGER DALE WENSIL	
	Roger Dale Wensil 14 Creek Court Aiken, SC 29801	
AG-1	My statement deals with the construction of this proposed cooling tower project as well as other construction, maintenance and operations activities on the Savannah River Plant. I would like to address this meeting about the problem of illegal drug use on the Savannah River Plant. We all know the nature of the work on the Savannah River Plant, and because of the potential dangers involved in this work, I say that if there is any place in the United States that should be drug-free, the Savannah River Plant is it. Drug users pose a terrible danger to us, whether they work in construction, operations, or maintenance. You are being too lenient on these drug users. Your policy of rehabilitation for drug users is admirable, but I feel that for our protection, these people should be permanently removed from the Savannah River Plant. At present, people who are found to have drugs in their bodies on the Savannah River Plant are sent home for thirty days, and then are allowed to return to work. One of your chief responsibilities is the safe operation of this facility. By knowingly allowing known drug users to return to work on the plant	These comments are outside the scope of this EIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	site, you are just as guilty as they are in the event of an accident. In such an event, I feel that the courts of this land would find you, the Department of Energy, criminally negligent and liable for any damages done to us by these drug users.	
	The South Carolina Electric and Gas Company and the Georgia Power Company have a policy that when a person is found to have drugs in their system while at work, they are fired and permanently barred from employment.	
	I believe the citizens of Aiken County deserve at least the same protection as the citizens being protected by these companies.	
	I say that for the protection of the people of this area that no construction, operation or maintenance work should be done on the Savannah River Plant until this dangerous situation is corrected.	
	These drug users have the potential to cause the most disastrous effect that can be imagined on the environment.	
	Fire these drug users and bar them from future employment. Replace them with people who realize the responsibilities that go along with a job on the Savannah River Plant.	
	There are plenty of qualified people looking for jobs who would be glad to have the jobs that these drug users seem to have so little regard for.	
	I have deliberately not quoted the figures available to me concerning drug use on the plant site, but I think that if the people of this area were aware of what a serious problem you allow to exist on the site, it would scare the hell out of them.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	I challenge DOE to report to the public on a regular basis the percentage of people, plant wide, who test positive in your drug abuse program, and what actions you take. Thank you.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF RICHARD DICKISON, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
	Draft Environmental Impact Statement Aiken, South Carolina April 30, 1986	
	Comments of Richard Dickison	
AH-1	Hot water from the Savannah River Plant should not be considered a waste product, but a useful by-product. Presently, the Sandoz Company in Allendale County is burning fuel oil to make hot water. The hot water from Savannah River Plant could be purchased by Sandoz or other companies to make American products more competitive. Allendale currently has a depressed economy. Low-cost industrial hot water could be the economic incentive needed to attract new industries to Allendale County and Barnwell County. Instead of spending in excess of a hundred million dollars to create a capital structure which turns an economically feasible raw material or source of low-grade heat into plain river water, the Department of Energy should explore the possibilities of piping the hot water to Allendale County for use in existing or new industries. It may well be feasible to construct an insulated pipe and associated pumping facilities under the cost of constructing cooling towers, and, by marketing the hot water to industries, establish a reasonable pay-back period. Eventually, the sales of hot water could become a profit center for the Department of Energy. Certainly, the discussed plans using the hot water to produce ethanol and the spent water to irrigate	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	root crops used as the feed stock (sic) for the ethanol plant need to be fully explored before any construction of cooling towers begins. America needs jobs and Allendale and Barnwell Counties could certainly use the economic benefits created by new industry developed from farming and ethanol plants.	
	Thank you.	
	ADDITIONAL COMMENT: I have regretted that the ethanol plant has not so far been discussed in detail, and I suggest that a discussion of such a plant be included with the statements being prepared. Thank you.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF FRANK WATTERS, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
AI-1	I put my name down there to make sure that the subject that has already been discussed was going to be on the agenda and into the minutes, which was the utilization of the energy source from the hot water. Both the gentlemen, Mr. Hegg, and the previous gentleman, here, recommended that the DOE study the use of the water as irrigation and also as a heat source for the proposed demonstration ethanol plant. I think it's feasible. I'm quite familiar with quite a bit of what goes on at Savannah, having had thirty-one years' experience in it, and have studied the use of heat, for example, from spent fuel for irrigation or heating and other things. I know there are some problems, but I think those can be overcome by the double-containment system, which everybody should be familiar with. So, my only purpose was, getting my name on there, was not to be heard, but to make sure that the topics I was going to cover were covered, and they have been covered and I would second those recommendations. Thank you.	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF DIANE MAHONEY, APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
AJ-1	I have just one single question that I hope someone here can answer. Where does P-Reactor fall in all of this, and why has it been excluded in your consideration of cooling water alternatives? Specifically, can you tell me where ponds 1 through 4, and pond C fall in all of this? Is there someone who is supposed to answer my question, or ?	As stated on page 1-1 of Chapter 1 of the DEIS, discussions of P-Reactor are not within the scope of this EIS. This is because continued use of the recirculating cooling system for P-Reactor was approved by SCDHEC on May 14, 1987, based on Section 316(a) and 316(b) studies conducted by DOE which demonstrated the existence of a balanced biological community in Par Pond.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF SAM SCHILLACI APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
AK-1	I was just going to state about the same thing I stated last time, which you can read in the documents that went out. But, just to kind of briefly go over it, I'm a former employee with Savannah River Plant, and I was retired because of mental problems, and I question everybody here for listening to me, because I'm insane. But, that's beside the point. I did get a pension from the government, so I can't complain. O.K. My stress was brought on because of all the stress that the government, any government employee, can tell you about. Well, anyway, I had six months off without pay, and had time to think a lot, write, which I enjoy, and also I went into business for myself, which has been a plus for me. But, I'd like to correct the grammar here, on the statement, It says, "I like to drink a lot," but that's wrong, "I like to think a lot." I do drink a little bit, not much, but, really, I can't complain. And see, the reason, because my insanity is because I talk to the powers that be. And this accident that happened recently, we really shouldn't worry, because mankind usually works itself out for the best. And all she's wondering about is she would like to have a pony someday. (sic) Way in the future, plus some land to ride it on. But, anyway, that's the insane part. The only thing different I wanted to add today, if I could, is read one of my short stories if that's possible. And I wrote it--I'd like to be a cartoonist someday, but I doubt if I am--I'll just show you, this is an album cover that--I'll show it to the back of the room, here---it's a couple of men. And	Comments noted.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	they look like they're men from Earth, and that's the name of the album cover, but we've got a problem with the world today. There's a lot of men in the world, plus women. But, this is my short story about these two people that I made up. 10/85-F THE KINGDOM OF SOD or A COUPLE OF SONS OF MEN FROM THE GEORGIA BACKWOODS "Hell, Luke, where abouts we be delivering all this god-durn hay?" I hate to be so dramatic, but I.... "Some durn fool wants it for the land and the stinking horses." "Luke, here I am suffering and dying while this here vomit feeds horses with our blood!" "I know, I'm sick and tired of it. Horses are for working, anybody can tell you that. Not for tickling somebody's underpanties. Even Will Rogers knew that an airplane would take him to heaven. There's just too many snakes in the heads nowadays. Hell, we're all just living on a dream and a prayer. Just like this god-durn government and this kingdom of sod or whatever it is these sons of gad preachers are talking about." "Well, hell Luke, let's say we burn this god-durned hay, and then we get rid of that durned fool and take the land. Then, we could live in that durned farm house like we was virgins." Marco--that's the other guy's name, I named him Marco.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	"I'm hungry for action. I'm sick and tired of this nowadays love. Let's get a moving."	
	I speak crazy a lot, but to me it makes sense. But, anyway, I'd like to just stress to the government that they should really take their time with all their plans, and sometimes they think too much, and maybe a sabbatical will help some people. Who knows. It's up to the individual. I know it's not all for some people, they're in it for the money. But, for other people like myself, I'm here for a good time. So, to end my story, here, I'll repeat my demands, but I've reduced them a little bit. I'll take a quarter of a million dollars, a reporter named Lois, and an Indian princess probably named Lily, and I don't care about going to New Zealand, because they've probably got reactors down there anyway, and I'll shut my mouth. But I think the plant won, because my father came to move me back to Birmingham. Thank you. I have been a thorn in the side of the plant, and they can attest to that, too.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	TESTIMONY OF WILLIAM F. LAWLESS APRIL 30, 1986, BEFORE THE ALTERNATIVE COOLING WATER DRAFT EIS PUBLIC HEARING	
	Review Comments: Alternative Cooling Water Systems DEIS (DOE/EIS-0121D) W. F. Lawless Assistant Professor of Mathematics Paine College April 30, 1986	
	Review Comments: Alternative Cooling Water Systems DEIS (DOE/EIS-0121D) The recommendation of cooling towers in the Alternative Cooling Water Environmental Impact Statement represents a positive step forward. The Cooling Water EIS recommends a cooling water tower alternative instead of the cooling lake that was choosen for the L-Reactor. Nonetheless, this EIS is a highly technical document, but it has been written by experts for the purpose of informing a technically unsophisticated public about a subject few have the time, energy or inclination to validate.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	EIS statements are a step forward in their own right, because researchers with the inclination can delve into these studies. Yet, few researchers will review an EIS. Even fewer have the training to understand the doubly technical meanings, and still fewer have the experience to know what to look for unless they already work for the DOE. For example, during a recent talk in Las Vegas, I made a reference to the contaminated basins on the nearby Nevada Test Site. One person in the audience, a DOE contractor employee, denied that contaminated ponds were in use at the Nevada Test Site. However, a copy of the recent Nevada Test Site monitoring report, which discussed contaminated ponds at the site, resolved the issue. Whereas the experience and training were available to offer insight into that situation, that is not always the case, and this EIS is a different matter. No local independent group of qualified technical individuals in the Central Savannah River Area is paid to devote full time to a peer review of this EIS and to provide insight into what this EIS will mean to the citizens of this area.	
AL-1		This EIS has received extensive independent review by several agencies and groups with specialized expertise in evaluating the data and impact assessments provided in the EIS. In developing the EIS, DOE utilized most of the reference material contained in the L-Reactor EIS, used standard methodologies and relied on scientific and other sources of data compiled from more than 200 publicly available documents that had been developed over the past 30 years, including data from ongoing studies. Selection of the alternatives discussed in the EIS was based on the <u>Thermal Mitigation Study</u> that was submitted to the State of South Carolina as required by Consent Order and was subsequently approved. The environmental data utilized in the EIS to assess impacts was primarily derived from the DOE <u>Comprehensive Cooling Water Study</u> which was required by Consent Order with the State of

