L.4 CONSEQUENCES OF OPERATION

L.4.1 Normal operation

L.4.1.1 Nonradiological impacts

L.4.1.1.1 Water use and quality impacts

L.4.1.1.1.1 Surface-water impacts

The surface-water usage would be the same as in the reference case, with a withdrawal of 11 cubic meters per second from the Savannah River. The thermal discharge from L-Reactor would flow into the 1000-acre lake; the discharge from L-Reactor and from the lake would be about 11 cubic meters per second. Table L-4 lists the estimated downstream temperatures in Steel Creek below the embankment for the summer, spring, and winter.

Table L-4. Temperatures (°C) downstream in Steel Creek below the 1000-acre lake[a]

Location	Summer[b]	Spring[c]	Winter[c]
Discharge temperature[d]	31	26	17
Road A	31	26	17
Swamp	31	25	15
Mid-swamp	30	22	13
Mouth of creek at river	30	22	13

[a]Assumes power reduction when necessary to meet water-quality standards.

[b]Based on worst 5-day meteorological conditions (July 11-15, 1980) and estimated operating power of reactor. Five-day worst-case meteorological conditions provide the basis for a conservatively high estimate of discharge and downstream temperatures that are likely to result from the implementation of a thermal mitigation alternative. The selection of 5-day worst-case meteorology is also based on a typical cycle of consecutive meteorological conditions; it is considered to be representative of extreme temperatures for which the maintenance of a balanced biological community can be measured under Section 316(a) of the Federal Water Pollution Control Act.

[c]Based on 30-year average values for meteorological conditions and actual power of an operating reactor. Summer average temperatures have been included to show the discharge and Steel Creek temperatures that could be expected if significant temperature excursions above and below average did not occur.

[d]The temperature entering Steel Creek from the lake.

Projected water temperatures in the summer (5-day, worst-case) at the Steel Creek delta, mid-swamp, and the mouth of Steel Creek would be within about 1°C of ambient. In the spring, water temperatures at the Steel Creek delta would be

3°C above ambient. Water temperatures would be near ambient at the mouth of Steel Creek. These conditions do not pose any adverse impacts to aquatic and semiaquatic biota. In the winter however, projected temperatures at Road A and points downstream would be 7°C to 9°C above ambient. These warmer conditions could concentrate fish at the mouth of Steel Creek. Reactor shutdowns during the winter would result in a gradual heat loss in this area, which would minimize any cold shock effects. This alternative would not adversely impact access to, and the spawning of riverine and anadromous fishes in, the Savannah River swamp below the Steel Creek delta.

The habitat inundated by the 1000-acre lake alternative would include 225 acres of wetlands in the Steel Creek corridor. The lake would also inundate 775 acres of uplands. There would be minimal thermal impact on wetlands below the embankment. However, the flow rate would adversely impact between 215 and 335 acres of wetlands in the Steel Creek delta and swamp that provide foraging habitat for the endangered wood stork and the endangered American alligator. These wetlands also represent important feeding and roosting habitat for as many as 1200 mallard and 400 wood duck. These wetlands are classified as Resource Category 2 by the U.S. Fish and Wildlife Service. This resource category and its designation criteria include "high value for evaluation species and scarce or becoming scarce." The mitigation planning goal specifies that there be "no net loss of inkind habitat value" (USDOI, 1981).

Wastewater and sanitary discharges would be similar to those associated with the reference case; no impacts from these discharges are anticipated.

No appreciable change is expected in the chemical characteristics of the effluent as the result of its passing through the lake, except that about 6 percent of the suspended solids would be removed from the river water by the 186-Basin and the impoundment.

Criteria of embankment stability design have established that seepage of water is a critical consideration. Therefore, the embankment will be designed so that total permanent seepage loss through the embankment abutments and foundation will be limited. To ensure positive restriction through the foundation of the embankment, an impervious soil or grout cutoff trench will be constructed to the maximum depth that is economically feasible and tied into the abutments. Seepage through the embankment will be slight, because the embankment will consist of three or four zones.

Due to the sandy soil in the area of the natural saddle, some seepage could occur from the lake to Pen Branch. A cut-off wall would be constructed if seepage became a problem.

L.4.1.1.1.2 Ground-water impacts

The use of ground water for L-Reactor would be 0.94 cubic meter per minute). This withdrawal is estimated to have minimal impacts.

Impounded water for a cooling lake would cause a local ground-water mound in the water-table aquifer which would tend to increase the travel time from the L-Reactor seepage basin to seepline springs near the lake's shore from 18 to 21 years. This effect of the lake would dissipate with depth and would be expected to have a small effect on water levels in the McBean Formation. The green clay is an important confining unit separating the McBean from the underlying Congaree Formation. It would prevent the increased head associated with a cooling lake from impacting the head differential between the Tuscaloosa and Congaree Formations. It is also an important barrier to the migration of contaminants from near-surface to lower hydrostratigraphic units. In the Separations Areas and near the Central Shops, the green clay (about 2 to 3 meters thick) supports a head difference of about 21 to 24 meters between the McBean and Congaree Formations. Based on water samples obtained for tritium analysis from the Congaree near the H-Area seepage basin, the green clay has effectively protected the Congaree ground water from contamination seeping into the ground (Marine, 1965). In the L-Area, the green clay is about 7 meters thick. At the Par Pond pumphouse, along the strike of the McBean and Congaree Formations, the green clay also supports a large head difference; the water pumped from the Congaree Formation shows no evidence of tritium contamination, even though tritium concentrations in Par Pond were measured at 27,000 picocuries per liter.

L.4.1.1.2 Ecological impacts

The operation of L-Reactor with the preferred cooling alternative would have some impacts on the ecology of the Savannah River, Steel Creek below and above the lake, the Steel Creek corridor, and the Savannah River swamp (including the Steel Creek delta). In addition, a portion of the lake itself would be affected by the heated water discharged into it. This section describes operational impacts on each of these natural areas.

L.4.1.1.2.1 Savannah River

The impacts of impingement and entrainment would be the same as those of the direct-discharge alternative (reference case). An average of 16 fish per day (5840 fish per year) would be impinged on the cooling-water intake screens, and approximately 7.7 X 10^6 fish eggs and 11.9 X 10^6 fish larvae would be lost to entrainment through the plant.

