high water temperature. Isolated cool-water refuges might be utilized minimally by aquatic (fish) and semiaquatic (herpetofauna, wading birds, beaver) biota.

This alternative would inundate approximately 7.6 kilometers of Steel Creek from just north of Road B to the dam (Figure 4-38). Thus, about 240 acres of wetlands including active habitat of the American alligator would be inundated. The wetlands that would be impacted by this alternative are classified as Resource Category 2 by the U.S. Fish and Wildlife Service. This resource category and designation criteria include "high value for evaluation species and scarce or becoming scarce" (USDOI, 1981). The mitigation planning goal specifies that there be "no net loss of inkind habitat value." If releases from L-Pond into Steel Creek are maintained near the average natural flow (i.e., 0.6 cubic meter per second), foraging habitat of the endangered wood stork would not be affected. Additionally, this option would have no impact on the shortnose sturgeon.

The makeup water required for L-Pond would represent a 9-percent increase (1.8 cubic meters per second) over present SRP intake withdrawal rates from the Savannah River. This increase would result in impingement and entrainment losses from the river of about 956 additional fish per year and 1.3×10^6 fish eggs and 1.9×10^6 fish larvae per year, respectively.

The transport of radiocesium off the site is expected to amount to about 0.8 curie per year, about half the amount presently transported (Hayes, 1981). Approximately 24 curies of the cesium-137 currently in the Steel Creek channel and floodplain would lie beneath L-Pond. This alternative would release 2170 curies per year of tritium from L-Reactor to the Savannah River.

Nonradioactive atmospheric releases would result in a maximum of 130 hours per year of reduced visibility (less than 0.8 kilometer) on the leeward side of the impoundment, and a maximum of 115 hours per year of ice accumulation on horizontal surfaces. No deposition of salts due to drift is expected.

The area subject to impact by this alternative contains 10 archeological sites. Two to four sites could be inundated. A mitigation plan would be developed and implemented prior to restart similar to that described under direct discharge.

The inundation of 1300 acres would modify the bottom contours of the substrate and create vastly different patterns in water circulation, depth (32 meters at the dam), and temperature. The diversity and abundance of benthic organisms would also be markedly changed. Excavation of the creekbed for dam construction would necessitate the disposal of approximately 3000 cubic meters of possibly contaminated spoil. The overflow from L-Pond, which would be discharged into Steel Creek, would have a minimal impact on the substrate of the creek or its delta.

Spoil from the surface portion of the embankment foundation in the Steel Creek floodplain, estimated to contain a total of 0.2 curie of cesium-137 and 0.02 curie of cobalt-60, would be separated, contained, replaced outside the jurisdictional wetlands upstream of the embankment, and covered with subsurface spoil to prevent erosion during the construction period. This relocation would have no effect on net cesium transport estimates. All uncontaminated material would be removed and used for backfill in the borrow areas. Thus, any impacts on water quality and turbidity in the L-Pond would be temporary until suspended particulates settle and bottom sediments stabilize. Seasonal cycling of any remaining cesium-137 is probable in L-Pond (Alberts et al., 1979). The water quality of L-Pond should be very similar to that of Par Pond. An ion-concentration ratio (lake-to-river) of 1.0 to 2.5 is expected for L-Pond. Necessary precautions would be taken during embankment construction to contain suspended particulates and sediment from moving into the Steel Creek corridor. Embankment construction and L-Pond overflow is expected to have a minimal impact in water quality and turbidity in Steel Creek and the swamp.

L-Pond construction would vastly alter water levels and circulation patterns over the 1300 acres. Erosion control and removal of the excavated material would minimize the discharge of material that could obstruct or change the direction or velocity of flows both above the embankment and in Steel Creek below the embankment. The small increase in water levels below the embankment should have minimal impact on Steel Creek and the swamp.

This alternative would require the following permits or processes: (1) a U.S. Army COE 404 permit, (2) an SCDHEC 401 certification, (3) an NPDES permit, (4) a 316(a) demonstration, (5) consultations with the FWS, and (6) the preparation of a biological assessment for endangered species.

If this alternative is implemented before the restart of L-Reactor, the environmental impacts would be as described above. If it is implemented after direct discharge occurs, the environmental impacts would be the same as those described in Section 4.4.2.2.1 for once-through direct discharge (i.e., loss of 730 to 1000 acres of wetlands, etc.). The mitigative effects resulting from this alternative are that the Steel Creek ecosystem and swamp below the L-Pond dam would not be impacted. This would not begin until the end of the 40-month construction period.

4.4.2.4.2 Kal Pond

The feasibility of creating Kal Pond, which would serve both K- and L-Reactors, has been studied. Such a lake would not only mitigate thermal impacts associated with a direct discharge to Steel Creek by L-Reactor, it would also mitigate thermal impacts of K-Reactor on Indian Grave Branch and Pen Branch. Heated effluent from both reactors would enter Kal Pond; after natural cooling, it would be pumped back to the reactors for recirculation.

One large 2620-acre lake would be created by constructing embankments across both Steel Creek and Pen Branch (Figure 4-39). The Pen Branch embankment would be approximately 750 meters above Road A and the Steel Creek embankment would be about 300 meters above Road A-14. The location of the embankment on Steel Creek would eliminate any impact on one of the two 115-kilovolt transmission and control cable lines mentioned for L-Pond. It would also allow Road A-14 to remain undisturbed and would reduce the maximum height of the Steel Creek embankment by about 5 meters. The Pen Branch embankment would be approximately 800 meters long and the Steel Creek embankment would extend about 1400 meters. About 900,000 cubic meters of fill would be required to construct the two embankments. The normal water-surface elevation would be about 64 meters. This water level would necessitate raising, rerouting, or abandoning several SRP roads. Access roads for construction activities would be routed to minimize environmental impacts.

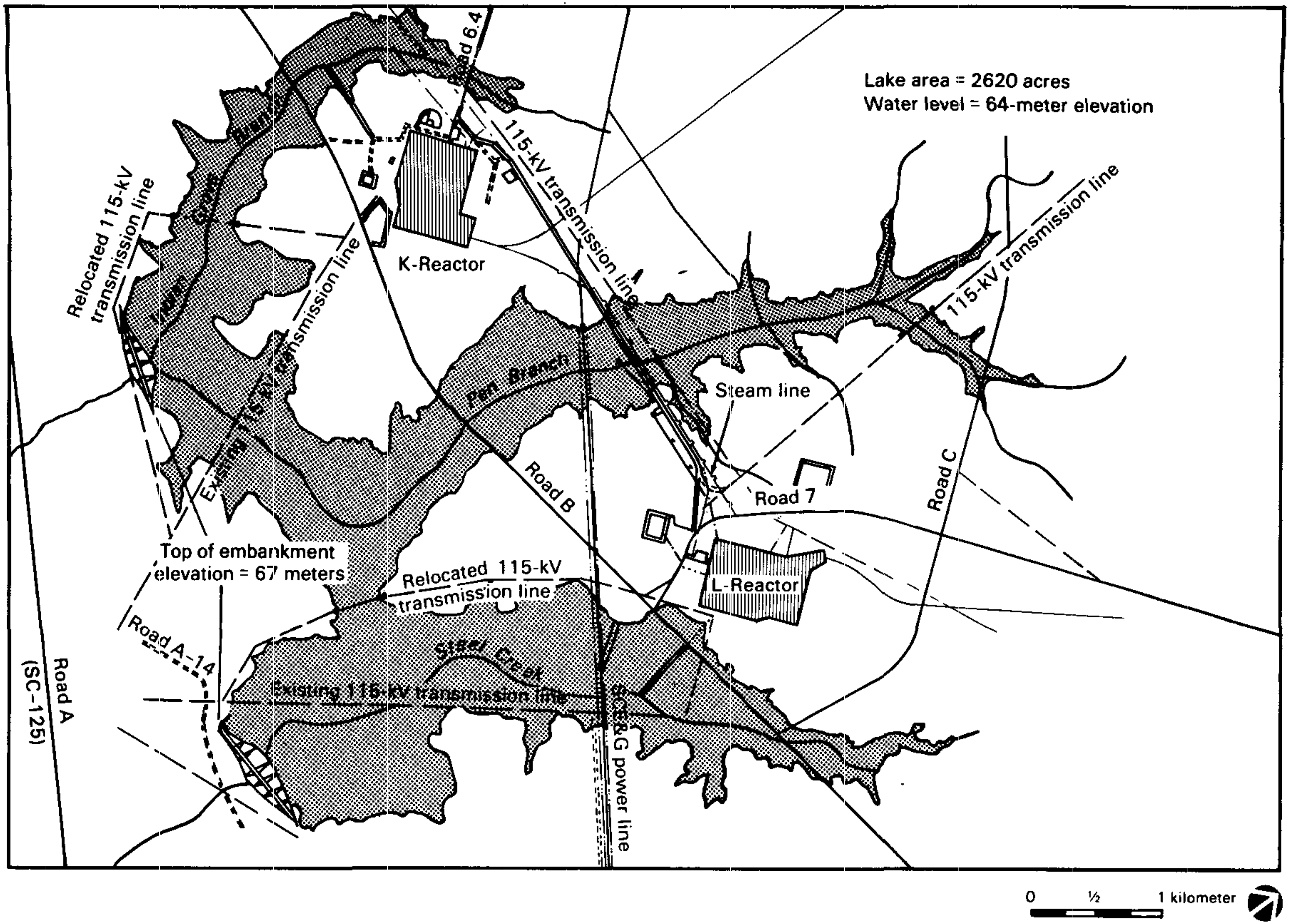


Figure 4-39. Conceptual design for Kal Pond.

A new outlet structure would be constructed at the edge of the new lake north of the abandoned section of Road B. Few modifications would be required at the K-Reactor discharge because the present canal extends above the elevation of the proposed water level.

Some modifications would have to be made to the K-Area-to-L-Area steam line and the river water lines serving K-, L-, and P-Reactors because Kal Pond would flood the areas where they cross Indian Grave Branch and Pen Branch.

Two 115-kilovolt transmission lines and control cables would have to be relocated, one along Steel Creek and another paralleling Indian Grave Branch. In addition, steel towers and new conductor would be needed where another 115-kilovolt transmission line and control cable line cross Pen Branch near Road C, where the Steel Creek lines cross the new lake south of Road B, and where the Indian Grave Branch lines cross the new lake near Road B.

The amount of time required to design and construct this alternative would be between 60 and 66 months (Du Pont, 1983d). This alternative would require about a 1-month downtime for both K- and L-Reactors. However, the shutdown of the two reactors could be scheduled at the same or different times, as desired.

Because of its structural complexity, capital costs for Kal Pond are estimated to be $190 million, the most costly of the alternatives (Du Pont, 1983d). Annual operating costs would be approximately $2 million. The present worth of this alternative would be $299 million and the annualized cost would be $35 million (Du Pont, 1983d). An estimated 870 construction personnel would be required.