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		South Carolina. As discussed in Chapter 5 of the EIS, 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 participated in this study in a review and advisory capacity. In addition, reviewing agencies provided comments on the scope of the EIS at a public hearing and on the draft EIS at a public hearing and during the 45 day public comment period. DOE provided working drafts of the EIS to the State of South Carolina and the U.S. Environmental Protection Agency (Region IV), met with their representatives, and incorporated their comments into the EIS. All required consultations with agencies on endangered species, historic preservation, habitat evaluation procedures, and permit requirements were completed and discussed in the EIS.
AL-2	A lack of oversight can lead to abuses in the continued use of obsolete practices and equipment. The abuses and antiquated practices used by the engineers and scientists at the Savannah River Plant in the past have been well documented. As examples: the coverup of corrosion-pitting in the high-level waste tanks; coverup of the strontium-90 contamination in turtles at an Savannah River Plant seepage basin and found off the plant in a commercial hog farm; the use of cardboard boxes to dispose of radioactive wastes; the contamination of the Tuscaloosa aquifer and drinking water at the plant for at least two years without informing Savannah River Plant employees and so forth. These	A discussion of high-level waste, Savannah River Plant waste management practices, and containment of radionuclides is outside the scope of this EIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	abuses stopped only when the public began to find out about these practices performed by Department of Energy - Savannah River Plant engineers and scientists. But, many other abuses continue: for example, seepage basins, the lack of containment domes on the Savannah River Plant reactors; and the injection of solvents into the air at the Savannah River Plant.	
AL-3	When scientists and engineers operate in a bureaucracy behind closed doors without public oversight or input such as has happened at the Savannah River Plant, abuse is inevitable. When the public gains insight, the exposed abuses stop or are slowed. The Cooling Water Environmental Impact Statement is a difficult document to review within the alloted time. A competent technical review of this EIS should take three to six months, with qualified individuals that have the right to ask the Department of Energy questions and the right to have those questions answered. That last point is very important. Three weeks ago, on April 10, 1986, I was invited to Congress to discuss the new DOE rule on by-product management. The by-product rule redefines most radioactive waste as by-product exempt from EPA and state hazardous waste regulations. The by-product discussion was planned to include introductory statements from both the DOE and a second panel of which I was a member. The introductory statements were to be followed by questions from Congressional members of the subcommittee to both panels in order to debate the by-product rule before Congress. Although DOE made their initial presentation, DOE refused to honor its commitment to participate in an open discussion between the two panels. Three times during the hearing, Congress requested that DOE stay for the peer panel discussion, but to no avail. The Department of Energy walked out.	See response to comment AO-1.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Secretary Herrington of the Department of Energy claims that the DOE environmental programs are aggressive and that DOE is doing a good job of protecting the environment. Admiral Foley, Assistant DOE Secretary for Defense Programs, stated at that April 10th Congressional hearing, that the public will be the ultimate judge of the waste management job done by DOE. He said this just before he and Mary Walker, who is DOE Assistant Secretary for Environment, Safety and Health, walked out of the meeting. If the DOE programs are aggressive as claimed by Secretary Herrington, the DOE should not be afraid to defend its work before the public.	
	What is needed to properly review this cooling water environmental impact statement is a local independent peer review group composed of technical and non-technical members from the CSRA community affected by this and other EIS statements yet to be presented to the public. This peer review group should be funded by DOE through the State of South Carolina but remain independent of both. Precedents have been set in New Mexico at the WIPP facility and Oak Ridge. Both are as a result of lawsuits filed by the states. The peer review group would have the right to access any technical information or have their technical questions answered. EIS documents would be reviewed by the independent review group, and not presented to the public until their review was completed.	
	For too long, scientists and engineers at the Savannah River Plant have held the upper hand over information released to the public. This practice has led to abuses by an unchecked bureaucracy. Congress has drafted legislation that may lead to the end of this self-regulation by the DOE.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Whenever scientists and engineers do not include the public in their decision making process, as in the self-regulation practiced by DOE, the public is held hostage to their work. Not only should such practices cease because the public is excluded, but because such practices are wasteful, and lead to wrong decisions--decisions that are too often destructive to the environment, the public, and the Savannah River Plant employees.	
	An independent peer review group would provide an important check and balance to the work done at the Savannah River Plant. A local peer review group would establish a partnership between DOE and the public, and it would help improve the Department's credibility. When DOE describes its environmental programs as aggressive, that is just a play on words. However, establishing an independent peer review group would give DOE a chance to put those words into action. In closing, I would hope that the day for self-regulated bureaucracies is almost over. Thank you.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF RALPH F. CULLINAN	
	<u>STATEMENT ON COOLING TOWERS - RALPH F. CULLINAN.</u>	
	<u>AIKEN, S.C.</u>	
AM-1	In my opinion, the outflow of Savannah River Plant reactor cooling water at elevated temperatures causes no damage while using the present set-up. Building cooling towers to remove this heat would represent a total waste of scarce taxpayer funds.	The No Action consideration in this EIS is required pursuant to regulations of the Council on Environmental Quality for implementing the procedural provisions of the National Environmental Policy Act (40 CFR 1500-1508). Chapters 2 and 4 of the EIS present and discuss both adverse and benefical impacts of the cooling water alternatives considered.
AM-2	If the energy in this cooling water could be harnessed by an agricultural or other process, it would produce a benefit rather than a depletion of economic resources.	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Ralph F. Cullinan
423 Homestead Lane
Aiken, S.C. 29801