Thermal impacts on the biota in the river would be minimal because water temperatures would be very close to ambient at the point the discharge flow enters the river. There would be a zone of passage for the movement of fish up and down the river past the SRP site.

L.4.1.1.2.2 Steel Creek downstream from the lake

Projected water temperatures in the summer (5-day, worst-case) at the Steel Creek delta, mid-swamp and the mouth of Steel Creek would be within about 1°C of ambient (see Table 4-31). In the spring, water temperatures at the Steel Creek delta would be 3°C above ambient. Water temperatures would be near ambient at the mouth of Steel Creek. These conditions would not pose any adverse impacts to aquatic and semiaquatic biota. In the winter, however, projected temperatures at Road A and points downstream would be 7°C to 9°C above ambient. These warmer conditions could concentrate fish at the mouth of Steel Creek. Reactor shutdowns during the winter would result in gradual heat loss in this area which would minimize any cold shock effects. This alternative would not adversely impact access to and the spawning of riverine and anadromous fishes in the Savannah River swamp below the Steel Creek delta.

There would be minimal impacts in Steel Creek below the embankment. However, the flow of discharge water would have adverse impacts on between 215 and 335 acres of wetlands in the Steel Creek delta and swamp. This area, which is dominated by forested (45 percent) and scrub-shrub (36 percent) wetlands, provides foraging habitat for the endangered wood stork and American alligator. These wetlands also represent important feeding and roosting habitat for as many as 1200 mallard and 400 wood duck. A delta growth rate of about 1 to 2 acres per year is anticipated.

L.4.1.1.2.3 Steel Creek upstream from the lake

The embankment and cooling lake would prevent access by riverine and anadromous fish to about 100 acres of wetlands along Steel Creek above L-Reactor. However, the only migratory fish in this reach of Steel Creek would be the American eel. Also, access to Meyers Branch would not be affected by the embankment.

Preliminary results of investigations in Upper Steel Creek indicate that the macroinvertebrate community there is self-sustaining and therefore unlikely to undergo significant changes as a result of the creation of the 1000-acre lake. Sixteen species of fish have also been collected in this reach of Steel Creek during two recent surveys. Most of the species are small fish that prefer stream habitats. However, all but one of the species collected have been reported in thermal refugia (backwater or tributary stream areas) peripheral to reactor effluent streams on SRP; therefore, the fish populations in Upper Steel Creek could be capable of maintaining their present status in the 3- to 4-kilometer reach that would be isolated above the cooling lake when the reactor is operating. There would undoubtedly be shifts in patterns of relative abundance. For example, the thermally tolerant mosquitofish would probably increase in abundance and species that prefer pond habitats could thrive in the upper portions of the lake, where temperatures would be moderated by the inflow from Steel Creek.

L.4.1.1.2.4 Cooling lake

One of the principal concerns regarding the impacts of the operation of a 1000-acre cooling lake is the types of biological communities that would develop in the lake. Of particular importance is the requirement, pursuant to Section 316(a) of the Clean Water Act, for establishing and maintaining "balanced indigenous populations" in at least a portion of this water body. DOE has committed to operating L-Reactor in such a manner that such balanced communities would be maintained. Present estimates are that about 50 percent of the lake (about 500 acres) would have water temperatures below 32.2°C during the summer, which would be the most critical period for most aquatic organisms. During the remainder of the year, maximum water temperatures would be less critical, but nonetheless important.

Precisely describing in advance the aquatic communities that would develop in the cooling lake is difficult because:

1. Every new impoundment is unique because its physical and, particularly, its chemical characteristics depend on such factors as: the topography of the inundated area, the chemistry of the soil, the nature and extent of submerged vegetation, the internal pattern of circulation, the

source and quality of inflowing water, the exchange rate, mixing characteristics, etc. The biological communities that develop depend on the physical and chemical environment and on the types and numbers of organisms that move in to occupy the new water body and the speed and order in which they do so. The combinations of these important physical, chemical and biological factors are different for each impoundment that is created. Accordingly, the ecosystem that develops in each is also unique and changes slowly to resemble that in a natural water body of similar characteristics.

2. An artificial thermal regime would be present in this environment.

However, an indication of what might reasonably be expected can be obtained from analyzing the results of the biological studies of Par Pond and other thermally impacted water bodies on SRP. The following sections make this analysis for each of the major groups of organisms that would comprise the balanced aquatic community that would develop in the 1000-acre cooling lake. Due to the thermal regime in part of the lake, it is possible that Aeromonas bacteria could occur.

Fish

The inundation of this 7-kilometer reach of Steel Creek would create a lake environment where a flowing stream now exists. Accordingly, the productivity in this area would greatly increase because the cooling lake would be able to support many more fish than the existing reach of Steel Creek that it would replace. As explained below, the nature of the fish community that will develop can be predicted only in general terms, based on observations of the communities in existing SRP thermal ponds.

For example, the Par Pond system shows a generalized pattern of increasing fish abundance and diversity from Pond C, which is affected more heavily by heated discharges, to Par Pond, which receives less thermal impact. The structure of the fish communities in the two ponds is primarily determined by water temperature, although other factors such as habitat size and characteristics, historic introduction of species, and/or recolonization from the impounded drainage system are also important. Table L-5 lists the fish species found in these two cooling ponds and their relative abundance. Pond C contains fewer fish species (18), of which only two (largemouth bass and bluegill) make up more than 95 percent of the game fish species in this pond (Clugston, 1973). Par Pond contains 29 species of fish, seven of which are abundant; the fish community in Par Pond can be considered "balanced" and self-sustaining and, although the environment is thermally stressed, the community is not dominated by pollution-tolerant species. The standing crop of fishes in Par Pond was similar to that in nearby reservoirs in South Carolina (Clugston, 1973).