The production efficiency of Kal Pond would be about 96 percent (derived from Du Pont, 1983d). Elevated Savannah River temperatures would not directly affect reactor operation. Makeup to Kal Pond would require 3.5 cubic meters per second from the Savannah River; of this total, about 0.5 cubic meter per second would be released to Pen Branch and Steel Creek.

Under extreme summer meteorological conditions, the overflow would have an exit temperature of about 33°C. Under average conditions, the discharge temperature would be about 31°C. Near-ambient temperatures should be reached at the Steel Creek and Pen Branch deltas. Thus, this alternative would have minor effects on the temperature of the Savannah River water. The water discharge rate from Kal Pond to Steel Creek and Pen Branch would be equal to their normal seasonal flow rates.

This alternative would provide normal compliance with the maximum 32.2°C discharge temperature limit.

Kal Pond is expected to show thermal behavior much like that of Par Pond. It should experience thermal stratification from April through October, and should be well mixed from November through March. During periods of thermal stratification, the hypolimnion could become intensely anoxic with ferrous iron and other metals being dissolved from the sediment (Marshall and LeRoy, 1971). The seasonal cycling of cesium-137, which follows the seasonal stratification cycle (Alberts et al., 1979), would be probable.

Because this recirculation alternative would greatly reduce the thermal discharge to Steel Creek, it would result in a significant reduction in impacts to the biota of the creek, its delta, the floodplain, and the Savannah River in comparison to the effects caused by direct discharge. A reduction of thermal impacts to Pen Branch and the Pen Branch delta would also occur.

Approximately 615 acres of riparian wetlands and 2005 acres of upland conifers would be inundated by the Kal impoundment. This would include 7.0 kilometers along Pen Branch, 5.0 kilometers along Steel Creek, and 4.0 kilometers along Indian Grave Branch. The wetlands that would be impacted by this alternative are classified as Resource Category 2 by the U.S. Fish and Wildlife Service. This resource category and designation criteria include "high value for evaluation species and scarce or becoming scarce" (USDOI, 1981). The mitigation planning goal specifies that there be "no net loss of inkind habitat value." This impoundment would flood forested habitats that once contained the endangered red-cockaded woodpecker. This lake would support minimal aquatic life because of continually high water temperatures.

Kal Pond would require a maximum of 3.5 cubic meters per second of water from the Savannah River. Assuming that K-Reactor currently uses 17 cubic meters of water per second, the current impingement is about 5840 fish per year (based on the latest 12 months of data) and the current entrainment is 7.7×10^6 eggs (1982 data) and 11.9×10^6 larvae (1983 data) per year. These values would decrease to 1858 fish per year and 2.5×10^6 eggs and 3.8×10^6 larvae per year, respectively, for the combined operation of K- and L-Reactors.

Radiocesium transport from Steel Creek is expected to be about 0.8 curie per year. Small quantities of radiocesium also would be delivered to the river and swamp from Pen Branch. Approximately 20 curies of cesium-137 that are in the Steel Creek channel and floodplain would lie beneath the lake. In addition, the Savannah River would receive about 870 curies of tritium per year from L-Reactor.

Nonradioactive atmospheric releases would result in (1) a maximum of 25 hours per year reduced visibility (less than 800 meters) on the leeward side of the impoundment, and (2) a maximum of 15 hours per year of ice accumulation on horizontal surfaces. No deposition of salts due to drift is expected.

Twenty-nine archeological sites could be affected by this alternative. Of these, 8 to 10 sites could be flooded. A mitigation plan would be developed and implemented prior to restart similar to that described for direct discharge.

Little or no change is expected in the substrate, erosion, or sedimentation patterns in Steel Creek or Pen Branch because the overflow would not produce large increases to their normal flows and because, below the reactor outfalls, the streams are in approximate equilibrium for flow rates of 11 cubic meters per second.

Spoil from the surface portion of the embankment foundation in the Steel Creek floodplain, estimated to contain a total of 0.2 curie of cesium-137 and 0.02 curie of cobalt-60, would be separated, contained, replaced outside the jurisdictional wetlands upstream of the embankment, and covered with subsurface spoil to prevent erosion during the construction period. This relocation would have no effect on net cesium transport estimates. All uncontaminated material would be removed and used for backfill in the borrow areas.

The chemical characteristics of the overflow to either stream are expected to be similar to those of Savannah River water and the natural conditions of the receiving streams. No appreciable changes in the characteristics of the blowdown should occur as the result of river water (makeup) passing through Kal Pond, except its concentration of suspended solids would be lower. The water quality of Kal Pond should be similar to that of Par Pond; these lakes would be nearly equal in size (Kal Pond would contain 8.37×10^7 cubic meters and Par Pond contains 6.62×10^7 cubic meters). An ion-concentration (lake-to-river-water) ratio of 1.0 to 3.2 is expected for Kal Pond (Tilly, 1974). The concentration of tritium could reach 91,000 picocuries per liter, about 2.5 times the 7-year Par Pond average.

Kal Pond construction would vastly alter water levels and circulation patterns over 2620 acres, which would affect Steel Creek, Pen Branch, and Indian Grave Branch upstream of the dam. Erosion control and removal of much of the dredged material to the onsite burial ground would minimize the discharge of material that could obstruct or change the direction or velocity of flows both above the embankments and in Steel Creek and Pen Branch below the embankments.

This alternative would require the following permits or processes: (1) a U.S. Army COE 404 permit, (2) an SCDHEC 401 certification, (3) an NPDES permit, (4) a 316(a) demonstration, (5) consultations with the FWS, and (6) the preparation of a biological assessment for endangered species.

If this alternative is implemented before direct discharge occurs, the environmental impacts would be as described above. If it is implemented after direct discharge occurs, the environmental impacts would include those described in Section 4.4.2.2.1 (i.e., loss of 730 to 1000 acres of wetlands, etc.) plus those (i.e., 615 acres of wetlands and 2005 acres of uplands) resulting from the Kal Pond alternative. Any mitigative effects resulting from this alternative would not begin until the end of the 66-month construction period.

4.4.2.4.3 High-Level Pond

Two embankment sites across Pen Branch were studied for the construction of a High-Level Pond; both would provide the same water elevation (83 meters). The first site would have provided a lake area of approximately 1225 acres, which could not match the cooling efficiency of the other cooling lakes studied. Therefore, a second site (Figure 4-40) was studied that would add 560 acres to the first lake. The embankment for the second lake would be about 2750 meters long with a maximum height of 35 meters. Two sections of earthen berm would be constructed across a natural saddle west of this embankment; they would total 460 meters long but not more than 3 meters high. The total amount of material required to construct the embankments would be 1,900,000 cubic meters.

This lake would be upstream from the existing river water lines and, therefore, would have no impact on them or on the steam line from K-Reactor to L-Reactor. However, it would require the abandonment of Road C between Roads 6 and 7; approximately 1200 meters of Road 6 would have to be raised as much as 12 meters. About 6 kilometers of 115-kilovolt transmission line and its buried

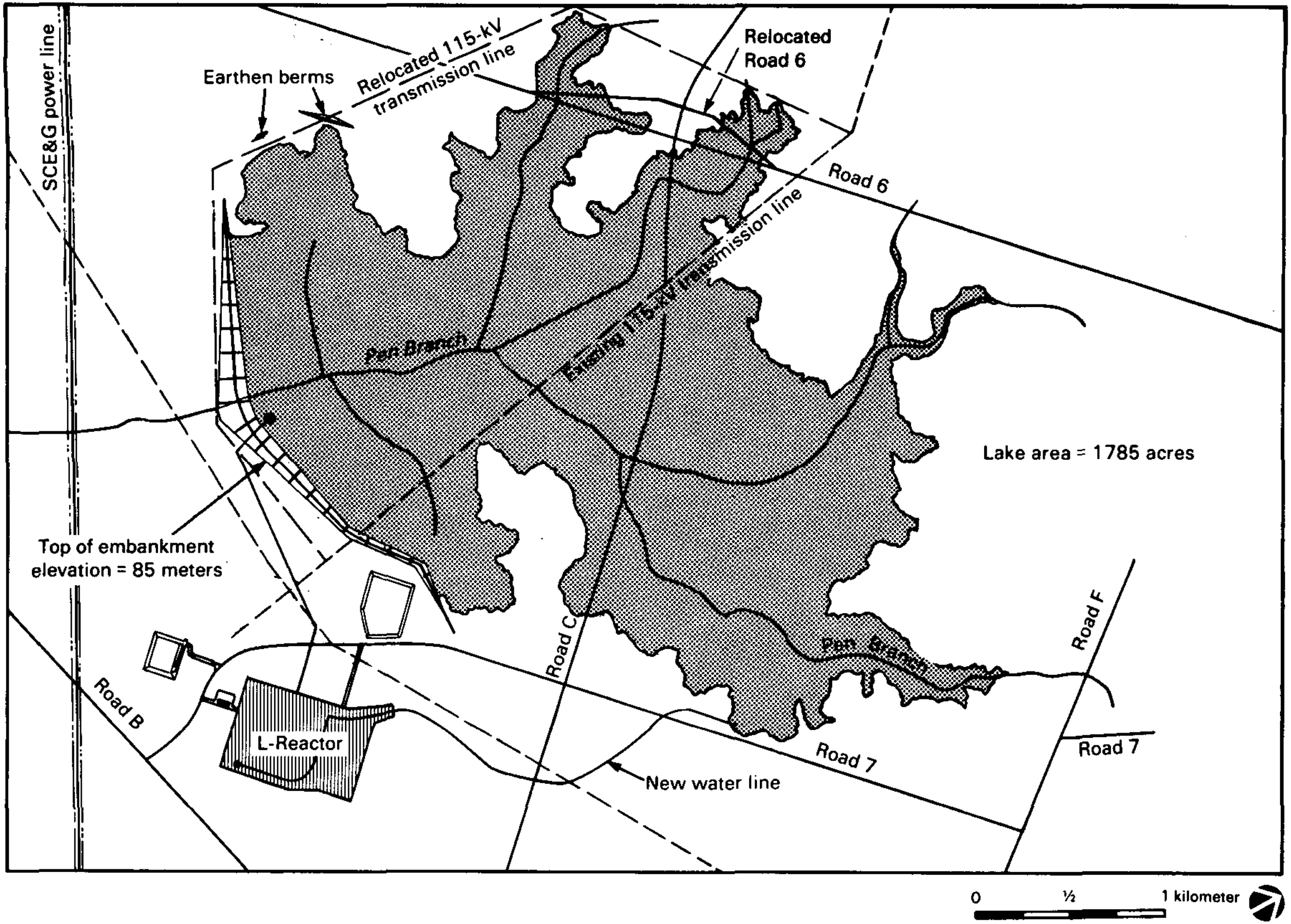


Figure 4-40. Conceptual design for High-Level Pond.

supervisor control cable would have to be relocated. Access roads for construction activities would be routed to minimize environmental impacts.