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF SHERMAN R. ELLIS United States Department of the Interior Geological Survey U.S. Geological Survey, WRD 1835 Assembly St., Suite 658 Columbia, S.C. 29201 Mr. R. P. Whitfield Director, Envirnmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Akin, South Carolina 29802 Dear Sir:	
AN-1	The Department of Energy Draft Environmental Impact Statement, "Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina" (DOE/EIS-0121D) was reviewed by this office. We reviewed the water quality and hydrology sections of the chapters on Affected Environment and Environmental Consequences. The staff of this office has no technical questions on the water quality and hydrology sections. Sincerely, Sherman R. Ellis Hydrologist /kd	Comments noted.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF WILLIAM D. ANDERSON, JR. Telephone Area 803 795-3716 College of Charleston Grice Marine Biological Laboratory 205 Fort Johnson Charleston, South Carolina 29412 29 April 1986 Mr. R. P. Whitfield, Director Environmental Division U.S. Department of Energy Savannah River Operations Office P. O. Box A Aiken, South Carolina 29802 RE: DEIS for Cooling Water Systems Dear Mr. Whitfield: I have examined the Draft Environmental Impact Statement (DEIS) (DOE/EIS-0121D) entitled Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina, dated March 1986, and offer the following for your consideration.	
AO-1	Based on the data presented in the DEIS the construction of recirculating cooling towers for C- and K- Reactors is by far the best alternative in each case because it would result in a considerable improvement in water quality and in the reestablishment of a large acreage of wetlands (ca. 1500 acres, according to Tables 2-10 and 2-11).	The Record of Decision prepared by DOE on this EIS will present the alternatives DOE considered in reaching its decision and will specify the alternative(s) that were considered to be environmentally preferable.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
AO-2	Although the estimated costs of construction are higher for recirculating towers than for once-through cooling towers for C- and K- Reactors ($153 million vs. $92-109 millon), the estimated operating costs for recirculating towers for both reactors is considerably less ($1 million per year vs. $3.8-6.2 million per year). The additional outlay required for construction of recirculating towers would be paid for in 8.5 to 22 years in savings generated by lower operating costs. Thereafter the operation of recirculating towers would save $2.8-5.2 million per year. (Calculations are based on data provided in Tables 2-10 and 2-11.)	The operating life of the reactors is assumed to be 15 years after cooling towers are built. The calculations in comment AO-2 do not include the greater production loss for recirculating cooling towers than for once-through cooling towers. The life cycle costs which include capital expenditure, operating costs, and production losses indicate that a gravity-fed natural draft once-through cooling tower is most economical. Also see response to comments AO-1 and BC-5 for cost components and present worth analysis.
AO-3	The alternatives for D-Area, increased flow with mixing or direct discharge to the Savannah River, are more difficult to evaluate. The preservation of habitat for the American alligator and wood stork which would result from the alternative of "increased flow with mixing" perhaps outweighs the complete elimination of all thermal discharges to Beaver Dam Creek which would result from "direct discharge to the Savannah River." In any event I strongly recommend that recirculating towers be constructed for C- and K- Reactors and that one of the two alternatives -- increased flow with mixing or direct discharge to the Savannah River -- be implemented for D-Area. I appreciate being given an opportunity to comment on the DEIS. Yours very truly, William D. Anderson, Jr. Professor of Biology WDA/fb	See response to comment AO-1.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF BRUCE RIPPETEAU University of South Carolina Columbia, S.C. 29208 The South Carolina Institute of Archaeology and Anthropology (803) 777-8170 April 22nd, 1986 Mr. R. P. Whitfield, Director, Environmental Division, U. S. Department of Energy, Savannah River Operations Office, Post Office Box A, Aiken, SC 29802 RE: EIS-8604-008 Dear Mr. Whitfield	
AP-1	I have received and reviewed your Draft Environmental Impact Statement, Alternative Cooling Water Systems, Savannah River Plant EIS-8604-008. I would like to congratulate you and your Department of Energy and Savannah River Plant staff on its quality. The document is an excellent example of the proper attention to both archaeological and historical resources under the provision of an environmental impact statement. Since the archaeological studies were completed by the Savannah River Plant Archaeological Resource Program staff in an ongoing contract arrangement with us at the South Carolina Institute of	Comments noted.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Archaeology & Anthropology at the University of South Carolina, I will not comment on this portion of the statement. An independent state agency review will be made by the South Carolina Department of Archives & History, in their capacity as the State Historic Preservation Officer, commenting under Federal Regulation to the Department of Energy. I await their comments with interest. Sincerely, Bruce Rippeteau, Director, State Archaeologist BER/mn cc: Mr. Danny Cromer, State Clearinghouse, Mr. Glen Hansen, Head, SRP Archaeological Resources Program Dr. Charles Lee, State Historic Preservation Officer	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF J. LEONARD LEDBETTER Georgia Department of Natural Resources 205 Bulter Street, S.E., Suite 1252, Atlanta, Georgia 30334 J. Leonard Ledbetter, Commissioner 404/656-3500 May 5, 1986 Mr. R. P. Whitfield, Director Environmental Division U. S. Department of Energy Savannah River Operations Office P. O. Box A Aiken, South Carolina 29802 Re: Draft Environmental Impact Statement Alternative Cooling Water Systems Savannah River Plant Dear Mr. Whitfield:	
AQ-1	We have reviewed this draft EIS dated March 1986. Although Georgia is concerned with any activity which can affect the Savannah River, most of the thermal effects from the Savannah River Plant cooling water discharges occur in South Carolina, and these discharges are regulated by the South Carolina Department of Health and Environmental Control (SCDHEC). Therefore, we will not make specific recommendations among the alternatives considered. We do expect that the Department of	The Department of Energy prepared this environmental impact statement to fulfill requirements pursuant to the National Environmental Policy Act--as identified in the current Consent Order with the South Carolina Department of Health and Environmental Control--in attaining compliance with South Carolina's Class B water classification standards.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Energy will cooperate with the SCDHEC in taking all necessary action to protect water quality in the Savannah River and to maintain a healthy ecological system. Sincerely, J. Leonard Ledbetter Commissioner JLL:mck:036 cc: Robert G. Gross	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF RICHARD W. RILEY	
	State of South Carolina Office of the Governor	
	Richard W. Riley, Governor — Post Office Box 11450, Columbia 29211	
	May 8, 1986	
	The Honorable John S. Herrington Secretary of Energy United States Department of Energy Room 7A-257 1000 Independence Avenue, SW Washington, D.C. 20585	
	Dear Secretary Herrington:	
AR-1	I am writing to express my support for the Draft Environmental Impact Statement (EIS) on alternative cooling water systems for the Savannah River Plant.	Comments noted.
	The cooling towers proposed in the Draft EIS should properly protect the region's water supply, and comply with federal and state laws and regulations. My staff has informed me that recycling cooling towers are preferrable from a natural resource management standpoint, as less water would be drawn from the Savannah River and less habitat would be flooded in the Steel Creek basin. However, other cooling tower alternatives would also be acceptable.	
	I am pleased that state and federal officials can agree on the need for alternative cooling water systems. Such cooperation should enable private	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	developers to more clearly see the need to follow state and federal laws when other portions of the Savannah River Basin are developed. Yours sincerely, Richard W. Riley RWR:bd cc: Mr. R. Lewis Shaw Mr. R. P. Whitfield	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF RICHARD O. HEGG Clemson University College of Agricultural Sciences Department of Agricultural Engineering May 14, 1986 Mr. R. P. Whitfield, Director Environmental Division US-DOE, SRP Office P.O. Box A Aiken, SC 29802 Dear Mr. Whitfield:	
AS-1	I am writing to request that DOE-SRP evaluate the feasibility of using the cooling water from the C and K reactors for agricultural purposes. After discussions with several persons at Clemson University, DOE in Washington, S.C. Commissioner of Agriculture, and others, it certainly seems worth making an evaluation to assess the legal, technical, and economic feasibility of such a project. S.C. agriculture is very depressed presently and will probably continue to be so in the near future. This resource (400,000 gpm of warm water) could be used by agriculture to increase crop yields or make it possible to grow alternative crops that will give a higher net return to the farmers. There are many factors that need to be considered. Legal aspects such as land application of water which may contain some radioactive contamination, SCDHEC requirement that water be cooled to 90°F or within 5° of ambient at the plant, consumptive use, and interbasin transfer of water for irrigation,	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Comment number	Comments	Responses
	etc. have to be addressed. It is also necessary to evaluate the effects of the reactors being periodically shut down. This will impact the types of crops grown and whether a backup irrigation water supply is needed. During winter some other use, such as greenhouses or aquaculture, may be an ideal way to utilize the water. A major assessment of social and economic factors involved will be needed. If such a source of water is made available to agriculture, an organization would need to be formed to distribute, maintain, operate, allocate water, etc. for the system. Makeup and operation of such an organization would have to be developed with input from Federal, state, and county officials and the ultimate user, the farmer. The cost of constructing various phases of such a project would have to be estimated. Costs would include distribution canals or pipes, pumps, meters, roads, bridges, etc. The environmental impacts on crops, soil, wildlife, surface and groundwater would also need to be evaluated. The above items are a few of many that need to be included in such a feasibility study. Due to the size of the resource (cooling waer) and the needs of S.C. agriculture, I feel a study should be made and estimate the cost of a 6-9 month study at approximately $150,000. This should be done by	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	DOE-SRP as part of the EIS with input from Clemson scientists in the College of Agricultural Sciences and other state agencies. Sincerely, Richard O. Hegg, Head Agricultural Engineering Department lw xc: Lee Thomas, Administrator, US-EPA L. P. Anderson, Dean, College of Agriculture, Clemson University Admiral Foley, DOE, Washington, DC Les Tindal, S.C. Commissioner of Agriculture Senator Strom Thurmond Senator Ernest Hollings Representative Carroll Campbell Representative Butler Derrick	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses

STATEMENT OF CHARLES E. LEE

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S.C.

P. O. Box 11,669
Capitol Station 29211-1669
803-758-5816

May 9, 1986

Dr. Robert J. Stern
U.S. Department of Energy
Office of Environmental Guidance
(EH-23) Room 3G-092 Forrestal Building
1000 Independence Ave., SW
Washington, D.C. 20585

Re: Draft EIS
Alternative Cooling Water Systems
Savannah River Plant
EIS-8604-008

Dear Dr. Stern:

Thank you for the opportunity to review and comment on the Draft EIS for the proposed Alternative Cooling Water Systems at the Savannah River Plant in South Carolina. A copy of the Draft EIS was provided to us by the State Clearinghouse.

As the State Historic Preservation Office, our concern is whether the proposed project will have an effect on cultural resources eligible or potentially eligible for inclusion in the National Register of Historic Places. The cultural resources survey for those areas affected by the

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	cooling water discharge of the C- and K-Reactors and the D-Area has been provided to us under separate cover by the Savannah River Plant.	
	We note that 65 archaeological sites were identified along the banks of Beaver Dam and Four Mile Creeks and Pen Branch; we concur with the assessment of National Register eligibility for 23 of these archaeological sites. Since these National Register eligible sites will not be directly affected by construction of the alternative water cooling systems at the C- and K-Reactors and the D-Area, it is our opinion that the construction presently proposed will have No Adverse Effect on National Register eligible	
AT-1	sites. Our determination of No Adverse Effect is contingent on the condition that the discharge water levels into Beaver Dam and Four Mile Creeks and Pen Branch be monitored on a regular basis to ensure that these significant cultural resources are not affected by inundation and/or erosion.	DOE, as part of its monitoring program of the onsite streams, will monitor flows in Beaver Dam, Four Mile, and Pen Branch Creeks on a regular basis. Should evidence of erosion occur on any archaeological site, DOE will notify the SHPO.
AT-2	If the Department of Energy concurs with the SHPO's determination of Conditional No Adverse Effect, then the Advisory Council on Historic Preservation should be provided the opportunity to comment. A copy of this letter should be included as evidence of DOE's consultation with the SHPO.	A letter of concurrence has been received from the Advisory Council on Historic Preservation. See comment AZ-1 concerning the no objection to a determination of "no effect" from the Advisory Council on Historic Preservation.
	The Federal regulations for the protection of historic properties (36 CFR Part 800) require that the Federal agency official in charge of a federally funded or licensed project consult with the appropriate State Historic Preservation Officer. The regulations do not relieve the Federal agency official of the final responsibility for reaching an opinion of his own as to whether or not historic values have been taken into account in allowing the project to proceed. The opinion of	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	the State Historic Preservation Officer is not definitive, either by law or by established Federal procedure. In reaching a conclusion of his own, the Federal agency official may well wish to consult other experts. The above comments are made in accordance with Section 106 of the National Historic Preservation Act and the regulations codified at 36 CFR Part 800. If you have questions, please do not hesitate to contact Ms. Nancy Brock, Environmental Review Specialist, or Ms. F. Langdon Edmunds, Historic Preservation Protection and Planning Head, at (803) 758-5816. Sincerely, Charles E. Lee State Historic Preservation Officer cc: Mr. R. P. Whitfield Savannah River Plant Mr. Glen Hanson SCIAA Mr. Danny Cromer State Clearinghouse Ms. Trish Jerman Office of Energy and the Environment Mr. Ron Anzelone Advisory Council Dr. Bruce E. Rippeteau State Archaeologist	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF DANNY L. CROMER State of South Carolina Office of the Governor Richard W. Riley, Governor — Office of Executive Policy and Programs May 15, 1986 Dr. Robert J. Stern Director Office of Environmental Guidance United States Department of Energy Room 3G-092 1000 Independence Avenue, S.W. Washington, D. C. 20585 Dear Dr. Stern: The South Carolina Project Notification and Review System (SCPNRS) has conducted an intergovernmental review on the Draft Environmental Impact Statement on Alternative Cooling Water Systems at the Savannah River Plant in Aiken, South Carolina. The intergovernmental review was conducted through the review system established under the authority of Presidential Executive Order 12372, "Intergovernmental Review of Federal Programs". All comments received by this office are enclosed for your use.	
AU-1	While no correspondence has been received indicating this direct federal development is not subject to Department of Energy intergovernmental review regulations promulgated at 10 CFR Part 1005, this office assumes the proposed activity is exempt	DOE is exempt from intergovernmental review regulations by virtue of national security considerations.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	from the referenced regulations by virtue of national security considerations. If this assumption is incorrect, please advise.	
AU-2	The only comment received by this office expressing a concern regarding the referenced Draft EIS is from the South Carolina Department of Archives and History. Therefore, the regular monitoring of discharge water levels into Beaver Dam and Four Mile Creeks and Pen Branch is strongly encouraged, as per the enclosed conditional determination of No Adverse Effect from the South Carolina Department of Archives and History.	See response to comment AT-1.
	The State Application Identifier number for this project is EIS-8604-008. This number should be used in any future correspondence with this office regarding this proposal. The State of South Carolina is appreciative of the opportunity to review this proposed activity, and looks forward to reviewing the Final EIS upon its completion. If I may answer any questions, or be of further service in any way, please do not hesitate to contact me at (803) 758-2417.	
	Sincerely,	
	Danny L. Cromer State Single Point of Contact Intergovernmental Review	
	Enclosures	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	cc: Mr. R. P. Whitfield Savannah River Plant Ms. Suzanne Rhodes Governor's Division of Energy and the Environment Mr. Charles Lee South Carolina Department of Archives and History	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF HILARY J. RAUCH	
	Department of Energy Chicago Operations Office 9800 South Cass Avenue Argonne, Illinois 60439	
	May 20, 1986	
	R. P. Whitfield, Director Environmental Division Savannah River Operations Office	
	SUBJECT: SAVANNAH RIVER PLANT DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS), "ALTERNATIVE COOLING WATER SYSTEMS" - AIKEN, SOUTH CAROLINA (DOE/EIS-0121D)	
AV-1	We have reviewed the subject document to identify any items to be addressed at the upcoming hearing or incorporated in the final EIS. We have no comments.	Comments noted.
	Thank you for the opportunity to review the document. If you have questions, contact Jerry Nelsen, Operational and Environmental Safety Division, on FTS 972-2256.	
	Hilary J. Rauch Manager	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF THOMAS F. HARTNETT Congress of the United States House of Representatives Washington, DC 20515 May 8, 1986 The Honorable John S. Herrington Secretary of Energy 1000 Independence Ave. SW Washington, D.C. 20585 Dear Mr. Secretary:	
AW-1	I am writing in regard to the possibility of alternative uses for the cooling water from nuclear reactors at the Savannah River Plant. As you know, Senator Thurmond recently sponsored a meeting that produced an open discussion among several of the principals who are considering the viability of these alternative uses. Mr. Fred Christensen, a participant of the meeting and a retired engineer at the Savannah River Plant, remained quite dismayed at the reaction by the representatives of the Department of Energy toward his ideas for usage of the cooling water. Specifically, he stated that he could not understand why $100 million can be set aside for the construction of cooling towers, but one tenth of one percent of this amount cannot be allocated for a study into the effectiveness of alternative applications for the cooling water. Therefore, for my own clarification, I would greatly appreciate hearing your response to Mr. Christensen's proposal to study the logistics of irrigation as an option to heat abatement.	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and aquacultural uses, industrial applications, direct power generation, and ethanol production.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	As always, thank you for your time and consideration. With kind regards, I am Sincerely, Thomas F. Hartnett, M.C. TFH/bu	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF BUTLER DERRICK Congress of the United States House of Representatives Washington, D.C. 20515 May 14, 1986 Mr. R.P. Whitfield, Director Environmental Division U.S. Department of Energy Savananh River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Whitfield: This is in reference to the recently issued Draft Environmental Impact Statement (DEIS) concerning Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina (DOE/EIS-0121D). At the outset, let me note that I am pleased to learn that the Department of Energy (DOE) is moving forward to implement alternative cooling water systems in order to bring the C and K production reactors at the Savannah River Plant (SRP) into compliance with the National Pollutant Discharge Elimination System (NPDES) permit issued by the South Carolina Department of Health and Environmental Control (DHEC). I appreciate receiving a copy of the DEIS for review of this matter.	
AX-1	During the recent public hearings in Aiken, South Carolina, on this DEIS, I understand several witnesses addressed the issue of potential uses of the water discharged from the C and K reactors for	DOE prepared a new appendix in this EIS (Appendix I) to address the feasibility of using the cooling water discharges from K- and C-Reactors for agricultural and