It is anticipated that the 1000-acre lake will contain a balanced fish community similar to that present in Par Pond. Also, other species from the Savannah River can enter the lake as eggs, larvae or fry in the cooling water that passes through the plant when thermal stress is low. The exact balance of species that will develop cannot be predicted accurately. However, based on Par Pond, it is anticipated that a bass-bluegill-sunfish dominated community will develop. Clugsten (1973) found that the size of the largemouth bass population in Par Pond is greater than that in other South Carolina reservoirs. This species occurs in a density of about 20 individuals per acre in Par Pond (Gilbert and Hightower, 1981). Accordingly, the numbers of this species that could be supported in the 500 acres of the 1000-acre lake to be maintained below 32.2°C is estimated to be 10,000. This is well above the level of 500 adult breeding individuals that has been identified as the minimum required for maintaining long-term balanced populations of these species. The size of the unstressed zone with the 1000-acre lake is sufficient to support a self-sustaining fish community made up of many other species such as sunfish, crappies, and silversides which are abundant in Par Pond. In addition, the mosquitofish is expected to be numerically abundant both in the stressed and unstressed lake areas.

The normal seasonal cycles evident in natural unstressed water bodies will be modified somewhat by the input of heated water to the cooling lake. Preliminary data from studies in Par Pond have shown that some fish species might spawn and produce fry successfully during the winter months rather than only during their normal reproductive season. Also, growth rates of fishes can be expected to be greater because of the absence of cold-weather dormant periods. Under the proposed operation plan, the fish would have large areas to seek optimum water temperatures year-round. They would be able to avoid hot, stressful zones during the summer and to seek out warmer water in the winter when the reactor is in operation. This artificial thermal regime has not prevented the establishment of a balanced fish community in Par Pond, and it is expected that a fish community of similar structure and function would develop in the 1000-acre lake. The stocking of certain species could also be a method to enhance the establishment of a balanced biological commmunity.

Benthic macroinvertebrates

It is anticipated that a balanced community of benthic macroinvertebrates will be developed and maintained in a portion of the cooling lake. Based on observations in Par Pond and the other thermally stressed SRP ponds, three different temperature zones can be identified:

Zone I (less than 32.2°C)--Balanced benthic community
Zone II (32.2°C to 35°C)--Stressed community
Zone III (35°C to 37°C)--Depauperate populations

Table L-6 lists the common invertebrates that might be found in these zones.

Zone I. Balanced benthic community. In this area, water temperatures will not exceed 32.2°C, even in the summer. A balanced biological community could develop in this zone. It would probably resemble the benthic assemblage present in the warm (but not hot) areas of Par Pond (Table L-6). Such assemblages are characterized by high diversity and density. They are not dominated by stress-tolerant taxa but resemble communities in other SRP areas that never received heated effluent or that are post-thermal. These groups of invertebrates can support organisms at higher trophic levels, including a range of fish species.

Another important criterion for the development of a balanced invertebrate community would be the availability of adequate shallow-water areas with suitable sediment. It is anticipated that such areas will be present along most of the shoreline of the cooling lake, particularly in any embayments or backwaters. There will be adequate dissolved oxygen in these critical habitat areas

Table L-6. Common macroinvertebrates that might be found in thermal zones in 1000-acre lake

Zone I. Water temperatures less than 32.2°C ("balanced")

Turbellaria (flatworms)

Nematoda (Nematodes)

Oligochaeta (Segmented worms), mainly Noididae

Hirudinea (leeches)

Mollusca

Gastropoda (snails)

Physella heterostropha (Say)
Helisoma trivolvis (Say)
Helisoma anceps (Marke)
Campeloma docuim (Say)
Gyraulus parvus (Say)

Pelecypoda (clams and mussels)

Sphaeriidae (Sphaerium)
Corbicula fluminea (Muller)
Anodonta imbecillus (Say)

Arthropoda

Amphipoda (Scuds)

Hyalella azteca (Saussure)

Acari (water mites)

Decapoda (crayfish)

Procambarus spp.

Insecta (Insects)

Ephemeroptera (Mayflies)

Caenis diminuta (Walker)
Callibaetis sp.

Odonata (Dragonflies and damselflies)

Celithemis spp.
Epicordulia princeps (Hagen)

Table L-6. Common macroinvertebrates that might be found in thermal zones in 1000-acre lake (continued)

Zone I. Less than 32.2°C ("balanced") (continued)

Erythemis simplicollis (Say)
Ladona deplamota (Pambur)
Pachydiplax longipennis (Burmeister)
Perithemis tenera (Say)
Tetragoneuria cynosura (Say)
Aphylla willamsoni (Gloyd)
Anax junius (Diurg)
Enallagma spp.
Ischnura spp.

Trichoptera (Caddisflies)

Oecetis spp.
Oxyethira spp.
Orthotrichia sp.
Cernotina spirata (Kris)
Agrypnia vestita (Walker)
Ptilostomis spp.

Megaloptera (fishflies and alderflies)

Chauliodes spp.
Sialis spp.

Lepidoptera (butterflies and moths)

Parapoynx sp.

Hemiptera (true bugs)

Trichocorixa sp.
Hesperacorixa sp.
Sigara spp.
Belostoma sp.
Ranatra buenoi (Hungerford)
Buenoa spp.
Gerris spp.
Metrobates sp.
Mesovelia sp.
Microvelia sp.

Coleoptera (Beetles)

Berosus spp.
Hydroporus spp.
Hydrovatus spp.
Tropisternus spp.

Table L-6. Common macroinvertebrates that might be found in thermal zones in 1000-acre lake (continued)

Zone I. Less than 32.2°C ("balanced") (continued)

Peltodytes spp.
Cymbiodyta spp.
Celina spp.

Diptera (True flies)

Tipulidae

Culicidae

Ceratopogonidae

Chironomidae

Ablabeskyia spp.
Larsia sp.
Procladius spp.
Labrurdinia spp.
Coryoneura sp.
Cricitopus sp.
Eukieffer sp.
Brilla sp.
Chironomus spp.
Cryptochiromous
Dicrotendipes spp.
Glyptotendipes sp.
Microtomadipes
Polypedilum spp.
Harnischia spp.
Phaenopsecta spp.
Pseudochironamus spp.
Rheotanytarsus spp.
Tanytarsus spp.

Chaoboridae

Chaoborus punctipennis (Sax)

Tabanidae

Chrysops spp.
Tabanus spp.