Thermal effluent from L-Reactor would flow through existing pipes to a new reinforced concrete sump, similar to that required by the cooling-tower alternative. The pumps in this sump would pump the hot water through a new pipeline to discharge into the High-Level Pond. The water would flow through the lake to an intake structure near the embankment. A new pipeline would run 1750 meters, from the intake structure, through the embankment, and to the L-Reactor lake. Valves would control the gravity flow to provide the quantity of water required for reactor cooling. Approximately 42 to 48 months would be required to design, construct, and permit this alternative.

L-Reactor shutdown time under this alternative would be the same as that for the cooling towers, because the same pumping system would be constructed. All other construction would take place away from the effluent system.

Estimated capital costs for the High-Level Pond would be about $120 million. Annual operating costs should approach $1.9 million. The present worth of this alternative would be $174 million and the annualized cost would be $20.4 million (Du Pont, 1983a). An estimated 1215 construction personnel would be required.

The High-Level Pond is estimated to have a relative production efficiency of 96 percent. This alternative would allow all of Steel Creek to remain in post-thermal recovery, unaffected by cooling-water effluents from L-Reactor. In addition, thermal discharges to the Savannah River and its associated floodplain swamp would remain at present levels. High-Level Pond makeup water would increase withdrawal from the Savannah River by 9 percent (1.8 cubic meters per second) over present withdrawal rates. Approximately 0.5 cubic meter per second would be released to Pen Branch.

Under extreme summer meteorological conditions, the overflow from High-Level Pond would have an exit temperature of about 35°C. Under average conditions, the temperature would be 34°C. This thermal discharge would impact biota in the 4-kilometer section of Pen Branch between the embankment and the stream's confluence with the K-Reactor thermal effluent (Indian Grave Branch), because the stream waters would be slightly above ambient. Ambient temperatures in Steel Creek would be unaffected by L-Reactor operation.

This alternative would not comply with the maximum 32.2°C State discharge temperature nor would it comply with the 2.8°C allowable temperature rise limit in Steel Creek.

Because this recirculation alternative would greatly reduce the thermal discharge to Steel Creek, it would result in a significant reduction of impacts to the biota of the creek, its delta, the floodplain, and the Savannah River in comparison to the effects caused by direct discharge.

The High-Level Pond would be similar to Par Pond. With time, a resident community of flora and fauna would develop from those hardy organisms that either were present before the impoundment or that might be introduced during the addition of makeup water.

After the impoundment, a portion of Pen Branch would remain as stream habitat between the High-Level Pond and the thermally impacted reach below K-Reactor. The stream flow and water temperatures in this portion would be affected little by the operations of K- and L-Reactors. However, surviving fish in this segment would become essentially landlocked; their access to upstream portions would be prevented by the High-Level Pond dam and their access to downstream portions and the floodplain swamp would be limited to periods of K-Reactor shutdown.

The High-Level Pond would inundate approximately 1175 acres of upland forest habitat, and about 610 acres of riparian wetlands associated with three headwater tributaries of Pen Branch. The wetlands that would be impacted by this alternative are classified as Resource Category 2 by the U.S. Fish and Wildlife Service. This resource category and designation criteria include "high value for evaluation species and scarce or becoming scarce" (USDOI, 1981). The mitigation planning goal specifies that there be "no net loss of inkind habitat value." Some acreage would be used for pipeline rights-of-way. This impoundment would not affect documented habitats of endangered or threatened species.

High-Level Pond makeup water would increase withdrawal from the Savannah River by 9 percent (1.8 cubic meters per second) over present usage. This increase would raise current impingement losses by about 956 fish per year and entrainment losses by 1.3×10^6 eggs and 1.9×10^6 larvae per year.

Radiocesium transported from Steel Creek is expected to remain at its current level of about 0.25 curie per year. Small quantities of cesium-137 would be transported from Pen Branch. In addition, the Savannah River would receive about 5820 curies of tritium per year from L-Reactor.

Nonradiological atmospheric releases would result in a maximum of 10 hours per year of reduced visibility (less than 800 meters) on the leeward side of the impoundment. No icing or salt deposition due to drift is expected.

This upland area characteristically has fewer archeological sites than floodplain areas. Eight to 10 sites, of which one or two would be eligible for the National Register are estimated to exist in this area; they would be subject to flooding. A mitigation plan would be developed and implemented prior to restart similar to that described for direct discharge.

The chemical characteristics of the overflow are expected to be similar to those of the waters of Pen Branch and the Savannah River, except the concentration of suspended solids would be lower. The water quality of the High-Level Pond should be similar to that of Par Pond. An ion-concentration (lake-to-river) ratio of 1.0 to 1.3 is expected for the High-Level Pond (Tilly, 1974).

The overflow to Pen Branch would not cause any erosion or sedimentation patterns to change in the stream or its delta because its flow would be increased significantly from its present level. Spoil from the surface portion of the embankment foundation in the Steel Creek floodplain, estimated to contain a total of 0.2 curie of cesium-137 and 0.02 curie of cobalt-60, would be separated, contained, replaced outside the jurisdictional wetlands upstream of the embankment, and covered with subsurface spoil to prevent erosion during the construction period. This relocation would have no effect on net cesium transport estimates. All uncontaminated material would be removed and used for backfill in the borrow areas. Thus, any impacts on water quality and turbidity would be temporary until suspended particulates settle and bottom sediments stabilize.

This alternative would require the following permits or processes: (1) a U.S. Army COE 404 permit, (2) an SCDHEC 401 certification, (3) an NPDES permit, (4) a 316(a) demonstration, (5) consultations with the FWS, and (6) the preparation of a biological assessment for endangered species.

If this alternative is implemented before the restart of L-Reactor, the environmental impacts would be as described above. If it is implemented after direct discharge occurs, the environmental impacts would include those described in Section 4.4.2.2.1 for once-through direct discharge (i.e., loss of 730 to 1000 acres of wetlands, etc.) plus those (i.e., loss of 610 acres of wetlands and 1175 acres of uplands) resulting from the High-Level Pond alternative. Any mitigative effects resulting from this alternative would not begin until the end of the 48-month construction period.

4.4.2.4.4 Par Pond

Under this alternative, the existing Par Pond would be used to cool the effluent from both P- and L-Reactors. A pumping station similar to that required for the cooling-tower alternative, but with larger pumps (because of the longer distance) would be built south of L-Reactor (Figure 4-41). An underground discharge pipe from these pumps would run to the northeast to a knoll on the ridgeline between the watersheds of Pen Branch and Lower Three Runs Creek (Par Pond). At this point, the pipe would discharge into a new excavated canal similar to those constructed to carry P- and R-Reactor effluents to Par Pond. The new canal would follow the ground contours to the northeast to connect to Pond A near the R-Reactor effluent canal. From this point, the cooling water for L-Reactor would follow the same path through Par Pond that R-Reactor cooling water followed when that reactor was operating.

The Par Pond pumphouse served both P- and R-Reactors for some time but would require modification to serve both L- and P-Reactors; at present this pumphouse has a capacity for only one and a half reactors. Some new underground pipelines would be required to return Par Pond water to the L-Reactor reservoir. The amount of time required to design and construct this option should range between 30 and 44 months (Du Pont, 1982b). This alternative would use the same pumping system as the cooling-tower and High-Level-Pond alternatives. Therefore, the same 1-month shutdown would be required.

The estimated capital costs for the Par Pond alternative would be $104 million. Annual operating costs would be approximately $4.3 million. The present worth would be $178 million and the annualized cost would be $20.9 million (Du Pont, 1983d). An estimated 360 construction personnel would be required.

The relative production efficiency of Par Pond should be about 96 percent (derived from Du Pont, 1982b) of that for the direct discharge option. Water withdrawn from the Savannah River would increase by about 17 percent (3.5 cubic meters per second) over present usage by SRP, including the use of Par Pond for cooling P-Reactor.

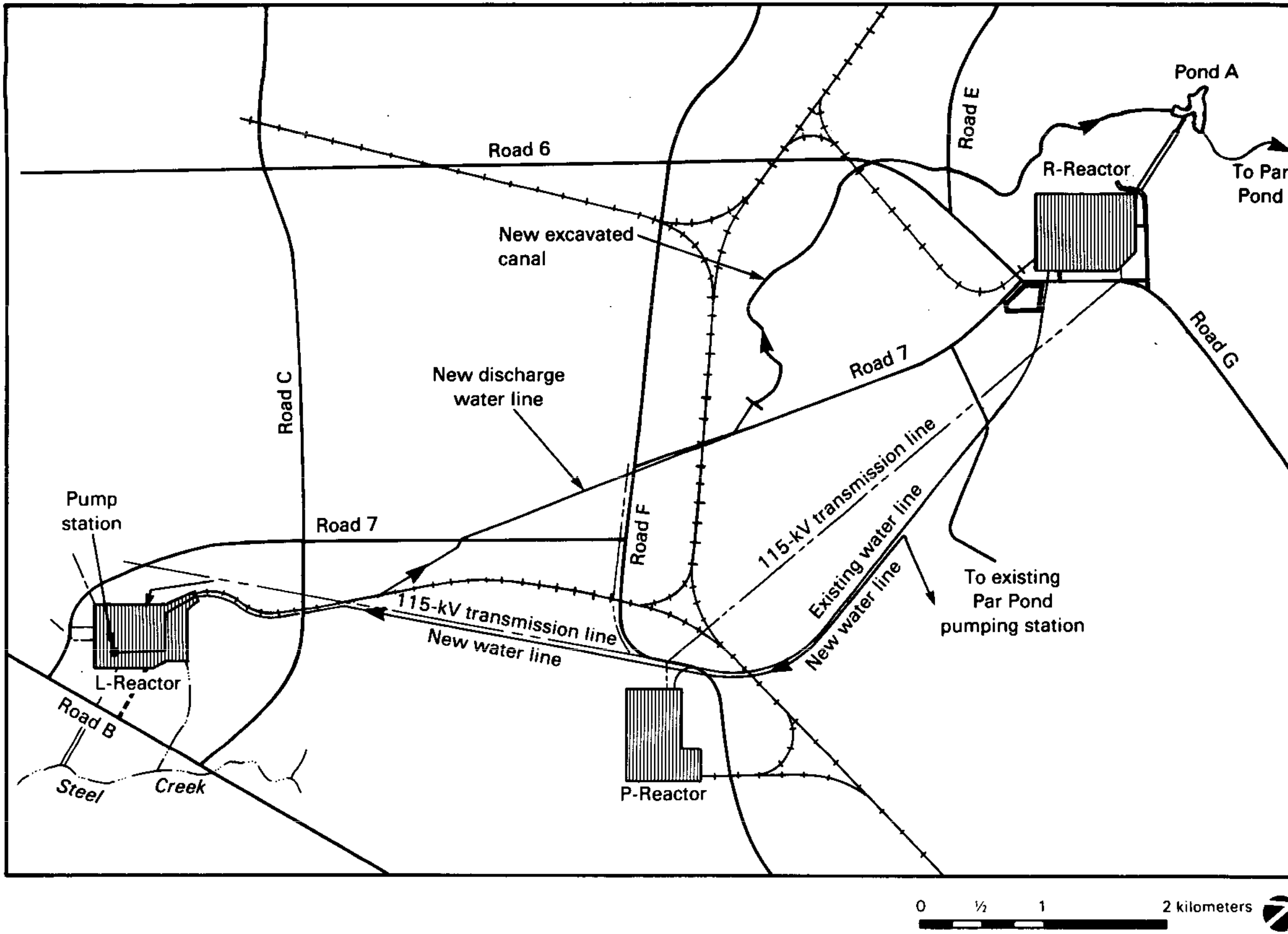


Figure 4-41. Conceptual design for the Par Pond cooling-system alternative.