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	agricultural purposes such as irrigation. Moreover, this is an option which has been publicly discussed for several years, although no formal studies have been undertaken recently to fully evaluate the merits of the proposal.	aquacultural uses, industrial applications, direct power generation, and ethanol production.
	My purpose is writing, therefore, it to suggest that a full evaluation of potential agricultural uses of this discharge water, particularly for irrigation purposes, be undertaken as part of your review of alternatives to mitigate the environmental impacts of the thermal discharges as mandated by the National Environmental Policy Act of 1969. Specifically, I request that a Supplemental Draft Environmental Impact Statement be issued on this proposal, which is a significant alternative to the proposed mitigation presented in your DEIS.	
	It is my understanding that a meeting was recently held in Washington, D.C. with the Assistant Secretary for Defense Programs, Department of Energy (DOE). While this meeting was conducted at the staff level (a member of my staff was in attendance) it is my understanding that the general consensus from the meeting was that the potential agricultural uses of this waste water warranted further and comprehensive study.	
	Moreover, I am not in a position to evaluate nor pass on the technical, health and environmental safety aspects of this proposal. I believe, however, that the Department of Energy is in a unique position to supply the requisite personnel and resources to preform a full analysis of this subject. And the Environmental Impact Statement process is the logical framework in which to conduct such a study.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Thank you for your time and consideration in the above. Please let me know if I may be of further assistance to facilitate your review of this matter. With kindest regards, I am, Respectfully, Butler Derrick Member of Congress D/ht	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF JOHN C. VILLFORTH	
	Department of Health & Human Services Public Health Service Food and Drug Administration Rockville MD 20857	
	May 19, 1986	
	Mr. R. P. Whitfield Director, Environmental Division Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802	
	The Center for Devices and Radiological Health staff has reviewed the Draft Environmental Impact Statement (DOE/EIS-0121 D) on Alternative Cooling Water Systems, Savannah River Plant, dated March 1986. Our effort is primarily directed to an evaluation of the public health and safety impacts associated with the proposed alternative cooling water systems for C- and K- reactors and the D-area coal-fired powerhouse. We have the following comments to offer:	
AY-1	1. The discussion in Chapter 4 and Appendix D have adequately assessed the radiological releases to the environment and the potential impact on individual and population dose for cooling water alternatives for the C- and K- reactors. There is no impact for cooling water alternatives for the D- area since there are no radiological releases.	Comments noted.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	2. The environmental pathways identified in Appendix G (Figure G-1) cover all possible emission pathways that could impact on the population in the environs of the Savannah River Plant. The radiation dose calculation methods and assumptions presented in Appendix D have provided reasonable estimates of annual dose to the maximally exposed individual and collective dose to the population within the 80-kilometer area from operation of alternative cooling water systems for the C- and K-reactors. Results of these calculations are shown in Appendix D, Tables G-7 through G-38, and indicate that the doses are minimal and are well within current radiation protection standards.	
	3. It appears from our review of this Draft Environmental Impact Statement that the radiological dose changes are not significant compared with the doses resulting from existing operations. Thus, because of these low radiation related impacts, it is concluded that either once through cooling towers or recirculating cooling towers would be acceptable and that the choice of alternatives should not be based on radiological considerations. We believe that this conclusion is valid from a public health and safety viewpoint and is justified by the technical assessment of the radiological impact.	
	Thank you for the opportunity to review and comment on the Draft Environmental Impact Statement. Sincerely, John C. Villforth Director Center for Devices and Radiological Health	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF DON L. KLIMA	
	Advisory Council on Historic Preservation The Old Post Office Building 1100 Pennsylvania Avenue, NW, #809 Washington, DC 20004 May 21, 1986 Mr. R. P. Whitfield Director, Environmental Division Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802 REF: Draft Environmental Impact Statement, Alternative Cooling Water Systems Savannah River Plant, Aiken, South Carolina Dear Mr. Whitfield:	
AZ-1	We have reviewed the referenced document, including its Appendix E. The discussion of historic and archeological properties and effects on them appears thorough and complete. Based on the information provided, we would have no objection to a determination of "no effect" for Archeological site 38BR450 in relation to any increased flows in the Beaver Dam Creek (D-Area) under that alternative of the cooling water systems being considered. Please ensure that the South Carolina State Historic Preservation Officer has no	Comments noted. The South Carolina State Historic Preservation Officer concurs with the "no effect" determination. See comments AT-1 and AT-2.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	objection to such a determination. In the event he does, further discussions with the Council would be necessary. We appreciate your continued cooperation on the various projects at the Savannah River Plant. Should you or your staff have any questions, please contact Staff Archeologist Ronald D. Anzalone at 202-786-0505 (an FTS number). Sincerely, Don L. Klima Chief, Eastern Division of Project Review	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF DAN M. MAULDIN Department of the Army South Atlantic Division, Corps of Engineers 510 Title Building, 30 Pryor Street, S.W. Atlanta, Georgia 30335-6801 May 19, 1986 Reply to Attention of: Planning Division SUBJECT: Cooling Water EIS Mr. R. P. Whitfield Director, Environmental Division U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Whitfield: This is in response to your letter of March 28, 1986, to Brigadier General C. E. Edgar III requesting our review of the Draft Environmental Impact Statement, Alternative Cooling Systems, Savannah River Plant, Aiken, SC (DOE/EIS-0121D). We have reviewed the document and offer the following comments:	
BA-1	a. While we may understand the reasons for eliminating the alternative of cooling ponds, it may not be as readily apparent to other readers. It is suggested that a more detailed account of discussing engineering, economic,	DOE initially identified 22 possible alternative cooling water systems that would

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	and environmental reasons for dropping the alternative be provided. For example, the high cost of preparing the dam foundation, the wetland habitat loss involving an endangered species, the fact that DOE is already compensating for habitat loss due to Steel Creek Dam, and the operational constraints imposed by a cooling pond are all factors which should be discussed as affecting the choice of the alternative. b. Appendix A does not fully convince the reviewer that dams are not a viable option. Further explanation should be provided. The opportunity to review the document is appreciated. Sincerely, John W. Rushing for Dan M. Mauldin Chief, Planning Division	be implemented for K- and C-Reactors and four alternatives for the D-Area powerhouse. Subsequently, using a structured screening process, DOE identified those that would be reasonable to implement. The screening process, which included detailed engineering, economic and environmental assessments of each alternative, was documented in the Thermal Mitigation Study (DOE, 1984) that was submitted to SCDHEC under Consent Order and subsequently approved. Appendix A is a synopsis of the detailed screening process provided in the Thermal Mitigation Study and provides a brief rationale for alternatives that were considered in the EIS. Appendix A references the Thermal Mitigation Study (DOE, 1984) for a detailed evaluation of alternatives.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses

STATEMENT OF JAMES A. JOY, III

South Carolina Department of Health
and Environmental Control

2600 Bull Street
Columbia, S.C. 29201

Commissioner
Robert S. Jackson, M.D.

Board
Moses H. Clarkson, Jr., Chairman
Gerald A. Kaynard, Vice-Chairman
Oren L. Brady, Jr., Secretary
Barbara P. Nuessle
James A. Spruill, Jr.
William H. Hester, M.D.
Euta M. Colvin, M.D.