Table L-6. Common macroinvertebrates that might be found in thermal zones in 1000-acre lake (continued)

Zone II. Water temperatures 32.2°-35°C ("stressed")

Oligochaeta (segmented worms), mainly Naididae

Nematoda (Nematodes - roundworms)

Gastropoda (Snails)

Physella heterostropha (Say)
Helisoma trivolvis (Say)

Pelecypoda (clams and mussels)

Corbicula fluminea (Muller)

Amphipoda (scuds)

Hyalella azteca (Saussure) (questionable presence)

Acare (water mites)

Insecta (insects)

Ephemeroptera (Mayflies)

Caenis diminuta (Walker)

Odonata (Dragonflies and damselflies)

Erythemis simplicicollis (Say)
Pachydiplax longipennis (Burmeister)
Perithemis tenera (Say)
Enallagma spp.
Ischnura spp.

Trichoptera (Caddisflies)

Oecetis spp.

Hemiptera (true bugs)

Corixidae
Belostoma sp.

Coleoptera (Beetles)

Hydrophilidae
Dystiscidae

Diptera (true flies)

Table L-6. Common macroinvertebrates that might be found in thermal zones in 1000-acre lake (continued)

Zone II. 32.2°-35°C ("stressed") (continued)
Ceratopogonidae
Chironomidae
Ablabesmyia spp.
Procladius spp.
Labrundinia spp.
Cricotopus spp.
Dicrotendipes spp.
Polypedilum spp.
Tanytarsus spp.
Tanytarsini
Zone III. Water temperatures 35° to 37°C ("depauperate")
Some Oligochaeta (segmented worms)
Some Nematoda (Nematodes; roundworms)

within Zone I because the water temperatures will be lower, stratification of the water column will be less, and the distances from the stressed zones of accelerated organic decomposition will be greater.

Zone II. stressed community. Water temperatures in this area will range from 32.2°C to 35°C in the summer. The community structure will be intermediate in complexity between those in Zones I and III. The benthic populations will be self-sustaining and "balanced" but will be characterized by stress-tolerant organisms. A list of the dominant species expected within this zone is given in Table L-6. A large percentage of the species present in Zone I will also be represented here. The principal differences are that some more thermally sensitive forms will be excluded from Zone II and that the relative dominance of species will change. The majority of individuals should be present at depths between 1 and 3 meters. Below these depths, the oxygen concentration in the water becomes limiting. Only a few species (but many individuals each) can tolerate the low oxygen-anoerobic conditions that probably would be present at greater depths. If the water column is stratified, the benthic assemblage below the thermocline in Zone II could resemble the deepwater assemblages in most areas of Par Pond. Above the thermocline, the benthic assemblage would probably roughly resemble the fauna in Coleman's Cove, a thermally stressed area of Par Pond. Community functioning within this zone should resemble that in a balanced biological community (but with less species and linkages), unless the source of nutritive organic matter changes significantly (e.g., by an increase in the relative abundance of blue-green algae and a significant decrease in other rooted, floating, and emergent macrophytes), in which case the community structure would further degrade to more stress-tolerant forms.

The organisms in this benthic zone will be an important additional source of food for fishes in the 1000-acre lake, particularly during the periods when water temperatures fall and fish re-enter shoreline areas from which they were excluded during the warmest summer months.

Zone III. Depauperate community. The water temperatures in this zone are so high (35°C-37°C) that very few, if any, benthic invertebrates would survive. The food source would be different than in other areas of the cooling lake. Blue-green algae would be the dominant primary producer. This would further reduce the kinds and numbers of benthic consumers present, because very few forms can utilize blue-greens directly or indirectly. Table L-6 lists some taxa that could be present in this zone.

Plankton

Phytoplankton, periphyton and zooplankton populations that would develop in the 1000-acre lake will resemble those present in Par Pond and Pond C. Tables L-7, L-8, and L-9 list the species from these three groups that have been collected from the existing thermal ponds on SRP. The temperature regime within the cooling lake should be the principal factor that determines whether the new plankton community is most similar to one or the other of the existing environments. In those areas where summer water temperatures do not exceed 32.2°C, a balanced biological community of plankton will be present. This community will be similar to that in Par Pond, except that the continuous input of relatively nutrient-rich Savannah River water would make the 1000-acre lake more productive and more likely to develop nuisance algal blooms than Par Pond. However, the expected shorter retention time within the once-through system may partially or completely offset this potential. Also, the input of Savannah River water and water from Upper Steel Creek might also increase the species richness and diversity of the plankton community in the 1000-acre lake.

The seasonal effects on the plankton would primarily be an increase in primary production during the winter months when water temperatures in the coolant lake would be warmer than in ambient water bodies. This beneficial effect would be partially or completely offset in the warmest summer months by decreased production by useful species and augmented production by blue-green nuisance species. The blue-greens will be the dominant alga at water temperatures above about 37°C. Primary production by this group in the summer could result in large mats of organic material being carried into the non-thermally stressed zones and adversely affecting the populations of other organisms therein. Table L-10 summarizes the expected condition of the plankton community within various temperature zones in the 1000-acre lake. A balanced community can exist only where water temperatures do not exceed 32.2°C.

Macrophytes

The presence of macrophytes in the 1000-acre lake will be an important factor in the establishment and maintenance of a balanced fish community within this body of water. Based on observations in Par Pond, it is anticipated that a balanced vascular plant community will develop in some shoreline areas of the cooling lake where maximum water temperatures do not exceed 32.2°C. Very few plants will exist in areas of higher temperature. This can be seen clearly in Table L-11, which lists those vascular plant species present in Par Pond (moderately thermally stressed) and in Pond C (highly thermally stressed).

Only three plants are present in Pond C, and these live above the normal water level. However, 23 species are reported from Par Pond: 5 submerged forms, 4 floating-leafed, and 14 emergent. The standing crop of submerged macrophytes in heated areas of Par Pond was twice that of the unheated area (Grace and Tilly, 1976). This type of plant development in the 1000-acre lake would be sufficient to support a balanced fish community.

The aquatic communities in the reach of Steel Creek above the lake would probably be very similar to those present previously when L-Reactor was operational and the thermal effluent below the outfall isolated this area from downstream influences.