Under extreme summer meteorological conditions (Section 3.1.1), the overflow would have an exit temperature of about 33°C, which is about 4° to 5°C higher than the maximum summer temperatures measured in Lower Three Runs Creek below Par Pond. During average summer conditions, the discharge would be at 31°C. Thus, only minor thermal impacts would occur to Lower Three Runs Creek or the Savannah River as the result of both L- and P-Reactors discharging thermal effluents to Par Pond. The thermal stratification and chemical cycling in Par Pond are described in Marshall and LeRoy (1971) and Alberts et al. (1979).

This alternative would not produce thermal impacts on Steel Creek. It would provide normal compliance with the maximum 32.2°C State discharge temperature limit.

Because this recirculation alternative would greatly reduce the thermal discharge to Steel Creek, it would result in a significant reduction in impacts to the biota of the creek, its delta, the floodplain, and the Savannah River in comparison to the effects caused by direct discharge.

Because Par Pond already exists, any modifications of terrestrial habitat would be limited to a temporary disturbance to approximately 50 acres to construct a new pipe discharge canal and pipelines. This 2700-acre lake, however, contains a diversified and abundant assemblage of aquatic and semiaquatic biota, including more than 100 American alligators (Murphy, 1981). This alternative would increase water temperatures in the north arm (former R-Reactor discharge arm) of Par Pond, and potentially displace the alligator and wintering waterfowl.

Increasing water temperatures in Par Pond in the summer could affect reactor operating power. The water withdrawal rate for both P- and L-Reactors (about 3.5 cubic meters per second) would cause the impingement losses of 1858 fish per year and entrainment losses of 2.5×10^6 fish eggs and 3.8×10^6 fish larvae per year.

Radiocesium transported from Steel Creek is expected to remain at its current level of about 0.25 curie per year. A small amount of radiocesium is transported from Lower Three Runs Creek to the river (Shure and Gottschalk, 1976; Gladden, 1979); this alternative could increase the rate of transport but only by a minor amount (i.e., 0.25 curie). In addition, L-Reactor would discharge about 3600 curies of tritium to Par Pond each year (Du Pont, 1982b); in addition, several curies of radiocesium would be remobilized from the R-Reactor cooling-water canal and lakes enroute to Par Pond. The total release of tritium to the Savannah River from L-Reactor would be 6270 curies per year.

Nonradiological atmospheric releases would result in (1) a maximum of 20 hours per year of reduced visibility (less than 800 meters) on the leeward side of the impoundment, and (2) a maximum of 15 hours per year of ice accumulation on horizontal surfaces. No deposition of salts due to drift is expected.

Four archeological sites are known to exist and an estimated four others would occur in the impact area. One of these sites would be subject to impacts caused by the reworking of the ground. A mitigation plan would be developed and implemented prior to restart similar to that described for direct discharge.

Little or no change is expected in erosion or sedimentation patterns in Lower Three Runs Creek because the overflow discharged to the creek would remain approximately the same as it is now and the creek bed is in equilibrium with this flow rate. There would be no change in the chemical characteristics of the overflow from Par Pond dam. Dredged material would be monitored and handled to meet applicable regulatory requirements. Thus, no adverse impacts to water quality, aquatic substrate, or existing turbidity levels would occur.

This alternative would require the following permits or processes: (1) an NPDES permit, (2) a 316(a) demonstration, (3) consultations with the FWS, and (4) the preparation of a biological assessment for endangered species. A U.S. Army COE 404 permit would not be required.

If this alternative is implemented before direct discharge occurs, the environmental impacts would be as described above (successional recovery of about 730 to 1000 acres of wetlands). If it is implemented after direct discharge occurs, the environmental impacts would be the same as those described in Section 4.4.2.2.1 for once-through direct discharge (i.e., loss of 730 to 1000 acres of wetlands, etc.). Any mitigative effects resulting from this alternative would not begin until the end of the construction period.

4.4.2.5 Other alternatives

The alternatives described below are not intended to be used alone, but rather in combination with either direct discharge (reference case) or one of the cooling-water mitigation measures.

4.4.2.5.1 Thermal cogeneration

Different thermal cogeneration systems were evaluated (ADL, 1983) for technical and economic feasibility at the Savannah River Plant. This study considered the following alternatives:

- Heat pumps for onsite steam generation

- Electrical production with Rankine cycles

- Onsite industrial applications in which private industry would construct new plants on SRP that would use the energy in the effluent streams

- Onsite agricultural/aquacultural applications

- Hot water delivery to offsite users

The study considers only the first two alternatives to be economically attractive. However, the thermal mitigation achieved by these alternatives is insignificant. If either of these alternatives is considered for installation, it would have to be justified on its own energy recovery.

Two different scenarios were considered for onsite steam generation. The first one would use an open-open cycle heat pump system to produce 1.9 kilograms per second of 275,790-pascal steam for use in L-Area. The preliminary cost estimate indicated this option was economical. However, the option would remove only 0.3 percent of the heat from the effluent stream. This reduction amounts to an insignificant 0.3°C drop in effluent temperature at the outfall. Using the results, a preliminary assessment of using heat pumps to generate steam was completed (Du Pont, 1983g). The assessment made the following conclusions:

- The system would be unreliable for continuous operation because the reactor would not operate continuously.

- The steam from the river water would contaminate the system it served.

In summary, the heat pumps would have a minor thermal mitigation effect and appear to be unfeasible for SRP operation.

A Rankine cycle using ammonia as the working fluid has been proposed to generate electricity from the energy in the heated effluent. ADL (1983) discussed variations on the basic system.

The Rankine cycle would lower the effluent temperature from 71°C to 49°C. The effluent flow was assumed to be 11 cubic meters per second. For the Rankine cycle alone, 58 cubic meters per second of cooling water would have a temperature drop from 23°C to 19°C across its cooling tower. This tower design is a 14°C wet bulb, 9°C approach tower. The preliminary power output was revised in a followup study (Du Pont, 1983g) to be 29 megawatts.

Capital costs (ADL, 1983) for the Rankine cycle are $101 million. The Du Pont (1983g) estimate is $270 million. Approximately 8 to 12 years would be required for research and development, design, and construction of the Rankine cycle. Currently, the largest commercially available and proven units are in the 1-megawatt range and operate at source temperatures greater than 93°C (Du Pont, 1983g).

The Rankine cycle could also be used in a precooler mode (ADL, 1983), which would slightly improve the economics. In the precooler mode, the effluent leaving the Rankine cycle evaporator would be piped to a cooling tower. This tower would be separate from the Rankine cycle tower. Because of the low reliability of the Rankine cycle, the effluent cooling tower would be sized to handle the inlet water temperature directly from the reactor heat exchangers. By lowering the inlet temperature of the tower to 49°C, which is possible by the Rankine cycle, the coolant exit temperature from the tower would be approximately 0.6°C lower than when the inlet water temperature is 71°C. This lower exit temperature is based on using the 27°C wet bulb and 2.8°C approach cooling towers. If the cooling-water system was operating in a complete recirculation mode, the reactor power would be increased slightly. The increased reactor power would be worth $540,000 (Du Pont, 1983e) on a yearly basis if the complete recirculation mode was in use continuously.

The environmental effects of the Rankine cycle would differ depending on whether it was used alone or in a precooler mode. For the precooler mode, the environmental effects would be nearly identical to those described for the partial recirculation cooling-tower alternative, because similar amounts of water are being evaporated in both cases.

If the Rankine cycle is used in its standalone operation, a combination of environmental effects would occur for cooling towers and the direct discharge alternative. Because the Rankine cycle has its own cooling tower, the environmental effects of fogging, icing, etc., for cooling towers would be applicable. The reactor effluent would leave the Rankine cycle evaporator at 49°C and enter the L-Area outfall. This temperature is the equivalent of running L-Reactor near 1200 megawatts. The entire Steel Creek system at this reactor power would still be above 32.2°C. Because of the cooler water temperatures than those produced by the direct discharge case, larger backwater areas could exist with temperatures low enough to support aquatic biota. Other than this exception, the environmental impacts on Steel Creek for the Rankine cycle would be similar to those for the direct discharge case.

The ADL (1983) report also considered some Rankine cycle cases that would have altered the existing reactor heat exchangers. As with the heat pump cases, these variations are not economically feasible and could compromise reactor safety.

4.4.2.5.2 Low-head hydropower

Planning studies were carried out (Tudor Engineering Co., 1980) to evaluate the potential for hydroelectric power generation along the existing effluent channels that convey the cooling-water discharges from K- and C-Areas. The cooling-water discharge from each area is about the same as that for L-Reactor, and the effluent channels for each area convey the cooling-water discharges from an existing outlet pipe to a natural stream similar to L-Reactor. Therefore, the K- and C-Area studies as well as other studies (Jarriel and Price, 1979; Price, 1980) provided a basis for the following paragraphs.

Two locations for turbines were considered. Both are shown in Figure 4-42. The upstream location would include a penstock attached to the existing pipe that would carry the cooling effluent from the effluent sump to the outfall. This new penstock would bypass the outfall and discharge the effluent to Steel Creek downstream of the outfall. Energy would be generated by passing the water through a single hydroelectric turbine of the propeller type shown in Figure 4-43. The other location for a turbine would be below a new embankment impounding a 500-acre lake. The lake would provide cooling for reactor effluent before its discharge into the swamp and the Savannah River.

A turbine located beside the L-Reactor outfall would have a capacity of about 1100 kilowatts and generate about 7700 megawatt-hours annually. This power plant would cost about $11.5 million to construct. Annual operation and maintenance would cost about $100,000. The value of the energy produced was assumed to be $0.17 per kilowatt-hour. The project could be completed in mid-1985.

An alternative system for an outfall turbine would attach the turbine to a spray cooling pipe. The spray cooling valves would be closed during the late fall and winter, when they would not be necessary. With the spray cooling turned off, turbine generation would occur as it would in the conventional system beside the outfall. Some generation could be possible when the spray cooling system was operating. The savings in energy from hydroelectric generation for this alternative does not justify the additional cost.