June 6, 1986

W. E. Wisenbaker
Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, S.C. 29802

Re: Draft Environmental Impact Statement (DEIS) Alternative Cooling Water Systems Savannah River Plant - General

Dear Mr. Wisenbaker:

The South Carolina Department of Health and Environmental Control has completed its review of the above referenced document received March 31, 1986. The Department has the following comments concerning the DEIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
BB-1	1. The impact of total residual chlorine on the receiving stream needs to be further discussed because it may effect the alternative selected (i.e., dechlorination vs ponds after the cooling towers). It should be noted that the Ambient Water Criteria for Chlorine Document (EPA/5-40-030) recommends a total residual chlorine of 11 ug/l for an instream concentration. Since the reactor cooling water is basically the stream, the discharge of these waters would need to meet 11 ug/l. If it is felt by SRP that a higher total residual chlorine is warranted other than that above, we would like this topic to be further discussed and justified in the FEIS. It should be noted that a mixing zone other than immediately at the outfall will not be considered.	DOE plans to dechlorinate K- and C-Reactor cooling waters prior to discharge from the cooling towers to onsite streams. Discussion of the method to be used and an assessment of the potential impact based on the results of chlorination/dechlorination studies conducted at SRP have been included in Chapter 4 with additional support information provided in Appendix C of the FEIS.
BB-2	2. Does SRP plan to use corrosion inhibitory compounds and/or additional biocides other than chlorine in the cooling towers, and if so, how will they affect the receiving stream? As stated above since the reactor cooling water is basically the stream, a small amount of a biocide in the cooling water discharge may have a detrimental impact to the stream.	Once-through cooling tower systems would not use corrosion inhibitors. Allowance for injection of a corrosion inhibitor has been made for recirculating systems. A non-chromated, organic-based chemical made by Wright Chemical Company would be used if needed. Currently, this chemical is approved by SCDHEC for use in cooling tower systems and is being used at the Savannah River Plant. Chlorine is the only biocide planned for use in the cooling towers.
	3. The Department has advised you previously in a letter dated March 4, 1985 that both recirculating cooling towers and once through cooling towers satisfy state standards. We also stated that for the alternatives chosen in the Thermal	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Mitigation study that 316(a) studies would need to be developed and implemented to assure that the rise above ambient stream temperature (t) would not adversely impact the receiving stream. In further review of the DEIS some concerns have surfaced from this office on whether or not once-through cooling towers are capable of demonstrating a successful 316(a) study. The streams to which the reactor cooling water will discharge are Class B waters. The Water Classification and Standards (Reg. 61-68) for Class B waters concerning temperature state: "The water temperature of all...Class B free flowing waters shall not be increased more than 5°F (2.8°C) above natural temperature conditions or exceed a maximum of 90°F (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 Clean Water Act has been completed." Since the delta 5°F (2.8°C) requirement cannot be met SRP plans to conduct a 316(a) study. In order for this study to be successful SRP must demonstrate that under the operating conditions of the once through cooling towers the receiving stream can meet the requirements for a Class B stream. The Class B requirements are (Regulation 61-68 E.5). CLASS B - freshwaters suitable for secondary contact recreation and as a source for drinking	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses.	
BB-3	Based on our further investigation and discussions with EPA, it is felt that SRP may not be able to demonstrate that indigenous species are able to reproduce in the receiving stream due to elevated temperatures. Therefore, if SRP should propose any alternative cooling technology which would require a 316(a) variance, it will be necessary that the Final Environmental Impact Statement (FEIS) provide predictive biological data which substantiates a reasonable probability that Section 316(a) requirements can be achieved.	Substantive Section 316(a) Demonstration - type information relating to K- and C-Reactors and the D-Area powerhouse has been included in Chapter 4 of the FEIS and a complete predictive Section 316(a) Demonstration will be provided to SCDHEC at an agreed-to date. In addition, per Consent Order No. 84-4-W between DOE and SCDHEC, if the selected cooling water systems discharge temperature does not comply with the 2.8°C T above ambient temperature requirement, DOE will conduct Section 316(a) Demonstration studies to assess directly during plant operations whether thermal discharge conditions will ensure the protection and propagation of balanced indigenous populations of fish and wildlife in the affected areas.
BB-4	4. In the May 20th meeting attended by SRP, EPA, and DHEC personnel concerning the DEIS, SRP personnel described the sequence of events for reactor shut downs. The reactor shuts down for a five day period after every 30 days of operation, along with a 20 day shut down after every sixth cycle. This office feels that this flow variation may cause detrimental effects on the receiving stream and feels the FEIS should further discuss the flow variation and shut	See response to comment BB-3. Potential impacts from reactor shutdown and the associated flow variability have been addressed in Chapter 4 of the FEIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	down effects on the aquatic habitat. It is felt that the above should be addressed in the predictive biological data requested to be provided in the FEIS.	
BB-5	5. This office would also like predictive biological data to be in the FEIS for the D-area powerhouse which would substantiate a reasonable probability that Section 316(a) requirements can be achieved. In conclusion, the recirculating cooling tower alternative as expressed in the DEIS appears capable of meeting the state standards. However, the once through cooling tower alternative needs to be further discussed in the FEIS, specifically whether or not the once through cooling tower alternative is capable of demonstrating a successful 316(a) study.	Substantive Section 316(a) Demonstration - type information relating to the D-Area powerhouse has been included in Chapter 4 of the FEIS. In addition, a complete predictive Section 316(a) Demonstration will be provided to SCDHEC at an agreed-to date. Should the selected cooling water systems discharge temperature not comply with the 2.8°C rise above ambient temperature criterion, Section 316(a) Demonstration studies will be conducted during plant operations to assess directly whether the protection and propagation of balanced indigenous populations of fish and wildlife are maintained in the affected areas.
	Based on the information provided in the DEIS we feel recirculating cooling towers for C and K reactors will provide a higher degree of certainty of meeting the state stream standards than that of the once through cooling tower alternative. We appreciate the extra time you have given us to comment on the DEIS and if you would like to discuss the above comments please call (758-5483). Sincerely, James A. Joy, III, P.E., Director Industrial & Agricultural Wastewater Division	The Record of Decision prepared by DOE on this EIS will present the alternatives DOE considered in reaching its decision and will specify the alternative(s) that were considered to be environmentally preferable.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	JAJ/JBR/jf cc: Kin Hill, Lower Savannah Russ Sherer, Division of Water Quality & Enforcement Mike Marcus, Biological Section Harry Gaymon, Biological Section John Marlar, EPA	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF JACK E. RAVAN UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION IV 345 Courtland Street Atlanta, Georgia 30365 June 12, 1986 4 PM - EA/HJM Mr. R. L. Morgan Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 SUBJECT: DEIS for Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina Dear Mr. Morgan: Pursuant to our responsibilities under Section 309 of the Clean Air Act (CAA) and the National Environmental Policy Act (NEPA), the Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (DEIS) for Alternative Cooling Water Systems at the Savannah River Plant, Aiken, South Carolina. Our review has concentrated on the potential environmental impacts on water and air quality, wetlands, aquatic habitat and radiological considerations of the proposed alternatives. The purpose of the DEIS document is to assess the relative impacts of various alternative ways to comply with the discharge temperature limitations for the on-site streams. The document covers the discharge from the C-Reactor, the K-Reactor and the D-Area coal-fired power plant.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	For both of the reactors, two primary alternatives are proposed: once-through cooling (subsequently referred to as "helper cooling" herein) and recirculating cooling (referred to as "closed-cycle cooling" herein. For the D-Area power plant, direct discharge to the Savannah River and increased flow with continued discharge to Beaver Dam Creek were the alternatives considered. Although all the proposed action alternatives are a major improvement over existing conditions, our review has identified several areas of major concern which must be addressed in the Final Environmental Impact Statement (FEIS) before an alternative can be selected.	
	In formulating our comments we have met with the SRP staff on two occasions to discuss our concerns and have coordinated our review with the South Carolina Department of Health and Environmental Control (SCDHEC) and the U.S. Fish and Wildlife Service (USFWS).	
BC-1	Should DOE continue to prefer an alternative cooling technology which would require a 316 variance, the FEIS should present predictive biological data which demonstrates a reasonable probability that Section 316 requirements can be achieved. Prior to implementation of a cooling alternative, it will be necessary for DOE to assure that the system will achieve compliance with water quality standards requirements or to obtain a variance to those standards under Section 316(a) of the Clean Water Act.	See response to comment BB-3.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	A summary of additional areas of concern follow (a more complete discussion is contained in the attached "Detailed Comments").	
	• The high sedimentation levels and the resultant stream delta growth expected from the helper cooling alternative would continue to adversely impact vegetated wetlands and aquatic habitat.	
	• The requirements for biocides and corrosion inhibitors for the cooling system alternatives and their potential impacts on the aquatic community were not addressed in adequate detail in the DEIS.	
	<u>Conclusions</u>	
	EPA's review of the DEIS has identified a number of major environmental concerns which need to be addressed in the FEIS before a final alternative can be selected for implementation. These concerns relate directly to the alternatives ability to meet water quality standards or obtain a variance under Section 316(a), and thus be environmentally acceptable and permitable. To provide a technical basis for resolving our concerns additional information should be provided in the FEIS for a number of areas including:	
BC-2	• Predictive biological data for alternatives requiring a 316(a) variance;	See response to comments BB-3 and BB-5.
BC-3	• The results of the proposed Habitat Evaluation Procedure (HEP);	A HEP analysis was conducted for the habitats of the receiving streams. The results of this analysis are presented in Chapter 4 and Appendix C; the complete report is available at DOE Public Reading Rooms in Aiken, South Carolina, and Washington, D.C.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
BC-6	• A present worth analysis of the considered alternatives to provide a common basis for comparing capital, operating and production costs.	Costs in the draft EIS were based on preliminary engineering information used for the alternatives listed on pages 2-43 and 2-50 of the draft EIS. Revised costs shown below reflect additional engineering studies; they are also included in Comparison of Alternatives (Section 2.3) of the FEIS. For the conceptual designs evaluated, the estimated production loss for a once-through cooling water system is about 0.2 percent, and that for a recirculation system is about 3.7 percent. Present worth was calculated using the following parameters: 15 year life; 10 percent discount rate; 6.2 percent escalation; power cost $47.50/MW-hr.; and reactor cost $300,000/day. A 15 year life is assumed for the current reactors. For recirculating cooling water systems the costs include the decrease in electricity use (i.e., a savings) because much less water is pumped from the river. <u>C-AREA</u> • <u>Gravity Flow Mechanical Draft, once-through system</u> – Present worth excluding production losses $60,300,000 – Present worth including production losses $64,300,000 • <u>Pumped Flow Mechanical Draft, once-through system</u> – Present worth excluding production losses $81,400,000 – Present worth including production losses $86,000,000