L.4.1.1.3 <u>Socioeconomic impacts</u>

The socioeconomic impacts of operation would be almost the same with the 1000-acre lake as with the direct discharge alternative (reference case). Operational employment for L-Reactor, which began in 1981, peaked at about 400 employees in mid-1983 and is expected to decrease to 350 by mid-1984, or about 4 percent of the current work force at the Savannah River Plant (Du Pont, 1982b). Essentially all the operating work force for L-Reactor has been hired and resides in the SRP area; therefore, no additional impacts due to in-migrating workers are expected to local communities and services. Operating, maintenance, and general service requirements would be performed by personnel sharing duties with normal L-Reactor requirements.

L-Reactor operation is expected to have annual total local expenditures on materials and services of approximately $3 million and a total payroll and overhead expenditure of about $21 million. These expenditures are expected to result in the creation of about 50 regional job opportunities. In addition, these expected expenditures are anticipated to produce an additional direct and indirect income of another $3 million. The total economic benefit to the SRP region during L-Reactor operation will amount to at least 400 direct and indirect job opportunities, about $25 million in direct and indirect annual income and payroll, and $3 million in direct annual expenditures on materials and services.

These contributions to the local economy will help pay for public services directly through income, property, and license taxes and user fees and help indirectly through sales taxes on goods and services. The benefits provided by the project will help offset the small increase in demands that it generates for local services.

L.4.1.2 Radiological impacts

L.4.1.2.1 <u>L-Reactor radiological releases</u>

The operation of L-Reactor with the preferred cooling-water alternative would have the same radiological releases and associated impacts as those described in Section 4.1.2, except power levels would be reduced to meet the criterion of about 50 percent of the lake being maintained below 32.2°C. The power reduction would be approximately 14 percent; if precoolers are installed, the reduction would be approximately 3 percent.

L.4.1.2.2 Cesium-137/cobalt-60 remobilization

The resumption of L-Reactor operation would add only small amounts of radionuclides to Steel Creek. However, the reactivation would transport a portion of the cesium-137 and cobalt-60 inventories that remain in the Steel Creek channel and floodplain.

The transport of radioactivity associated with sediments from the 1000-acre lake would be smaller than that related to direct discharge to Steel Creek. This reduction would be due primarily to the low water velocities over the bottom of the lake and the near-zero erosion of contaminated sediments on the bottom of the lake. However, discharge water from the lake, which would be relatively sediment-free, could rapidly reach equilibrium sediment loading downstream from the embankment. Thus, the total transport of radioactivity by suspended sediments in the Steel Creek system might not differ much from that estimated for direct discharge (i.e., 2.3 curies in the first and second years).

The effects of a thermal lake on desorptive transport (i.e., solution transport) compared to the effects of a flowing stream are somewhat uncertain. However, they are expected to be no greater than those with a flowing stream. The area of contaminated soil exposed to water from a lake covering the contaminated floodplain sediment would be nearly the same as that if the L-Reactor cooling stream is discharged directly to the creek. The hot water would desorb the cesium-137 from the surface sediments on the bottom of the lake; however, the rate of desorption is expected to be significantly slower, because sediments would not be mixed with the water as vigorously as compared to a flowing stream, and the average temperature of water at the bottom of the lake would be considerably lower than the average temperature to which sediments are exposed during direct discharge. As cesium-137 concentration on the surface of the lake bottom sediments reduced from transport out of the lake, further loss would be smaller because diffusion is an extremely slow process for the transfer of material through the sediments.

It is known that in Par Pond, cesium deposits on the bottom of the pond become more soluble during anaerobic conditions (bottom water concentrations are about twice the surface concentrations) when there is thermal stratification in the spring and summer, and then cesium is mixed throughout the depth of the pond when water turnover occurs in the fall. Thermal stratification in the 1000-acre lake would enhance desorption somewhat; however, the net consequence of reduced temperature, reduced flow rate, and the anaerobic effect would be to lessen the transport.

Because the factors that could influence activity transport in the combined lake-stream system are difficult to quantify precisely, transport with the lake-stream system is conservatively estimated to be no more than that associated with direct discharge of cooling water to Steel Creek (i.e., 4.4 ± 2.2 curies of cesium-137 and 0.25 curie of cobalt-60 would be transported in the first year). In the second year, it is anticipated that this value would be reduced to 2.3 ±

1.8 curies. Thereafter, a 20-percent reduction in transport per year is assumed.

L.4.2 Accidents

L.4.2.1 Reactor accidents

Possible accidents and their consequences for the preferred cooling-water alternative are not expected to be different from those described in Section 4.2. Section 4.2.1 discusses reactor malfunctions and Section 4.2.2 discusses hazards due to natural phenomena and non-nuclear hazards. Appendix G treats reactor accidents in detail.

L.4.2.2 Embankment failure

The probability of an embankment failure is extremely low. As indicated in Section L.2.3.2, applicable seismic design criteria would be used for embankment construction. Similarly, the embankment and outlet works and the emergency spillway have been designed to control the runoff (Section L.2.3.1) from the U.S. Army Corps of Engineers' "standard project flood." At SRP this flood is the result of a 96-hour rainfall of 51 centimeters. The standard project flood does not have a direct correspondence to a recurrence interval. However, 51 centimeters in 96 hours is nearly twice the 100-year recurrence interval depth for the area. Extrapolation of the depth-versus-recurrence-interval relationship for the 96-hour duration at the site would imply a recurrence interval of over 10,000 years. An even rarer flood, the probable maximum flood, was also included in the design basis. The embankment is designed to withstand these events.

The consequence analyses of embankment failure indicate that any loss of life is unlikely because no SRP facilities or offsite residences exist in the expected path of the resulting flood wave. However, severe economic loss and environmental impacts would occur.

The consequence analyses of embankment failure were based on a reservoir water-surface elevation of 61 meters. This is the elevation at the top of the embankment, 1.2 meters above the emergency spillway and 1.6 meters above the peak pool level for the standard project flood. Results of the analyses indicate that a failure with the water at the 61-meter elevation would produce a 14-meter-high flood wave. The wave height would decrease as it proceeded downstream. At a distance of 3.7 kilometers downstream from the embankment, the wave height would be about half the initial height, or 7 meters. This station is below the Seaboard Coast Line Railroad bridge and the bridge over Road A (SC Highway 125). These bridges would be overtopped and probably destroyed, and their debris would be carried by the flood wave.