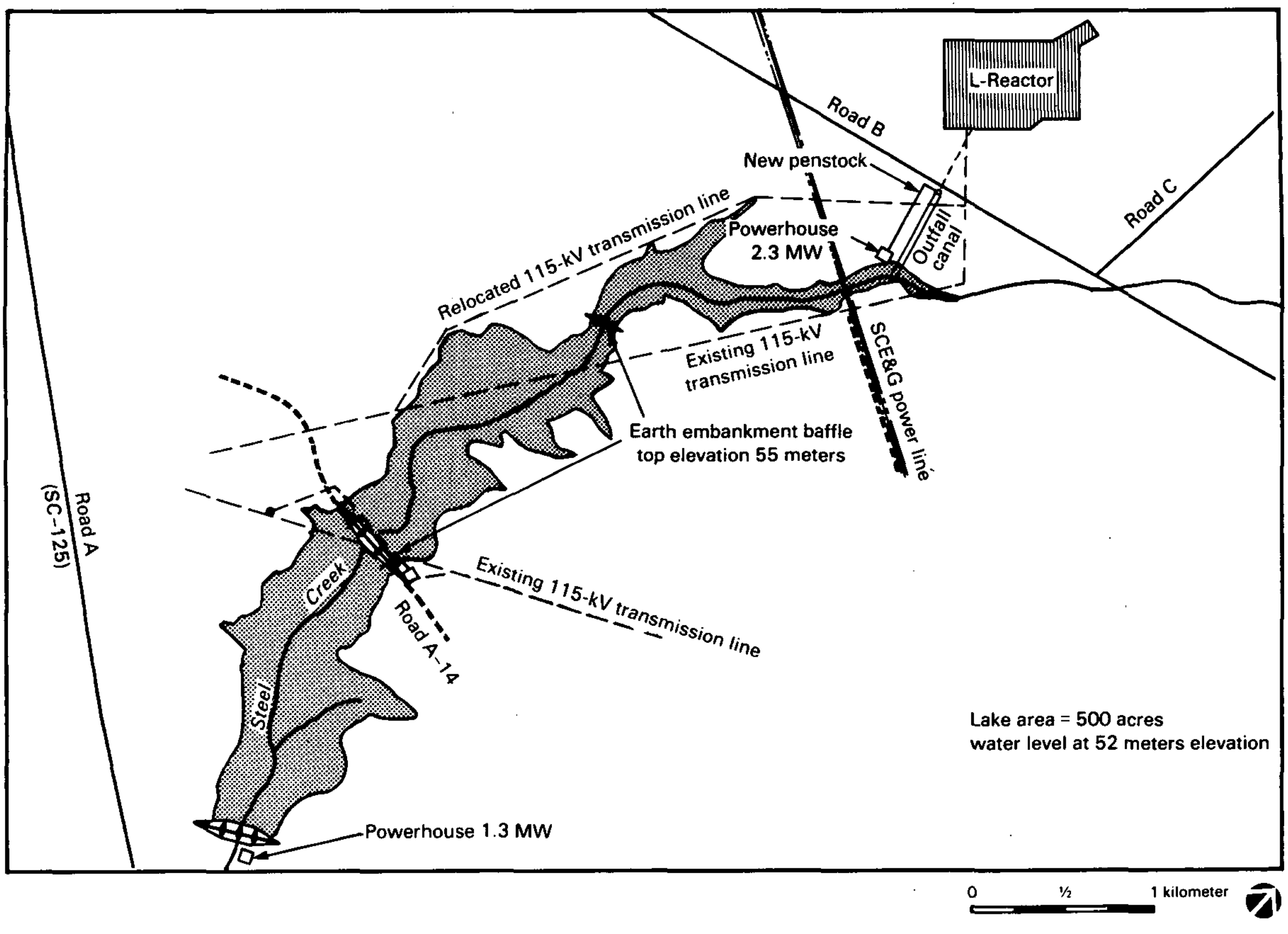


Figure 4-42. Location of outfall and below-embankment powerplants.

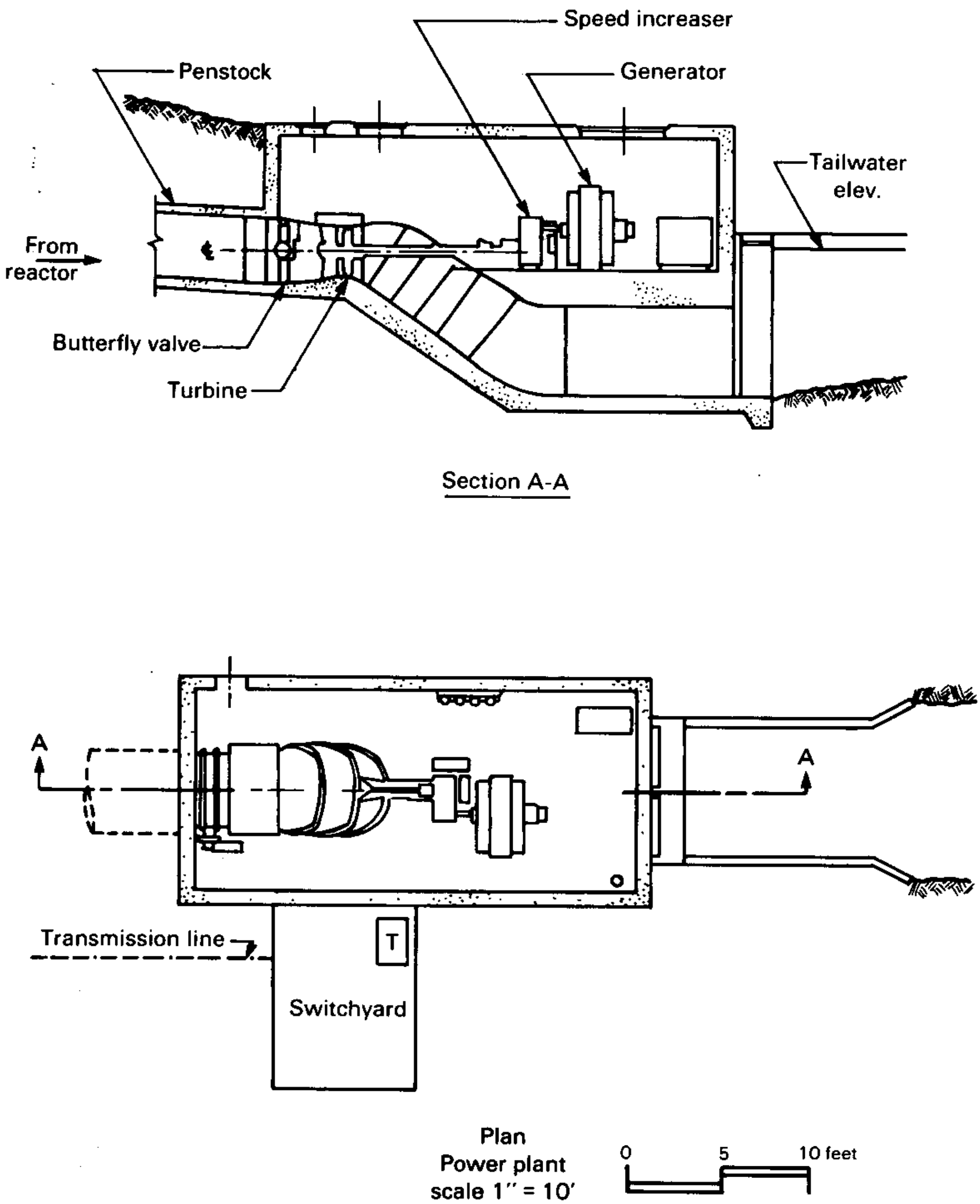


Figure 4-43. Powerhouse and turbine for outfall and below-embankment powerplants.

If a 500-acre lake was built to allow once-through cooling for L-Reactor, it might be economically feasible to install a hydroelectric turbine in the outflow. The turbine would attach to the normal release from the lake and discharge into Steel Creek. There would be no temperature reduction due to the addition of hydroelectric power, but the economics of the 500-acre lake would benefit from energy savings.

A power plant below the embankment would have a capacity of about 1350 kilowatts and generate about 9440 megawatt-hours annually. The additional cost for the hydroelectric plant would be about $4.9 million. Construction would be complete only a few months after that of the embankment. The annual operation and maintenance cost would be about $100,000 per year.

Another alternative considered was construction of both the outfall plant and the plant below the 500-acre lake. For the combined system, the economic benefits of the plant below the 500-acre lake would be the same as those described above. The economics of the outfall power plant would be reduced due to the head reduction resulting from a higher tailwater (the 500-acre lake). For the combined system the outfall power plant would still cost about $11.5 million and could be complete in mid-1985. However, the capacity would be reduced to about 1000 kilowatts and annual generation would be about 7000 megawatt-hours.

The use of hydroelectric turbines along the discharge canal of L-Reactor would not reduce the thermal impact on Steel Creek or downstream wetlands. However, the hydroelectric turbines would utilize an energy source and could have a positive impact environmentally in reducing the use of fossil fuels at SRP.

4.4.2.5.3 Modified reactor operation

The total heat load discharged into Steel Creek is a direct function of reactor power. Therefore, power could, in theory, be limited to a level below that achieved at normal operating limits to control this heat load. As power is reduced, the temperature (under extreme summer conditions) would be reduced from about 80°C at the outfall for 2400 megawatts-thermal to 71°C at 2000 megawatts-thermal, to 53°C at 1200 megawatts-thermal, and to 40°C at 600 megawatts-thermal. The temperatures within the Steel Creek system would also be affected by reactor power levels. Simultaneous reduction of power and flow would increase the outfall temperatures higher than those reported above and, therefore, offer little benefit to the upper portions of Steel Creek.

While low power operation would not be practical for extended periods of time, it could provide a means of meeting thermal limitations for short periods. If the power were reduced, cooling-water flow could also be set to reduce either the total flow or the temperature of Steel Creek. At reduced power, production efficiency would be correspondingly reduced.

When modified reactor operation is used in conjunction with alternative cooling systems, the temperature of the effluent could be reduced further. For example, temperatures in the lower portion of the Steel Creek and in the swamp and Savannah River downstream of Steel Creek would be determined not only by the operating power and cooling-water flow of L- and K-Reactors, but also by the atmospheric conditions and river temperatures and flow. Thus, this option could be appropriate during periods of extreme meteorological conditions (such as occurred between July 11 and 15, 1980).

If extreme conditions combined to provide a thermal plume in the river that is large enough to threaten the zone of passage, then the power and cooling-water flow to either or both reactors could be adjusted.

4.4.2.5.4 Fisheries management programs

As discussed in Section 4.1.1, the reference case (direct discharge to Steel Creek) would have adverse thermal, entrainment, and impingement effects on some of the biological systems in Steel Creek and, to a lesser extent, the Savannah River. One option for mitigation of these effects would be the provision of replacement habitat or substitute individuals to compensate for the losses incurred. Although such losses would not be confined to one trophic level or group of aquatic organisms, the mitigation alternatives would focus on fish because of their commercial, recreational, or ecological value, and, in one case, their endangered species status.

This alternative would use the existing cooling-water system without any modifications and would have no effect on any impact of L-Reactor operation other than fish losses.