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
BC-4	• Further assurances that the cooling tower design will be able to achieve the projected discharge temperatures;	Cooling-tower performance and sizing calculations were based on once-through operations. The temperatures of water directed from an SRP reactor into a cooling tower is much higher than for steam-electric generating plants. Therefore, Du Pont employed a cooling-tower consultant and contacted cooling-tower vendors to discuss sizing and performance of potential towers for the SRP's unusually high inlet temperature with low approach temperature. In addition, the specification for production losses were "less than 10 percent" for a once-through system and "approximately 4 percent" for a recirculating system. The request for bids from cooling-tower vendors is based on a performance specification. It is the vendor's responsibility to design and build a tower that will meet or exceed the performance specifications. The contract with the successful bidder will include liquidated damages for failure of the tower to meet the performance specified. Based on current information and planned contract negotiations. Du Pont is confident the cooling towers will operate as stated in the EIS.
BC-5	• A more in-depth evaluation of water chemistry requirements (biocides and corrosion inhibitors) and their possible air and water quality impacts; and	See response to comments BB-1 and BB-2.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		• <u>Pumped Flow Mechanical Draft, recirculating system</u> – Present worth excluding production losses $65,800,000 – Present worth including production losses $97,600,000 <u>K-AREA</u> • <u>Gravity Flow Mechanical Draft, once-through system</u> – Present worth excluding production losses $59,000,000 – Present worth including production losses $63,300,000 • <u>Pumped Flow Mechanical Draft, once-through</u> – Present worth excluding production losses $80,400,000 – Present worth including production losses $86,000,000 • <u>Pumped Flow Mechanical Draft, recirculating</u> – Present worth excluding production losses $65,800,000 – Present worth including production losses $97,600,000 Although estimated costs for gravity-flow, once-through natural draft towers were not shown in the draft EIS, the estimates since developed are:

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		C-AREA • Gravity Flow Natural Draft, once-through system – Present worth excluding production losses $42,400,000 – Present worth including production losses $44,000,000 K-AREA • Gravity Flow Natural Draft, once-through system – Present worth excluding production losses $41,400,000 – Present worth including production losses $43,000,000 Below are estimated costs for a gravity flow natural draft tower with pumped feed to a mechanical draft tower in a recirculating mode that was developed after the draft EIS was completed and is explained in greater detail in Chapter 2 of this Final EIS: C- and K-AREAS • Recirculating System – Present worth excluding Production losses 58,000,000 – Present worth including Production losses $89,800,000

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	This additional information is important in assessing the impact of the proposed alternatives on the natural environment for the expected life of the project. In addition, EPA feels strongly that the NEPA process is the appropriate means of identifying and addressing any major permitting issues such as the Section 316(a) variance question. Only in this manner can an alternative be selected that both addresses environmental impacts and can successfully achieve permit requirements.	
	Based on our review, EPA rates the Draft Environmental Impact Statement for the Alternative Cooling Water Systems an EO-2 (i.e, significant issues have been identified relative to the preferred alternative being able to meet water quality standards thermal criteria, which may require substantial modification of the alternative or consideration of other alternatives). Also, as discussed above, the FEIS should contain the additional requested information as well as addressing the DEIS comments.	
	My staff will be available to meet with DOE, SCDHEC and USFWS in order to assist in further defining the needed studies and data. We appreciate the additional time you have given us to comment on the DEIS. We hope that through the on-going close cooperation with DOE the environmental concerns can be successfully resolved and the most acceptable	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	alternative can be identified. The primary EPA point of contact for this project is Heinz J. Mueller, (FTS) 257-7901 or (404) 347-7901. Sincerely yours, Jack E. Ravan Regional Administrator Enclosure cc: See attached cc: Mr. James A. Joy, III Director of Industrial and Agricultural Wastewater Management Division South Carolina Department of Health and Environmental Control Columbia, S.C. 29201 Mr. Roger Banks, Field Supervisor Ecological Services U.S. Fish and Wildlife Service 217 Ft. Johnson Road Charleston, S.C. 29412 ATTN: Mr. Prescott Brownell	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	DETAILED COMMENTS FOR ALTERNATIVE COOLING WATER SYSTEM DEIS Savannah River Plant, Aiken, South Carolina Water Quality Currently, both the C- and K-Reactor are discharging cooling water into Four Mile Creek and Pen Branch, respectively, at temperatures averaging 70° to 77°C (158° to 170.6°F). This exceeds the State of South Carolina Water Quality Standards (SCWQS) Class B criterion which specifies a maximum instream temperature of 32.2°C (90°F). Based on the calculations in the DEIS, both major alternatives being considered, helper and closed-cycle cooling, appear to meet this maximum temperature criterion. However, there are a number of areas of concern that must be addressed in the FEIS prior to selection of a final cooling system.	
BC-7	As indicated in the DEIS, the helper cooling alternative for the C- and K-Reactor will not achieve compliance with the 2.8°C (5°F) criterion allowed by the water quality standards for increases in ambient stream temperatures. During the winter and spring months projected increases will be 13 to 15°C (23.4° to 27°F) based on Table 2.1. Selection of the helper alternative would require a variance to the temperature increase criterion. Under Section 316(a) of the Clean Water Act, a permittee for an NPDES permit may obtain a variance to applicable thermal limitations if a demonstration can be made that the applicable limitations are more stringent than necessary to "assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife, in and on that body of water."	See responses to comments BB-3 and BB-5.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
BC-8	A predictive Section 316(a) assessment will be necessary prior to NPDES permit issuance to demonstrate that the level of thermal release calculated for the helper cooling alternative (or any alternative which would not achieve compliance with applicable temperature requirements) would assure compliance with 316 requirements. Therefore, to assure that the 316(a) process proceeds without delay, it will be necessary for DOE to provide predictive biological data in the FEIS. Such data must demonstrate that discharge from the alternative proposed has a reasonable chance to achieve 316(a) requirements. That is, that reasonable reproduction of aquatic organisms will be ensured in both the receiving creeks and associated marsh areas under all discharge temperature and flow conditions resulting from all planned plant operating modes, as well as periods of normal and extended shutdown. Data on rate of creek and wetland drainage as a function of reactor shutdown and Savannah River stage will be needed in this evaluation. Data presented in the DEIS indicate that discharge temperatures predicted for the helper cooling tower system during the spring (25 to 28°C) would be high and would likely prevent the successful spawning and reproduction of many of the fish species indigenous to the Savannah River system. As indicated in "Thermal Performance" below, these predicted temperatures may be low. Even should successful spawning occur, subsequent short- or long-term shutdown of the reactor could leave the eggs or fry in a dry overbank area of the creeks or section of marsh. Additionally, longer periods of shutdown have historically been observed which might further compound this impact. In order to obtain a 316(a) variance, it will be necessary for DOE to demonstrate that these concerns are not of	See responses to comments BB-3 and BB-5.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	significance to the propagation and protection of the aquatic community in both the free-flowing creeks and associated marshes.	
BC-9	According to the data in the DEIS, the discharge from the closed-cycle cooling alternative for both the C- and K-Reactor would exceed the ambient stream temperature by 1°C during winter conditions while the temperature of the effluent will approach the ambient for extreme summer conditions. Use of the closed-cycle system may achieve direct compliance with water quality standards thermal limitations and no 316(a) variance would be required. Therefore, greater consideration should be given to the closed-cycle system, if the blowdown temperatures noted in Table B-1 can be achieved (see "Thermal Performance" below).	The recirculating cooling-tower systems discussed in this final EIS have been modified from those described in the draft EIS. The recirculating system in the draft EIS assumed design for 10°C wet bulb temperature and 28°C approach. This has been determined to be difficult and costly to achieve. Recirculating cooling-tower systems for alternatives now being considered are designed to achieve 29.5°C cold water temperature (CWT) at 26.7°C WBT. Wet bulb temperatures would have to exceed 29.5°C before blowdown temperatures would reach 32.2°C; basic data indicates that 27.8°C WBT was exceeded only twice during the period from 1952 through 1983. Cooling-tower performance is dependent on ambient air conditions; Savannah River water temperatures lag behind seasonal air temperature changes. If receiving stream temperature is assumed to be the same as the Savannah River and historical monthly average temperatures are used, the 2.8°C maximum allowable temperature difference between cooling-tower blowdown and receiving stream will be exceeded during the period from December through July. Maximum monthly average difference is 6.7°C in March based on recirculating cooling-tower systems designed for 26.7°C WBT with 2.8°C approach.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		The maximum delta-T of 2.8°C must be met continuously, not as an average. No cooling tower system can guarantee compliance with that maximum at all times, particularly during sudden weather changes. The recirculation system would come closer to meeting the delta-T regulation than the once-through system because it is designed for a closer approach to ambient wet bulb temperature. This is achieved, however, at a much higher investment cost with greater system complexity. None of the recirculating systems presently being evaluated include blowdown cooling facilities. Blowdown temperatures from these recirculating systems is expected to be lower (due to two cooling towers in series) than those which occur at steam-electric generating plants for comparable ambient conditions. Therefore, blowdown cooling systems used by those plants would not be as effective for SRP systems.
BC-10	Due to the high flow rate of the helper cooling alternative, minimal reduction in the existing high level of suspended solids would be expected in the receiving creeks; especially, if the proposed holding ponds are eliminated. The closed-cycle system, however, would result in a significant reduction of suspended solids and the attendant stream/marsh sedimentation. Also see discussion in "Wetland", below.	The DEIS discussed the discharge of total suspended solids and sedimentation rates in the delta areas in Chapter 4. Discussions on water quality and hydrology summarized current conditions and changes expected with once-through and recirculating systems. The maximum flow rate discharged from a once-through cooling tower would be 11.3 cubic meters per second, which is the same as existing conditions. There would be minimal reduction in the total suspended solids from existing conditions. The discharge flow rate from a recirculating