At a distance of 5.2 kilometers downstream from the embankment, the wave would have a height of approximately 3.5 meters and be fully into the Savannah River swamp, both on and off the site. This is downstream from the second Seaboard Coast Line Railroad bridge which is about 900 meters above Cypress

Bridge. This railroad bridge would probably be destroyed or severely damaged. The swamp is not deep enough to sustain a wave height of 3.5 meters, and the trees and shrubs would also attenuate the wave. However, as the wave breaks and scatters through the swamp, it would uproot trees and vegetation and then deposit the entrained debris, including earth from the embankment, scoured sediment, and bridge debris. The effect on the Savannah River itself is expected to be minor.

L.5 MONITORING

L.5.1 Water-quality monitoring

NPDES permit conditions are not finalized. The following is an outline of the anticipated program of measurements designed to assure a balanced biological community in the 1000-acre cooling lake during the initial period of L-Reactor operation.

L.5.1.1 L-Reactor effluent monitoring

The L-Reactor outfall parameters would be monitored as required by the NPDES permit.

L.5.1.2 Lake monitoring

The temperature of the lake would be surveyed on a regular basis with sufficient monitoring points to validate the thermal predictions concerning the lake and also to demonstrate a balanced biological community in the lake and other NPDES requirements.

During the first 3 to 5 years of L-Reactor operation, the Section 316(a) studies would be reported to the State annually or in accordance with the requirements of the NPDES permit.

L.5.2 Embankment inspection and monitoring

Inspection of the embankment would be conducted on a regular basis. Three levels of inspection are planned: a monthly inspection of the embankment; a biannual inspection of all outlet works, gates, and spillways; and an annual settlement check. All inspections would follow standard procedures similar to those established for Par Pond.

The monthly inspection of the embankment would include but not be limited to the following:

1. Measurement of water levels in piezometers.

2. Observation of the embankment slopes for surface cracks, evidence of seepage on the surface, evidence of piping or boils, and condition of the protective covering.

3. Observation of the abutments for evidence of piping or boils or other evidence of seepage.

4. Observation of toe, the embankment, and downstream areas for surface cracks, heaving, and increased seepage.

A biannual inspection would be performed on all outlet works, gates, and the spillway area. The purpose of this inspection would be to determine the condition of the physical, mechanical, and electrical facilities and equipment associated with the various appurtenances with the embankment.

On an annual basis, surveying and leveling of settlement pins located on and around the embankment would be made to determine if there was any indication of excessive settlement or movement.

The results of all inspections would be formally documented and the data stored at SRP for easy access and comparison for further readings or observations.

L.5.3 Radiological monitoring

The radiological monitoring program would include the monitoring of air on and off the site, water from SRP streams and the Savannah River, the SRP ground water, and samples of soil, vegetation, food, drinking water, animals, and fish for their radionuclide content. In addition, aerial radiological surveys of the Savannah River Plant and surrounding areas are conducted periodically by the DOE Remote Sensing Laboratory, operated by EG&G. Independent radiological monitoring programs are also conducted by the South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR).

This program would be the same as that for the reference case (described in Section 6.1), except sampling in Steel Creek will include the lake water and lake sediments.

L.5.4 Radiocesium remobilization monitoring

DOE has established a comprehensive environmental monitoring program to determine the transport of cesium-137 from the Savannah River Plant resulting from the startup of L-Reactor. The program consists of analyses of water samples from Steel Creek, the Savannah River, and the downstream water supplies (Beaufort-Jasper, South Carolina, and Port Wentworth, Georgia). Cesium-137 is not detectable in upstream or downstream river samples by routine monitoring techniques that have minimum detection limits of about 1.0 picocurie per liter. The routine monitoring program has been in effect at the site for about 30 years. A special monitoring for cesium-137 and total suspended solids would be conducted for a minimum of 1 year following L-Reactor startup and operation.

Aerial radiological surveys of the Savannah River Plant and surrounding areas were conducted by the DOE Remote Sensing Laboratory, operated by EG&G, Las Vegas, in 1974, 1979, 1982, and 1983. These surveys would continue after L-Reactor startup.

Special monitoring programs for cesium-137 and total suspended solids were conducted during cooling-water cold-flow tests. These data were used to evaluate releases from individual tests and to verify transport models used to estimate the remobilization of cesium during reactor operations. During tests of limited flow, weekly composite water samples were taken at the mouth of Steel Creek and at Cypress Bridge. For the full-flow tests, daily composite water samples would be taken at multiple points along Steel Creek. Additional special sampling would be made to determine the amount of cesium-137 transported in the suspended sediments.

The drinking-water monitoring program would include measurements of both cesium-137 concentration in the Savannah River above and below the Savannah River Plant and water-treatment plant raw and finished water above and below the Plant. The Savannah River estuary and the Savannah River, as well as water-treatment sludge ponds, would be studied to determine potential cesium-137 buildup in sediments. These measurements started in March 1983, and will continue for at least 1 year following L-Reactor startup.

Measurements in the Savannah River would provide a material balance of the total cesium-137 discharged to and transported by the river. Measurements of raw river water and finished drinking water would provide cesium-137 concentrations to verify earlier estimates made for transport. Measurements of cesium-137 in the estuary would be compared to earlier measurements to determine long-term trends.

L.5.5 Ecological monitoring

The principal objective of the aquatic biological monitoring program that will be established will be to demonstrate that there is, in the cooling lake, a balanced community of aquatic organisms. The program will be designed to characterize the development and stabilization of the ecological communities that will evolve in the new impoundment. Information generated by the studies will also be used for preparing a predictive Section 316(a) demonstration for the cooling-lake system.

As with any newly filled reservoir, the ecological system in the cooling lake would require at least 3 to 5 years to reach maturity and stabilize. In the process, it would pass through a series of characteristic developmental stages that have been observed and documented at other new reservoirs. A balanced biological community of aquatic organisms would not be established until the lake reached maturity. Accordingly, the ecological program would have two phases: (1) monitoring the natural communities through the developmental period (from 3 to 5 years) and establishing when a state of balance has been achieved, and (2) monitoring the balanced community (for a period of time to be determined later) after stability is achieved to ensure that it does not degrade over the longer term. The second phase would require a lower level of effort than the first and would focus on carefully selected organisms to be chosen as indicators of the communities that eventually develop in the cooling lake. As described in Section L.4.1.1.2, it is not possible a priori to describe the nature and complexity of the aquatic community that will become established, nor is it possible to predict which species will be dominant or important or which will serve as good indicators of the balance within the community. Accordingly, the second phase of the biological monitoring program cannot be planned in detail until after the lake has reached maturity and the aquatic communities attain a balanced state. This should occur from 3 to 5 years after the lake is filled. At that time DOE, in consultation with SCDHEC officials, would design and institute a revised monitoring program.