Based on recent Savannah River and Steel Creek surveys (ECS, 1983a,b; Smith et al., 1982), the fish species most likely to be affected by the various environmental effects associated with once-through cooling from the Savannah River and direct discharge to Steel Creek would be American shad, striped and largemouth bass, blueback herring, catfish and sunfish (Table 4-53).

Table 4-53. Fish species impacted by direct discharge to Steel Creek

Environmental effect	Potential fish species affected
Entrainment of fish eggs and larvae	Blueback herring, striped bass, American shad
Impingement of fish	Clupeids (shad and herring), centrachids (sunfish)
Loss of spawning/nursery habitat in Steel Creek/swamp system	Channel catfish, redear and bluegill sunfish, largemouth bass, blueback herring
Effect of Steel Creek thermal plume in the Savannah River	Blueback herring, striped bass, American shad

Other species that were considered for possible mitigation action include the Atlantic sturgeon because of its commercial value and the shortnose sturgeon because of its endangered species status.

Replacement mitigation alternatives would include the following:

- Restock impacted species either by an onsite fish hatchery or through a cooperative agreement with local state and/or Federal fish hatcheries.

- Protect wetlands similar to the Steel Creek/swamp system by purchasing or establishing a fisheries/wildlife preserve.

- Conduct or support research as part of a coordinated Savannah River fisheries management program and/or support the development of culturing techniques for fish species that are not currently being raised for restocking purposes.

4.4.2.5.5 Restocking

The criteria used to select fish species for mitigation alternatives include present and potential commercial and recreational value, ecological value, endangered species status, and existing culture capacity and/or culture feasibility. Table 4-54 identifies both the species and the criteria for their selection.

The ecological value criterion was based on present or potential importance to the Savannah River ecosystem without consideration of system-carrying capacity. The culture feasibility criterion included availability of broodstock, availability of hatching and rearing techniques and present production capacity of local hatcheries. Cost was not considered as a criterion for species selection; however, cost estimates are provided below after a description of the mitigation alternatives.

The Savannah River Plant has several sites that are suitable for fish hatching and rearing, including the Flowing Streams Laboratory on Upper Three Runs Creek and the Par Pond facilities. Both a hatchery facility and rearing ponds would be required. Well water at a flow rate of 760 to 1135 liters per minute would be required for the hatching operation; surface water would be suitable for the rearing ponds. Costs to modify an existing facility for the hatching operation would be approximately $250,000; the construction of a new facility would cost approximately $400,000. Construction of the 10 to 12 0.5-acre rearing ponds would cost as much $400,000. Annual cost to operate the facilities, including support for a fish hatchery biologist and two technicians, would be at least $250,000. Approximately 18 months would be required to design and construct the facilities. Depending on the fish species cultured, full-scale production could be achieved in 5 to 10 years. A wastewater-treatment lagoon could be required for rearing-pond effluent but would probably not be required for the hatching facility.

Based on the species selection criteria, American shad and/or blueback herring are the best candidates for an SRP hatchery operation. No local hatcheries currently exist for these species. Broodstock could be obtained by gill netting in either the Savannah River or Upper Three Runs Creek. Techniques for fertilizing the eggs and hatching the embryos are available. However, problems have previously been encountered in rearing shad and herring fry to stocking size because of their susceptibility to handling stress at this life stage. Stocking at the larval stage could be required to minimize handling mortality. Several local striped bass hatcheries are already in full production. Also, collection of striped bass broodstock would be difficult. However, striped bass fingerlings could be obtained from another source and reared in SRP ponds. Techniques for hatching and rearing Atlantic and shortnose sturgeon are not available, but are currently being developed at the Orangeburg National Fish

Table 4-54. Criteria for selecting fish species for mitigation alternatives

Candidate species	Commercial value		Recreational value		Ecological value	Endangered species	Culture feasibility
	Existing	Potential	Existing	Potential			
			ANADROMOUS SPECIES				
Striped bass	None	Low	Low	High	Unknown	No	Local hatcheries in production; value of SRP hatchery would be minimal but rearing ponds are feasible.
Blueback herring	None	Medium	Low	Medium	High	No	No local hatcheries exist; SRP hatchery is feasible.
American shad	Medium	High	Low	High	High	No	No local hatchery exists; SRP hatchery is feasible.
Atlantic sturgeon	Low	Medium	Low	Medium	Unknown	No	Local hatchery is developing techniques; SRP hatchery not feasible nor practical.
Shortnose sturgeon	None	Medium	None	Low	Unknown	Yes	Local hatchery is developing techniques; SRP hatchery is not feasible nor practical.
			RESIDENT SPECIES				
Channel catfish	Low	Low	High	High	High	No	Local hatcheries in production; stock could be purchased.

Table 4-54. Criteria for selecting fish species for mitigation alternatives (continued)

Candidate species	Commercial value		Recreational value		Ecological value	Endangered species	Culture feasibility
	Existing	Potential	Existing	Potential			
Largemouth bass	None	None	High	High	High	No	Local hatcheries in production; stock could be purchased.
Sunfish (redear and bluegill)	None	None	High	High	High	No	Local hatcheries in production; stock could be purchased.

Hatchery. Obtaining and handling broodstock for these species would be a problem because of their low relative abundance and large size.

An alternative to using SRP land for hatcheries would be to obtain fish from local hatcheries. Both Georgia and South Carolina have hatchery facilities for striped bass, channel catfish, largemouth bass, and sunfish. A cooperative agreement could be established whereby SRP would provide support for the hatchery operation in exchange for fish of stocking size. The species and the number of individuals/species stocked would depend on estimates of L-Reactor impacts, mortality rate of natural and stocked fish, carrying capacity of the system stocked, and availability of hatchery fish. Cost of this mitigation alternative would be considerably less than the annual operating budget for an onsite hatchery (i.e., $100,000 per year).

4.4.2.5.6 Protect similar wetlands

If available, a property comparable in size and wetlands value to the impacted Steel Creek/swamp area could be purchased and set aside as a fisheries/wildlife preserve. Also, property of similar size could be set aside on the SRP site. Thermal discharges from L-Reactor could reduce the spawning/rearing habitat currently utilized by fish species in the Steel Creek/swamp system. Other creeks and associated wetlands with similar spawning/rearing habitat exist between the New Savannah Bluff Lock and Dam and the lower tidal reaches of the Savannah River. A large parcel of land (greater than 1000 acres) would cost approximately $500 per acre.

4.4.2.5.7 Support fisheries research

It could be desirable to conduct/support fisheries research. Thorough knowledge of the population dynamics and life history patterns of fish would be needed before good fisheries management decisions can be made. Recommendations for a fisheries management program based on a questionnaire completed by state and Federal fisheries biologists in the southeastern United States (Rulifson et al., 1982) emphasized these research needs. Additional research would also be required to develop techniques for hatching and rearing several species of importance to the Savannah River system, which include the shortnose and Atlantic sturgeon. A research program to collect fisheries data on selected anadromous fish species in the Savannah River would cost $150,000 per year. An additional $50,000 per year could be used to support the development of sturgeon culture techniques.

Initial costs (capital investment and construction), yearly operational costs, and total costs after 5 years are summarized in Table 4-55 for each of the programs described above.

4.4.2.6 Comparison of alternatives

Thirty-three alternative cooling-water systems were evaluated. The alternatives considered can be grouped into five major categories--once-through cooling lake, recirculating cooling lake, once-through cooling tower, recirculating cooling tower, and direct discharge. This section summarizes the engineering and environmental evaluations for the most favorable alternatives for each

Table 4-55. Yearly operational and total costs for mitigation alternatives

Mitigation alternative	Initial cost	Operation cost per year	5-year cost[a]
Restocking program			
SRP hatchery	$650,000	$250,000	$1,900,000
Agreement with local hatcheries	--	100,000	500,000
Fisheries/wildlife preserve	500,000	10,000	550,000
Support/conduct fisheries research	--	200,000	1,000,000

[a]Not adjusted for inflation.

category of cooling-water systems. This approach enables the reader to evaluate comparatively a range of reasonable alternatives, thus defining the issues and providing a clear basis for choice among alternatives. The criteria used in selecting the most favorable alternatives in each category are ability to meet South Carolina water-quality standards, production considerations, schedule, environmental factors, and the cost. Ability to expedite the schedule was also considered for these alternatives and the degree that reactor operation must be modified to meet State of South Carolina water-quality standards.

Seven once-through cooling-lake options were considered: small lakes, small lakes with upstream spray cooling, small lakes with upstream and downstream spray cooling, a 500-acre lake, a 500-acre lake with upstream spray cooling, a 500-acre lake with upstream and downstream cooling, and a 1000-acre lake. The 1000-acre lake evolved from the 500-acre lake in that it is the largest lake (thus providing better cooling and operational flexibility to comply with South Carolina water-quality standards) that could be constructed on Steel Creek in a single construction season (i.e., 6 months). For a lake size greater than 1000 acres, the construction schedule would be longer than a single construction season due to the need to build additional embankments and reroute major roads. The construction of the 1000-acre lake could also require more than one construction season if an unexpected delay occurred to the start of embankment construction. Thus, the 1000-acre lake is considered to be the best option for this category. Reduced reactor power levels would be required to comply with South Carolina water-quality standards (i.e., maintaining a balanced biological community in the lake). The schedule for lake construction can be greatly accelerated from the estimates given earlier because the U.S. Army Corps of Engineers (COE) has a staff readily available to design and construct the embankment to form the lake. This COE workforce is completing the construction of the Richard B. Russell Dam on the Savannah River and is now becoming available.

Four recirculating cooling-lake options are considered: a 1300-acre lake, Kal Pond, a High-Level Pond, and Par Pond. The Par Pond option is not considered further due to the significant impact on reactor operation for both P- and L-Reactors and the potential environmental effects on the Par Pond ecosystem. The 1300-acre lake option is considered to be the best because it requires the shortest time to implement with the least environmental effects.

Lake construction, however, would require more than one construction season. Reduced power operation would be required to maintain a balanced biological community in the lake.

For once-through cooling towers, three different designs--2.8°C, 5.6°C, and 8.4°C approach temperatures--for four different discharge options--discharge to Steel Creek, canal to swamp, spray canal and canal to swamp, and canal to swamp and pipe to the Savannah River--were considered. The 2.8°C approach cooling tower is considered the best because it has the lowest discharge temperature; direct discharge to Steel Creek is used in this comparison because it requires a minimum amount of time and cost to implement with the least impact on reactor operation (e.g., minimum annualized cost). Exceedances of the South Carolina water-quality standards of 32.2°C at the discharge point would be expected only rarely; however, a variance would have to be requested from the South Carolina Department of Health and Environmental Control (SCDHEC) for the 2.8°C temperature difference requirement. The schedule could be expedited to complete construction in slightly more than 1 year.