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		system would be about 0.51 to 0.57 cubic meter per second due to blowdown. The total suspended solids that would be discharged with the recirculating system would be greatly reduced because the intake flow of Savannah River water for this alternative is much less than for the once-through system. All discharges would comply with NPDES permit requirements and State Class B water classification standards.
BC-11	Although discussion to this point has centered on reactor discharges, the D-Area power plant preferred cooling alternative apparently will also require a 316(a) variance. Pumping of excess water for thermal pollution control is not normally accepted practice due to impingement and entrainment impacts and other factors. In this case, however, pumping to maintain the 32.2°C maximum thermal criterion of the South Carolina Water Quality Standards would appear to be the preferred alternative. Pumping during other periods should be minimized consistent with maintaining temperature patterns demonstrated to be acceptable for the protection and propagation of the aquatic community. In order to demonstrate the appropriateness of a variance and the establishment of appropriate discharge temperatures, it is suggested that DOE prepare a proposed plan of pump operation as a function of discharge temperature and month of the year as it relates to the life stages of the aquatic community.	See response to comment BB-5.
BC-12	The biological data necessary to support any required 316(a) variance request as well as the Habitat Evaluation Procedure (HEP) analysis should be documented in the FEIS.	See response to comments BB-3, BB-5, and BC-3.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Additional Alternatives	
BC-13	Although only two alternatives for reactor cooling were proposed in the DEIS, variations to those might be considered. Since the presently proposed closed-cycle series tower design appears to be capable of compliance with all SCWQS thermal criteria, use of these towers in helper mode or in partial recycle mode (i.e., with some recycle of cooling water to the reactor to reduce discharge flow relative to helper mode) may reduce aquatic impacts.	See discussion of the recirculating cooling tower alternative in Chapter 2 of the FEIS.
	Thermal Performance	
BC-14	Based on EPA experience with existing cooling tower performance at steam electric power generating facilities, the following items are presented for DOE consideration in the design of cooling towers for the SRP site. Calculation of helper tower discharge temperatures based on direct use of closed-cycle cooling tower performance curves is not appropriate since the discharge temperatures computed are low. This is due to the fact that recirculation of cooling water produces a build-up of heat in the cooling system and higher tower inlet temperatures relative to the design wet bulb temperature. Higher tower inlet temperatures produce a greater driving force for tower cooling which is incorporated in standard performance curves for closed-cycle towers. Available information has been provided to DOE to allow recomputation of helper tower discharge temperatures, if necessary.	In addition to the following see also response to comment BC-4. Performance curves used in the engineering evaluations were provided by cooling-tower vendors and reviewed by the consultant. Engineering evaluation studies were continued for the recirculating system alternatives after the draft EIS was issued. Estimated blowdown temperatures were calculated for the recirculating system described in Chapter 2 of the DEIS and for additional alternatives. The evaluation included estimating temperatures following reactor shutdown, including total loss of electrical power. The maximum flow of cooling water from a reactor to a cooling tower is 11.3 cubic meters per second. For short shutdowns, the flow is 3.3 cubic meters per second, but for long shutdowns the flow is reduced to 0.63 to 1.3 cubic meters per second. Following

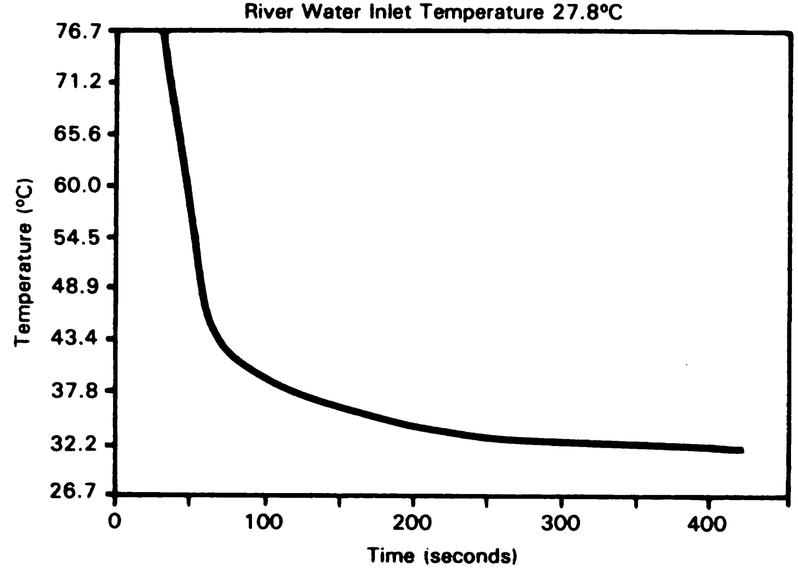
Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		shutdown of the reactor, the temperature of the cooling water discharged from the reactor heat exchangers rapidly decreases in 100 seconds after shutdown and approaches 32.2°C in 300 to 400 seconds after shutdown. The attached figure shows cooling water discharge temperature (water entering the cooling tower) following a reactor shutdown (scram). The temperatures shown are with a river water inlet temperature of 27.8°C, the approximate river water temperature in July. Although not shown on the figure, data obtained during the study showed that the reactor effluent temperature is within 1.1°C of reactor influent temperature 24 hours after shutdown. The temperature of the water in a recirculating system would rapidly decrease as the tower rejected the heat remaining in the recirculating system. Reactor heat would decline in a manner and time frame similar to that shown on the cooling water figure. The once-through cooling towers are bypassed only when the reactor is down. On recirculating system towers some maintenance can be completed while the tower is in operation. For maintenance requiring an empty system, near ambient temperature water (less than 32.2°C) would be discharged to the stream when the reactor is down.

Table J-2. DOE responses to comments on Draft EIS (continued)

Cooling Water Temperature Following Reactor Scram

River Water Inlet Temperature 27.8°C



Comment number	Comments	Responses
BC-15	Environmental Systems Corporation has reported (see Attachment A): "Based on data acquired by Environmental Systems Corporation from their own acceptance and performance tests of over twenty	An estimate of cooling performance with deficient design was addressed for the type systems being considered for SRP reactor coolant discharges. A consultant was

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	fossil and nuclear power plant closed-cycle cooling systems, as well as data from contributing electrical utilities, cooling tower capability averaged 85 percent. The lowest of these was 76 percent while the highest was 99 percent." They further concluded that "this translates into roughly 3°F above higher return water temperature..." Should the the towers proposed for SRP (either helper or closed-cycle) achieve only 85 percent of design capability, discharge temperatures of more than 3°F above the present estimates would probably result due to the higher inlet temperatures which occur at SRP compared to utility condensers. Unless flexibility is included in the tower design, once constructed it is seldom possible to significantly increase thermal performance. It is to be noted that where actual tower capability is less than design in a closed-cycle tower system, the owner suffers economic penalties due to lower production caused by the higher cooling water temperatures. However, in a helper tower system, only the environment suffers unless the production rate is reduced. It is therefore suggested that in addition to presentation of information for the 100 percent tower capability case, thermal data and biological data presented in the FEIS be based on a tower capability of 85 percent of design unless persuasive information can be provided as to why these conditions are not applicable to SRP.	hired to estimate the performance of the natural-draft cooling tower needed if it operates at 10 percent deficiency. The natural-draft cooling tower would be designed for: 1. Startup of the tower with 54.5°C inlet hot water temperature (HWT) with discharge cold water temperature of 32.2°C or less. 2. With reactor operating, 76.7°C inlet hot water temperature and approximately 31.1°C discharge cold water temperature. 3. 27.8°C wet bulb temperature (WBT) based on historical data and return-on-investment considerations to reduce reactor shutdowns caused by discharge temperatures being higher than 32.2°C, and 4. 40 percent relative humidity (RH). If this tower has a 90-percent thermal capability, the consultant estimates the following: 1. During startup of the tower when inlet water temperature reaches 54.5°C, tower discharge temperature (to tower basin) a. 32.8°C if wet bulb temperature is 27.8°C b. 32.4°C if wet bulb temperature is 27.2°C

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
		2. When the reactor is operating in the summer and the inlet temperature to the tower reaches 76.7°C, the tower discharge temperature is a. 31.7°C if wet bulb temperature is 27.8°C, or b. 31.1°C if wet bulb temperature is 27.2°C. 3. In winter operation the cold water temperature increase would be about 1° to 2°C for 90-percent capability at 50°C wet bulb temperature.
	<u>Cooling Tower Chemistry</u>	
BC-16	The type and management of the biocide and any corrosion inhibiting compounds being considered for the cooling alternatives is an important factor necessary for assessing the overall environmental impacts on the aquatic ecosystem. This is an area that was not adequately addressed in the DEIS and should be presented in detail in the FEIS.	See responses to comments BB-1 and BB-2.
BC-17	The FEIS should discuss the biocide alternatives being considered, expected effluent concentrations and duracions, associated environmental impacts, and any plans for treatment and control. If chlorination is planned, the FEIS should address the specific steps that will be taken to ensure that the SC toxicity criteria for total residual chlorine will be met. Dechlorination should be discussed in the FEIS.	See responses to comments BB-1 and BB-2.
BC-18	It is possible that in a recirculated cooling system with the high reactor temperatures and recycled water chemistry involved, corrosion of reactor cooling piping will be a more significant	See response to comment BB-2.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	problem than postulated and will require the use of high levels of chromium or other toxic corrosion inhibitors. The addition of these chemicals could require chemical treatment of blowdown prior to discharge. Thorough evaluation of this situation at SRP should be made in the FEIS with the information provided and a comparative assessment made relative to the cooling water system materials of construction as they relate to the blowdown water treatment provided at the Oak Ridge, Tennessee and Paducah, Kentucky DOE facilities.	
	Wetland	
	Current operations of the C- and K-Reactor have resulted in approximately 1827 acres of wetlands being impacted by thermal discharges high flow rates and the resultant sedimentation and growth of the stream deltas. D-Area operations has impacted 382 acres of wetlands.	
BC-19	Helper cooling would reduce wetland losses due to thermal discharges downstream from the C- and K-Reactor, however, reestablishment of vegetation would be limited because of continued high and fluctuating flow rates and the accompanying sedimentation. The high silt levels continue to build deltas in the swamps at the mouths of the receiving streams. This high level of sedimentation continues to remove aquatic habitat and adversely impact the environment and therefore should be reduced. The closed-cycle cooling system alternative would restore flows to near natural levels and greatly reduce the level of suspended solids. Successional revegetation to bottomland hardwoods would be expected of 1500 of the impacted acres for the C- and K-Reactor and for a major percentage of the D-Area impacted acreage.	Operational impacts to the wetland community are addressed in Chapter 4, Appendix C, and Appendix F of this Final EIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Aquatic Habitat	
BC-20	By reducing the temperature to within the 32.2°C criterion, both the helper and the closed-cycle cooling alternatives would significantly reduce the thermal impacts on the on-site streams and the Savannah River swamp. However, exceedances of the 2.8°C temperature increase criterion by the presently proposed helper cooling system (in addition to preventing the reproduction of fish as previously noted) may not permit the establishment of a stable aquatic community. This is a factor that must be considered in any 316(a) demonstration performed by DOE that assesses either helper or partially recycled cooling. The closed-cycle cooling system, however, would produce flows more nearly approaching natural levels in the impacted streams and thus permit the reestablishment of a more stable and diverse aquatic community. Spawning conditions for indigenous fish species would improve and there would be much less potential for cold shock from winter reactor shutdown. Because of the decreased flow rates of the closed-cycle alternative, stream sedimentation and changes in the stream morphology would be reduced proportionately, thus resulting in a more stable and healthy aquatic habitat. In addition, since the closed-cycle cooling water system decreases the raw water intake from the River, there would be a reduction in both the level of entrainment and impingement losses by as much as 85 percent.	See responses to comments BB-3 and BB-5.
	Air Quality	
BC-21	Air quality concerns exist for possible health effects of any releases of chromium if used as a corrosion inhibitor in the cooling system.	Design of cooling towers will include an allowance for injection of a corrosion inhibitor if needed. A non-chromated,