The first phase of the ecological monitoring program would begin as soon as the 1000-acre lake was constructed. It would be similar in design and execution to the program now underway at Par Pond; this program is summarized in Table L-12. Sampling gear types and collection techniques would be the same both to maximize the comparison of data obtained from the two lakes and to take maximum advantage of the experience being gained by the ongoing Par Pond investigations. The frequency of sampling would be similar--monthly or quarterly, depending on the parameter under study.

Parameter	Sampling frequency
Phytoplankton	Monthly
Zooplankton	Monthly
Meroplankton	Monthly
Macroinvertebrates	Quarterly
Macrophytes/habitat formers	Quarterly
Fish	Monthly
Water chemistry	Monthly

Sampling locations would be established at strategic points within the lake and in areas downstream and upstream of the lake. Based on experience with other ongoing studies at SRP, approximately 10 to 15 stations would be set up in the lake, as would some 4 to 6 stations in both the upstream and downstream reaches. The locations of these stations cannot be selected until detailed predictions of the isothermal patterns within the lake are completed prior to its being filled.

L.5.6 Archeological sites

Data recovery of sites impacted by the lake would be completed prior to flooding. During construction, historic, archeological, and cultural resources in the contractor's work area would be designated; precautions would be taken to preserve all such resources. The contractor would install protection for these resources and would be responsible for their preservation. If, during construction activities, the contractor observed unusual items that might have historic or archeological value, he would take precautions to preserve the items carefully; such observations would be reported as soon as practicable.

During the first 2 years of L-Reactor operation, those sites not expected to be affected but near Steel Creek below the embankment would be monitored on a monthly basis to determine whether erosion had occurred. If no erosion was evident at the end of the 2-year monitoring period, then the sites should be considered sufficiently protected to assure preservation.

Active erosion protection would be undertaken in the event that adverse erosion threatened the integrity of any of the sites. If erosion barriers were ineffective, recovery and documentation of the archeological data would be carried out.

L.6 FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

This section summarizes the Federal and State of South Carolina requirements that are applicable to the resumption of L-Reactor operation, based on the construction and operation of the preferred cooling-water alternative with a 1000-acre lake. Chapter 7 contains general synopses of the applicable laws and regulations. This alternative would require a number of permits or processes regarding water quality, floodplain/wetlands, historic preservation, endangered species, air quality, and noise. The specific requirements for each are described in the following sections:

L.6.1 Surface-water quality

Permits and processes associated with water quality include (1) an NPDES permit, (2) a predictive Section 316(a) demonstration, (3) a U.S. Army Corps of Engineers 404 permit, and (4) an SCDHEC 401 certification.

Section 402 of the Clean Water Act, as amended, is the basis for controlling "point source" discharges of pollutants into navigable waters of the United States through the National Pollutant Discharge Elimination System (NPDES); this system is administered by the EPA, which has delegated NPDES permitting authority in South Carolina to the State of South Carolina. DOE applied to the State in 1981 for renewal and consolidation of its original NPDES permits. All L-Area outfalls with the potential for future use were included in the NPDES permit renewal application. Between 1981 and 1983, negotiations between SCDHEC and DOE were held to resolve issues related to the L-Reactor NPDES permit.

On December 15, 1983, SCDHEC announced its determination to issue a renewal NPDES permit to DOE for the Savannah River Plant, to be effective January 1, 1984. Based on this permit and a mutually agreed on consent order, all discharges except the thermal discharge from L-Reactor would be permitted. Thermal discharges from the three operating SRP reactors (C, K, and P) would be permitted, provided DOE would:

1. Complete a comprehensive study of the thermal effects of all operations at the Savannah River Plant

2. Complete and submit thermal mitigation studies to SCDHEC within 9 months of signing of the consent order

3. Implement the recommended thermal mitigation alternative approved by SCDHEC under a schedule to be established by SCDHEC in a subsequent order

4. Submit and actively support appropriate funding requests to accomplish any actions resulting from the thermal studies.

All L-Area non-reactor cooling-water effluent discharges are permitted pursuant to the December 15, 1983, announcement, including the discharge of sanitary wastewater and various nonprocess cooling waters from the control building, pumphouse, offices, and security building.

SCDHEC considers the proposed 1000-acre lake to be Class B waters of the State. This interpretation would limit the temperature of thermal effluents from L-Reactor as follows [SCDHEC, 1981; Section C.(7)].

- Discharge to a lake or reservoir - The temperature of the discharge "shall not exceed a weekly average temperature of 90°F (32.2°C) after adequate mixing as a result of heated liquids, nor shall a weekly average temperature rise of more than 5°F (2.8°C) above temperatures existing under natural conditions be allowed as a result of the discharge of heated liquids unless an appropriate temperature criteria or mixing zone, as provided below, has been established. The water temperature at the inside boundary of the mixing zone shall not be more than 18°F (10°C) greater than that of water unaffected by the heated discharge. The appropriate temperature criteria or the size of the mixing zone shall be determined on an individual project basis and shall be based on biological, chemical, engineering and physical considerations. Any such determination shall assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on a body of water to which the heated discharge is made and shall allow passage of aquatic organisms."

- Case-by-case determinations - "Upon a case-by-case determination by the Department and in accordance with the Act, the Clean Water Act (P.L. 92-500, 95-217), and related regulations, the above temperature criteria may not apply to cooling water bodies with a primary purpose of providing a source and/or being a receptor of industrial cooling water."

As noted in Section C(8) of the Water Quality Standards (SCDHEC, 1981), the temperature standards for Class B waters of the State are applicable when the flow rate is equal to or greater than the minimum 7-day average flow rate that occurs with an average frequency of once in 10 years. However, the temperature of the discharge cannot be so high that it interferes with water uses or is harmful to human, animal, plant, or aquatic life.