For recirculating cooling towers, three different designs--2.8°C, 5.6°C and 8.4°C approach temperature--for four modes of discharges--total recirculation with blowdown to Steel Creek, total recirculation with blowdown treatment prior to discharge to Steel Creek, partial recirculation with discharge to Steel Creek, and partial recirculation with refrigeration before discharge to Steel Creek--were considered. A discharge of the blowdown to Steel Creek without treatment would require a variance from the SCDHEC requirement for a delta-T of 2.8°C. The 2.8°C approach temperature with total recirculation and treatment of blowdown is used in this comparison because it meets South Carolina water-quality standards and causes the least amount of impact on reactor operation (e.g., minimum annualized cost).

Four direct discharge options were considered--direct discharge to Steel Creek (reference case), spray canal, penstock diversion to Pen Branch, and lake-canal diversion to Pen Branch. Because the spray canal would only provide a minimum amount of thermal mitigation, and because the two diversions to Pen Branch options would impact previously unaffected areas, direct discharge has been used in this comparison. DOE does not intend to pursue the option of direct discharge; its implementation would require either a reclassification of the Steel Creek system by the State of South Carolina or a Presidential exemption from the requirements of the Clean Water Act.

Table 4-56 compares engineering and environmental factors for the five alternative cooling-water systems--once-through 1000-acre lake, recirculating 1300-acre lake, once-through 2.8°C approach temperature cooling tower, recirculating 2.8°C approach temperature cooling tower with treatment of blowdown, and direct discharge. After considering all factors, DOE has selected the once-through 1000-acre lake as its preferred cooling-water alternative because it:

1. Meets all State and Federal regulatory and environmental requirements, eliminating thermal impacts on the river, swamp, and unimpounded stream, while providing a productive balanced biological community within the lake

2. Provides the earliest reactor startup and the maximum plutonium deliveries of any regulatory and environmentally acceptable cooling-water alternative

Table 4-56. Comparison of cooling-water alternatives

Evaluation factors	Once-through cooling lake (1000 acres)	Recirculating cooling lake (1300 acres)	Once-through cooling towers (2.8°C approach)	Recirculating cooling tower (2.8°C approach and treatment of blowdown)	Direct discharge
Schedule for implementation	36-month construction schedule could be accelerated to complete lake in one construction season (6 months).	40-month construction schedule could be accelerated to complete lake, but would take longer (two construction seasons, i.e., about 18 months) than 1000-acre due to construction of recirculating system, road relocation, and additional embankments.	27-month construction schedule might be accelerated to complete the cooling tower in slightly more than 1 year.	27-month construction schedule; cannot be accelerated because of long-lead-time procurement of pumps.	Would not require any additional time for implementation.
Preliminary cost capital (million $)	25	73	50-55	75	0
Operating (million $/year)	3.4	2.9	5.5	3.2	3.4
Thermal compliance	Would meet South Carolina water-quality standards with changes in operating power levels.	Would meet South Carolina water-quality standards with changes in operating power levels.	Would meet South Carolina 32.2°C standard but variance would be required from ΔT of 2.8°C requirement.	Would meet South Carolina water-quality standards.	Would require reclassification of Steel Creek to be permittable.

Table 4-56. Comparison of cooling-water alternatives (continued)

Evaluation factors	Once-through cooling lake (1000 acres)	Recirculating cooling lake (1300 acres)	Once-through cooling towers (2.8°C approach)	Recirculating cooling tower (2.8°C approach and treatment of blowdown)	Direct discharge
Modification to operation	Power reduction would be necessary between late spring and early fall to maintain balanced biological community in lake. Average annual 14% power reduction. Amenable to installation of precoolers (~ $10M capital) that would allow an increase in power efficiency.	4% inherent operating power loss. Greater than 14% power loss to maintain a balanced biological community.	Operating power of 100%; infrequent periods (once in 4.5 years) might require some reductions.	Higher temperature of recirculating cooling water would cause a reduction in operating power levels; averages 6.5% power reduction.	Operating power of 100%.
Environmental Factors					
Thermal effects	Balanced biological community in the lake. Steel Creek corridor, delta, and Savannah River swamp protected from thermal effects downstream from embankment.	Same as for once-through 1000-acre lake.	Steel Creek corridor, delta, and Savannah River swamp protected from thermal effects.	No effects expected.	Steel Creek corridor, delta, and Savannah River swamp to be thermally impacted. Zone of passage to remain in the Savannah River. Also, there is a serious thermal shock effect.

Table 4-56. Comparison of cooling-water alternatives (continued)

Evaluation factors	Once-through cooling lake (1000 acres)	Recirculating cooling lake (1300 acres)	Once-through cooling towers (2.8°C approach)	Recirculating cooling tower (2.8°C approach and treatment of blowdown)	Direct discharge
Discharge flow effects	11 cubic meters per second to be discharged. Flow will impact downstream wetlands and will cause increased streambank erosion and delta growth below embankment.	About 0.5 cubic meter per second to be discharged below embankment. Erosion and wetland impacts downstream of embankment very small.	11.0 cubic meters per second. Erosion and delta growth would be greater than the 1000-acre lake due to erosion over longer reach of Steel Creek.	About 0.6 cubic meter per second; erosion and wetlands impacts downstream of embankment very small.	11 cubic meters per second to be discharged. Flow will impact downstream wetlands and will cause increased streambank erosion and delta growth below embankment.
Habitat impacts	735 to 1015 acres of wetlands would be affected by inundation or flow effects. 775 acres of uplands inundated.	240 acres of wetlands and 1060 acres of uplands would be inundated.	635 to 915 acres of wetlands would be affected by inundation and flow effects.	Slight impacts to wetlands.	Direct discharge will *eliminate between 730* to 1000 acres of wetlands in the Steel Creek corridor, delta, and Savannah River swamp.
Water withdrawal	About 11 cubic meters to be withdrawn from the Savannah River.	About 1.8 cubic meters per second to be withdrawn from the Savannah River.	Same as 1000-acre once-through lake.	About 1.4 cubic meters per second to be withdrawn from the Savannah River.	Same as 1000-acre once-through lake.
Entrainment/impingement	Water withdrawal will cause impingement of an additional 16 fish per day and entrainment of 3 to 6% of fish eggs and larvae passing SRP intakes.	Water withdrawal will cause impingement of less than 3 fish per day and entrainment of 0.5 to 2% of fish eggs and larvae passing SRP intakes.	Same as 1000-acre once-through lake.	Slightly less than recirculating cooling lake.	Same as 1000-acre once-through lake.

Table 4-56. Comparison of cooling-water alternatives (continued)

Evaluation factors	Once-through cooling lake (1000 acres)	Recirculating cooling lake (1300 acres)	Once-through cooling towers (2.8°C approach)	Recirculating cooling tower (2.8°C approach and treatment of blowdown)	Direct discharge
Endangered species	Habitat for American alligator and wood stork to be affected. Consultations with U.S. Fish and Wildlife Service in progress.	Habitat for American alligator affected; foraging habitat for wood stork not affected.	Same as 1000-acre once-through lake.	No impacts to endangered species.	Same as 1000-acre once-through lake.
Radiocesium remobilization	Radiocesium releases primarily related to flow. Maximum release to be no more than 4.4 curies in first year. Release within applicable standards.	Radiocesium releases would be smaller due to reduction in the amount of water discharged. Maximum release would be about 0.8 curie in the first year.	Radiocesium release would be smaller than for 1000-acre once-through lake and direct discharge. Maximum release would be 3.3 curies in the first year.	Same as 1300-acre recirculating cooling lake.	Radiocesium releases due to both hot water and flow effects. Maximum release to be about 4.4 curies in first year. Release within applicable standards.
Archeological sites	Four sites would be protected by monitoring and mitigation. One site to be flooded; recovery plan approved. Further surveys identified 10 potentially significant sites; mitigative measures to be taken as appropriate.	Same as 1000-acre once-through lake.	Five sites would be protected by monitoring and mitigation.	No archeological sites would be impacted.	Same as once-through cooling towers.

3. Has the lowest costs of any regulatory and environmentally acceptable cooling-water alternative

4. Is amenable to backfitting with precooler systems, if needed, which could improve reactor operational flexibility and the production capability.

The recirculating cooling tower alternative is considered the most favorable environmentally because it would not impact wetlands, the Steel Creek corridor, or uplands. This alternative was not identified as the preferred alternative, however, because it would require about 27 months to implement, even on an expedited basis; this would cause a large, unacceptable loss in material production. In addition, it would have a very high capital cost.

The recirculating cooling lake alternative is the next most favorable environmentally; its impacts are similar to those of the recirculating cooling tower, except it would inundate about 900 acres of uplands and 400 acres of wetlands. This alternative would have very high capital costs and a long schedule for construction in relation to that for the 1000-acre cooling lake. Even on an expedited basis (i.e., 18 months), the longer schedule would result in a large, unacceptable loss in material production.

The once-through cooling tower would have similar environmental impacts to those of the 1000-acre lake, except for the acreage inundated by the impoundment and the thermal shock effects of the discharge from the cooling tower on aquatic biota during startup or shutdown of the reactor. In addition, this alternative would have a longer construction schedule, with an attendant impact on material production, would have twice the cost of the 1000-acre lake, and would require a variance from South Carolina thermal standards.

4.4.3 Disassembly-basin water disposal

4.4.3.1 Background

The disassembly-basin water becomes contaminated when tritium and other radionuclides are carried over as process water adhering to the fuel and target assemblies and when tritium is contained as water of hydration in aluminum oxide on the assemblies. The disassembly-basin water is recirculated through sand filters and deionizers to clarify the water and remove radionuclides; tritium, however, is not removed in the process, and small residuals of other radionuclides also remain (Table 4-57). When the tritium content of the disassembly-basin water has built up to a procedural control level, the water is purged from the disassembly basin. Normally the basin is purged of as much as 1,890,000 liters of water following each reactor discharge. The purge is not continuous, but occurs at a frequency that depends on the type of reactor assemblies and the frequency of discharge operations; typically, the basin is purged twice each year.

Initially, the L-Area disassembly basin would contain very little tritium because the reactor would start up with a nontritiated charge of heavy water. The amount of tritium discharged would gradually increase as the tritium content of the reactor process water increases due to neutron activation. After about

Table 4-57. Expected average annual liquid releases of radionuclides to the L-Area seepage basin--tenth year

Radionuclide	To seepage basin (Ci/yr)	To Steel Creek from ground water[a] (Ci/yr)
H-3	[b]1.1×10^{4}	6.0×10^{3}
P-32	1.2×10^{-3}	--
S-35	9.5×10^{-3}	2.9×10^{-8}
Cr-51	1.8×10^{-1}	--
Co-58, Co-60	3.7×10^{-4}	2.1×10^{-4}
Sr-89	7.0×10^{-5}	--
Sr-90	2.0×10^{-4}	--
Y-91	5.1×10^{-3}	--
Zr-95	1.1×10^{-2}	--
Ru-106	3.4×10^{-4}	1.7×10^{-5}
Sb-125	8.0×10^{-3}	2.6×10^{-3}
I-131	6.9×10^{-3}	--
Cs-134	5.1×10^{-3}	--
Cs-137	4.4×10^{-2}	--
Ce-144	1.9×10^{-2}	3.8×10^{-4}
Pm-147	2.8×10^{-3}	8.8×10^{-4}
Unidentified beta-gamma	8.9×10^{-2}	--
Unidentified alpha	3.2×10^{-4}	--

[a]Outcrop activities after 15 years of L-Reactor operation. Due to long transport time in ground water, Sr-90 and Pu-239 would not reach outcrop until many years after L-Reactor operations have ceased. Estimated dose effects at this time are much smaller than those due to the listed radionuclides.