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	Although this is a relatively new area, research is underway by EPA at the Research Triangle Park to develop a model and determine potential health risks (A point of contact has been provided on the study). DOE should address the possible problems of using chromium in those alternatives where applicable (the results should be incorporated into the FEIS).	organic-based chemical made by Wright Chemical Company would be used. This chemical is approved by SCDHEC for use in cooling tower systems and is presently being used at the Savannah River Plant.
	<u>Radiological</u>	
BC-22	Only very small differences exist among the alternatives in radiological activity with the amount of release not being affected, just the pathway (with a slight decrease for liquid releases and a slight increase for the atmospheric pathway). Slight changes in the radiocesium transport would result from the differences in release rates into the streams. The recirculating cooling alternative would result in 0.4 curies (Ci) reduction in cesium release for the C-Reactor and 0.6 Ci for the K-Reactor over the existing and helper cooling systems.	The operation of the recirculating alternative would reduce flows in both Pen Branch (K-Reactor) and Four Mile Creek (C-Reactor), resulting in a calculated decrease in the cesium released to the Savannah River of 0.12 curie per year for Pen Branch and 0.21 curie per year for Four Mile Creek.
	<u>Construction Impacts</u>	
BC-23	Best Management Practices should be followed during all construction activities. The FEIS should address the following pre-construction and construction related impacts: • Point Source Discharges - sanitary, concrete mixing plant, etc.; • Solid Waste Management - clearing debris; • Other construction related water quality impacts - oil and hazardous substances spill prevention, and use of herbicides, insecticides, etc.; and • The use of erosion and sedimentation control measures such as - silt fences, sedimentation ponds and early revegetation of disturbed areas.	Best management practices would be followed during all construction activities. In addition, impacts of construction are addressed more completely in Chapter 4 of the FEIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses

TIN P2-1954
Attachment A

FLORIDA POWER CORPORATION
ANCLOTE SITE
CIRCULAR MECHANICAL DRAFT COOLING TOWER
THERMAL ACCEPTANCE TEST

PREPARED FOR:

FLORIDA POWER CORPORATION

BY:

ENVIRONMENTAL SYSTEMS CORPORATION
200 TECH CENTER DRIVE
KNOXVILLE, TENNESSEE 37912

JUNE, 1982

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	COOLING TOWER TEST FACILITY PROGRAM ESTIMATE OF THE ECONOMIC IMPACT OF DEFICIENT COOLING TOWERS	
	The performance of a power plant with a closed-cycle cooling system is intimately tied to the performance of the cooling system, especially during demanding meteorological conditions. If the cooling system is deficient, the condenser back pressure will be higher than design and the plant heat rate will increase. Capacity and energy penalties can be sizeable depending on unit design and the degree of inefficiency of the system.	
	Based on data acquired by Environmental Systems Corporation from their own acceptance and performance tests on over twenty fossil and nuclear power plant closed-cycle cooling systems, as well as data from contributing electrical utilities, cooling tower capabilities averaged 85 percent. The lowest of these was 76 percent while the highest was 99 percent. (As a point of interest, although not included in the subsequent economic analyses, four cooling towers tested at a geothermal installation averaged 87% capability, ranging from 70% to 95%). The majority of these tests were conducted on towers that have been operating for less than two years. Older cooling equipment, if not properly maintained, could be expected to have lower capabilities.	
	With this background, an estimate of the economic impact of deficient cooling towers follows. This technique is similar to that included in EPA-600/7-79-001 "Closed Cycle Cooling Systems for Steam Electric Power Plants: A State of the Art Manual." The megawatt ratings of existing and proposed plants with cooling towers were obtained	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	from the METER (Meteorological Effects of Thermal Energy Releases) computer inventory, which was part of an Oak Ridge National Laboratory study performed by Miller and Patrinos. There is assumed to be approximately 250,000 Mwe of fossil plants and 20,000 Mwe of nuclear plants serviced by cooling towers. If the cooling towers servicing these units are operating at 85 percent capability, this translates into roughly 3°F higher return water temperature to the condenser and attendant higher turbine exhaust pressures. In many cases, not only is unit heat rate increased, but during the more demanding summer meteorology, the unit is forced to reduce load to avoid higher-than-design turbine back pressures. The economic assessment, consisting of three parts, follows: 1. Replacement Capacity Penalty (P_1) $P_1 = k \times FCR \times \Delta kw$ where: P_1 = Capacity penalty in dollars k = Replacement capacity rate, \$/kw FCR = Annual fixed charge rate Δkw = Loss of capacity due to the deficient cooling system Assuming a total 100 units with 3 Mwe reduction each, and applying constants derived from recent utility data, $P_1 = (\$500/kw) \times (0.2) \times (300{,}000\ kw) = \$30{,}000{,}000$.	

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	STATEMENT OF BRUCE BLANCHARD United Stated Department of the Interior Office of the Secretary Washington, D.C. 20240 ER 86/552 June 30, 1986 Mr. R. P. Whitfield Director, Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Dear Mr. Whitfield: The Department of the Interior has reviewed the draft environmental impact statement for Alternative Cooling Water Systems, Savannah River Plant, Aiken, County, South Carolina and has the following comments. General	
BD-1	We recognize that each of the action alternatives offers significant reductions of existing thermal impacts to the affected wetland systems. However, a key consideration that appears to have been underemphasized in the draft statement is the projected lifetime of the reactors and consequent need for cooling systems. This consideration should have major bearing on the selection of preferred alternatives that may represent the best long-term balance among costs, production efficiency, and environmental quality. In consideration of the information presented, it appears that the recirculating cooling tower	The costs of electrical usage, as well as maintenance and production losses, are based on the assumption that reactors continue to operate for 15 years after construction of a cooling tower(s). Also see response to comment BC-6.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	alternative would provide the best long-term advantage from a cost standpoint, as well as providing significant reductions in impingement and entrainment. However, the habitat effects of each alternative should be carefully assessed before the proposed action is finalized.	
	<u>Alternatives</u>	
BD-2	We believe the proposal described in the draft statement offers significant benefits to fish and wildlife resources when compared to the existing No-Action condition. However, the final statement would be improved by the inclusion of a detailed long-term analysis of initial and operating costs, environmental effects, and production efficiency over the project lifetime for each alternative.	Initial and operating expenses, along with production efficiency, have been included in Chapter 2 of this FEIS. Environmental effects for construction and operation have been analyzed extensively and results are included in Chapter 4 of this FEIS. Also see responses to comments BD-1 and BC-6.
	The projected lifetime of the currently operating reactor systems or the likelihood of reactor replacement and long-term need for cooling systems should be factored into the analysis because the available information indicates that significant long-term differences in effects to fish and wildlife resources may exist between action alternatives, particularly in reference to the C- and K-Reactor action alternatives. We suggest long-term annual operating costs may favor the recirculating cooling tower systems after approximately 9-10 years of operation even though the once-through cooling tower systems may represent a lower initial cost.	Comment noted on preference for recirculating cooling towers. See discussion in Chapters 2 and 4 for more detail on this alternative.
	<u>Impacts to Wetlands</u>	
BD-3	Currently, annual forested wetland canopy losses of about 54 acres are occurring in response to thermal impact and increased flooding in the affected areas. The once-through cooling tower alternative	See response to comment BC-19.

Table J-2. DOE responses to comments on Draft EIS (continued)

Comment number	Comments	Responses
	would decrease forest canopy loss while allowing some revegetation of thermally impacted wetlands. Approximately 1,500 acres of previously forested wetlands would continue to be maintained in a permanently flooded condition by the discharges of C- and K-Reactors. With termination of thermal effects, these flooded areas would be expected to provide habitat for aquatic fish and wildlife species if discharge fluctuations are not too severe. The recirculating tower alternative would result in termination of both thermal and flooding effects due to C- and K-Reactor operations. This alternative would allow for successional revegetation of approximately 1,500 acres of previously forested wetland habitats.	
BD-4	The Habitat Evaluation Procedures (HEP) analysis being conducted for the Department of Energy by the Savannah River Laboratory will provide the best way to adequately compare alternatives with respect to long-term habitat effects.	See response to comment BC-3.
	Cumulative Impacts	
BD-5	The final statement for the L-Reactor Restart Project (ER 83/1211) states that on a cumulative basis, including all Savannah River Plant water intakes, the total entrainment losses would be up to 19 percent of the fish eggs and larvae passing the intake canal annually. The final statement should address the combined effects of D-Area, C-, K-, and L-Reactor operation on impingement and entrainment. The total losses from all intakes is significant. Consideration should be given to the installation of recirculating towers to reduce cumulative impacts from entrainment losses.	Entrainment and impingement impacts have been addressed in Chapter 4 with supportive information provided in Appendix C of the FEIS.

Table J-2. DOE responses to comments on Draft EIS (continued)

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	We hope these comments will be helpful to you. Sincerely, Bruce Blanchard, Director Environmental Project Review	