The preferred alternative (the 1000-acre cooling lake) is designed to meet these requirements; it is the subject of ongoing discussions with SCDHEC. The objective of these discussions is the incorporation of L-Reactor thermal discharges into the overall SRP NPDES permit.

In early December 1983, DOE also initiated discussions with the U.S. Army Corps of Engineers on dredge and fill permits under Sections 9 and 10 of the River and Harbor Act and Section 404 of the Clean Water Act. To allow a possible expedited schedule, DOE has submitted its 404 application for the 1000-acre lake, and the public notice describing the proposed construction has been issued.

The public notice of the 404 application also includes a paragraph that constitutes a request by the Corps of Engineers for a review in accordance with Section 401 of the Clean Water Act. Section 401 requires certification from the State (i.e., SCDHEC) that construction and operation-related discharges into the navigable waters will comply with the applicable effluent limitations and water-quality standards of the Clean Water Act. This certification is a prerequisite for the 404 permit approval from the U.S. Army Corps of Engineers.

L.6.2 Floodplain/wetlands

DOE issued a floodplain/wetlands notice regarding the proposed reactivation of L-Reactor on July 14, 1982 (47 FR 30563). A floodplain/wetlands determination regarding no practical alternative was published in the Federal Register on August 23, 1982 (47 FR 36691-2). The floodplain/wetlands assessment has been updated (see Appendix I) and the floodplain/wetlands determination will be updated and/or modified after the completion of the Final Environmental Impact Statement.

The Fish and Wildlife Service's mitigation policy for wetlands is stated in 46 FR 7644-7663. This policy establishes four resource categories to establish mitigation levels consistent with the fish and wildlife resources involved. The wetlands that would be impacted by the restart of L-Reactor are categorized under Resource Category 2 as habitat of "high value for evaluation species" and are "scarce or becoming scarce." The mitigation goal under this policy requires that there be "no net loss of inkind habitat value."

The Department of Energy is working with the Department of Interior to perform a Habitat Evaluation Procedure (HEP). The HEP will identify the value of habitat to be gained or lost with the implementation of the preferred cooling-water mitigation alternative for use in assessing further mitigation. If required, DOE will implement additional mitigative measures that might be identified through the HEP process, depending on Congressional authorization and appropriation.

L.6.3 Historic preservation

The area subject to impact by this alternative contains one prehistoric site and four historic sites eligible for inclusion in the National Register. These sites would be subject to erosion and flooding due to the high water-flow conditions and the establishment of the impoundment. A resource recovery plan has been developed by the University of South Carolina Institute of Archeology and Anthropology and consultations with the SHPO and the Advisory Council on Historic Preservation (ACHP) have been completed. The mitigation plan has been approved by the SHPO and ACHP (Lee, 1982). Erosion and transport of sediment are expected to be slightly reduced in relation to direct discharge.

In March 1984, an intensive survey of the proposed excavation areas (embankment and borrow pit areas) was made (Brooks, 1984). This survey identified seven sites described as of ephemeral quality and not eligible for nomination to the National Register of Historic Places.

Archeological surveying and testing are presently being conducted in the proposed lake area by the University of South Carolina Institute of Archeology and Anthropology. It is anticipated that several sites associated with the Ashley Plantation will be affected. The schedule for completion of the requirements under the National Historic Preservation Act, including data recovery, is consistent with the construction schedule for the embankment, and all mitigation will be completed prior to restart (Hanson, 1984).

L.6.4 Endangered species

Pursuant to the requirements of the Endangered Species Act of 1973, DOE has engaged in a consultation process with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for the species discussed below.

L.6.4.1 American alligator

Formal consultation on the American alligator was held under the Endangered Species Act in September 1982 with representatives of DOE-SR, Du Pont, NUS Corporation, the Savannah River Ecology Laboratory (SREL), and the U.S. Fish and Wildlife Service (FWS). A Biological Opinion received from the FWS judged that protection of the lagoons at SRP Road A should provide sufficient mitigation for the American alligator potentially affected by the L-Reactor restart under the direct discharge alternative. Protection of these lagoons has been completed. Because the preferred cooling-water alternative is now the 1000-acre lake, DOE has reinitiated consultations with FWS. DOE has transmitted the most recent information on impact projections for this species (Sires, 1984b) to the FWS. DOE is awaiting a decision on its conclusion that the impacts resulting from the delayed restart of L-Reactor will not jeopardize the continued existence of this species.

L.6.4.2 Red-cockaded woodpecker

The FWS has determined that the red-cockaded woodpecker will be unaffected by L-Area operations.

L.6.4.3 Shortnose sturgeon

Sturgeon larvae were identified in water samples taken near the SRP pumphouses at the Savannah River in 1982 and 1983. A few of these were determined to be the federally endangered shortnose sturgeon. A biological assessment and consultation process with the National Marine Fisheries Service (NMFS) has been completed for this species. NMFS has concurred with the DOE determination that the population of the shortnose sturgeon in the Savannah River would not be jeopardized (Oravetz, 1983).

L.6.4.4 Wood stork

The endangered wood stork forages at the Savannah River Plant, but does not breed on the site. The feeding individuals have been observed to be from the Birdsville Rookery, some 50 kilometers away. DOE initiated informal consultation with FWS in July 1983 and in March 1984. DOE has prepared a biological assessment for FWS review and use in formulating its Biological Opinion. DOE is continuing to conduct studies and apprise FWS of the results (Sires, 1984a).

L.6.5 Air quality

The authority for the regulation of air emissions has been delegated by the EPA to the Bureau of Air Quality Control of the SCDHEC. The Bureau issues operating permits and performs Prevention of Significant Deterioration reviews. Emissions due to the construction of the 1000-acre lake will fall within the conditions of the existing air quality permit.

L.6.6 Noise

DOE is obliged by the Noise Control Act of 1972 to carry out programs in a manner that furthers the national policy of promoting an environment free from noise that jeopardizes health or welfare. The major source of noise would be the construction activity in connection with the embankment for the 1000-acre lake. The contractor would be required to keep construction activities under surveillance, and to exercise control to minimize damage to the environment by noise. The contractor would use methods and devices to control noise emitted by equipment to the levels required in the COE, Savannah District General Safety Requirements Manual (COE, 1981a).