[b]Thirty percent of this tritium is expected to evaporate.

10 years of operation, the tritium content of the process water would approach an equilibrium; that is, the amount of new tritium produced would equal the amount lost through radioactive decay, leakage, and carryover during discharge operations.

The following subsections describe alternative disposal methods for disassembly-basin purge water and compare these methods on the bases of cost and offsite doses.

4.4.3.2 Discharge to seepage basin

DOE is conducting continuing studies of the detritiation of all SRP reactor moderator, the discontinued use of seepage basins, and related cleanup and remedial actions (Section F.6). Table 4-57 lists the expected annual releases of radionuclides to the L-Area seepage basin and the releases of radionuclides to Steel Creek by ground-water transport from the seepage basin.

Approximately 30 percent of the tritium entering the seepage basin would evaporate, and the remainder would seep into the ground, entering the uppermost water-table aquifer, the Barnwell Formation. The water is then expected to move horizontally, outcropping in Steel Creek approximately 4.4 years later. The quantity of tritium reaching Steel Creek is reduced to about 50 percent of that discharged to the seepage basin by evaporation and radioactive decay.

4.4.3.3 Discharge to Steel Creek

Direct discharge to Steel Creek would lose the advantage of radioactive decay found in the seepage basin disposal method. Also, concentrations of tritium and other radionuclides in Steel Creek and the Savannah River would reach maximums during purges and drop to lower levels afterward. If discharged to Steel Creek, the purge water would be diluted with cooling water and evaporative losses to the atmosphere would be small.

4.4.3.4 Evaporation

The purge water from the disassembly basin could be evaporated using a small commercially available boiler, vent stack, and dispersion fan. All the tritium would be dispersed in the atmosphere while other radionuclides would be retained in the evaporator bottoms and removed by ion change. No radioactive materials would enter Steel Creek under this alternative.

The estimated installation cost of such a unit would be $2-3 million and the operating cost would be $300,000 per year at $22 per thousand kilograms of steam.

4.4.3.5 Detritiation

As discussed in Section 4.4.5, detritiation of reactor moderator in a central facility is being considered for all four SRP reactors. The moderator detritiation plant is expected to reduce equilibrium moderator tritium levels by a factor of ten. Inasmuch as the moderator would be the source of the tritium that contaminates the disassembly-basin water, a corresponding factor of ten reduction in the basin water tritium concentrations and releases from this source is expected.

4.4.3.6 Comparison of alternatives

The contribution to offsite dose of disassembly-basin discharge to the seepage basin, of direct discharge to Steel Creek, and of evaporation were calculated for the purpose of comparing these alternatives. Calculations of total dose from L-Reactor operation with discharge to the seepage basin and with direct discharge to Steel Creek can be found in Appendix B.

The amounts of tritium entering the atmosphere and liquid pathways as a result of discharge to the seepage basin, discharge to Steel Creek, and evaporation are listed in Table 4-58. These releases are predicted to occur after the tenth year of L-Reactor operation. During the first year, about one-tenth of these amounts would be released. Some radionuclides other than tritium would be released to Steel Creek, from both seepage-basin disposal and direct discharge to Steel Creek. The values listed in Table 4-57 are only those associated with disassembly-basin purge water and do not include releases from other sources such as heat exchanger leakage, process sumps, and evaporative loss from process water leaks.

Table 4-58. Tritium releases from disassembly-basin water disposal alternatives--tenth year

Release pathway	Tritium releases (Ci) With seepage basin	Tritium releases (Ci) Direct to Steel Creek	Evaporation
Atmosphere	3,200	--	11,000
Steel Creek	6,000	11,000	--

Table 4-59 lists offsite doses from the tritium and other radionuclides. Doses to the maximum individual from seepage-basin disposal would be about half of those from a direct discharge to Steel Creek and twice those expected from the use of an evaporator. Estimated population doses from an evaporator would be slightly lower than those from either a discharge to the seepage basin or a direct discharge to Steel Creek. However, these differences would be small.

There would be little difference in cost between a discharge to the seepage basin and a direct discharge to Steel Creek; the cost of either method would be small. Considering only operating costs, the cost-benefit ratio for installing an evaporator system would be $42,000 per person-rem avoided in the offsite population doses; this is a costly alternative. The cost-benefit ratio for detritiation of the moderator would be even greater per person-rem avoided (Section 4.4.5). TE

Thus, DOE has selected the discharge to seepage basin as its preferred alternative; at the same time, research and development activities for detritiation are continuing for potential general application at the Savannah River Plant. TC

Table 4-59. Offsite doses from disassembly-basin water disposal alternatives--tenth year

Exposure pathway	With seepage basin	Direct to Steel Creek	Evaporator
MAXIMUM INDIVIDUAL (CHILD) DOSE (mrem/yr)			
Atmosphere[a]	0.013	--	0.044
Liquid[b]	0.074	0.15	--
Total	0.087	0.15	0.044
POPULATION DOSE (person-rem/yr)			
Atmosphere[a]			
80-kilometer radius	0.5	--	1.9
Liquid[b]	8.6	15.9	--
Total	9.1	15.9	1.9

[a]Tritium only released by atmospheric pathway.
[b]Radionuclides other than tritium also enter liquid exposure pathway.

4.4.4 186-Basin sludge removal

4.4.4.1 Background

L-Area is equipped with a 95-million-liter reservoir (186-Basin) to hold cooling water for the reactor. The reservoir is divided into three separate basins, which are connected by sluice gates. All the water that comes from the Savannah River, which is used to cool the reactor during periods of normal operation and shutdown, would pass through the 186-Basin. The basins would also be used as settling basins to remove suspended solids from the water, thereby preventing their accumulation in the heat exchangers.

The average suspended solids concentration of the water drawn from the Savannah River is 21 milligrams per liter. The primary source of the suspended solids in the Savannah River is from the erosion of Piedmont soils above the fall line. About 2 percent of the suspended solids that enter the 186-Basin are actually deposited in the basin, amounting to about 110 metric tons of sediment on an annual basis.

The sediment that accumulates in the 186-Basin has been found to be a habitat suitable for growth for the Asiatic clam, Corbicula. Clams, which would be swept up by the water flowing to and through the reactor heat exchangers, would attach themselves to the piping and heat exchangers and continue to thrive. Eventually, the piping and heat exchangers could become fouled, or even plugged, and their ability to transmit the heat generated by the nuclear fission process in the reactor to the secondary cooling water would be impaired. To reduce the potential for Asiatic clam growth and development, the sediment in the 186-Basin would be removed on a periodic basis.

The following is a discussion of four alternative methods that could be employed to eliminate the sediment accumulation problem in the 186-Basin. They are compared on the basis of relative effort to implement each alternative. These alternatives are as follows:

1. Batch discharge to Steel Creek
2. Land application
3. Borrow pit application
4. Continuous sediment suspension

4.4.4.2 Batch discharge to Steel Creek

During periods of reactor shutdown and after the basins have been drained, this alternative would flush the sludge to the process sewer and eventually to an onsite stream. This procedure would take about 2 weeks.

With EPA's establishment of the National Pollutant Discharge Elimination System (NPDES) permit, a daily maximum limit of 50 milligrams per liter for total suspended solids was established for discharges to surface-water streams. During the periods in which the basins were cleaned of sediment, the suspended solids concentration in the effluent to the onsite streams exceeded this limit by 10 to 110 milligrams per liter. An exemption from the suspended solids limits has been obtained for the basin-cleaning activities at C-, K-, and P-Reactors under the January 1, 1984, NPDES permit for SRP (Section 7.4). Daily composite samples for total suspended solids are required during the cleaning period, and the results must be reported annually to SCDHEC. TC

Batch discharge would allow sediments flushed from the 186-Basin in L-Area to be discharged to Steel Creek. The resuspended sediments discharged to Steel Creek would be deposited in the creek before they reach the Savannah River swamp. These sediments could possibly be resuspended and transported when the water flow in Steel Creek increases due to storms or reactor startup.

Since 1968, when L-Reactor was placed on standby status, daily maximum suspended solids concentrations in Steel Creek and in the Savannah River have been observed to exceed EPA NPDES limits due to natural causes, and are comparable to the values anticipated with the draining and cleaning of the L-Area 186-Basin. The draining and cleaning of the L-Area 186-Basin would be carried out over a period of several days to 2 weeks on an annual basis.

4.4.4.3 Land application

The sediments that need to be removed from the L-Area 186-Basin could be applied to the land to enhance growth of a vegetative cover. The sediment is essentially topsoil from the Piedmont region above the fall line that has been eroded and washed away by storm runoff into the Savannah River.

To be able to handle it in an efficient and economical manner for land application, the sediment would have to be dried to a high solids content (sludge). This could be accomplished during a scheduled extended reactor shutdown by decanting the water from the basin, leaving the sediment. This water could be discarded in the process sewer line that discharges to Steel Creek.

The remaining sediment and water (sludge) could then be transferred to a sludge-drying basin, via (1) another process sewer line or (2) truck transport. On completion of the transfer, the 186-Basin could be returned to service, with no effect on reactor restart. The sludge would dry, or thicken, under natural conditions. On reaching a solids content suitable for handling, the sludge would be trucked to a site designated for the application.

This alternative would require the construction of a basin for sludge drying and the installation of an additional process sewer line connecting the 186-Basin to the new basin, if the process sewer line option identified above were selected.

4.4.4.4 Borrow pit application

Another alternative to batch discharge to Steel Creek would be to place the material in retired borrow pits on the SRP site. These pits were sources of earth-fill material for various construction projects on the SRP.

This alternative would also require the construction of a sludge-drying basin and the additional process sewer line connecting the 186-Basin with the sludge-drying basin. The time requirements for this alternative would be similar to those for land application, and would not have an effect on reactor restart. This alternative, though, would be limited to the number of retired borrow pits on the SRP and their capacity.

4.4.4.5 Continuous sediment suspension

A means to prevent sediment accumulation in the 186-Basin would be to keep solids in suspension in the water as it transits the basin. Agitation and turbulence of the basin water would accomplish this objective.

If implemented, the suspended solids concentration of the effluent stream discharged to Steel Creek would be essentially the same as that of the water drawn from the Savannah River. The total amount of sediment discharged to Steel Creek under this alternative would be the same amount discharged under the "batch discharge to Steel Creek" alternative described above. Continuous suspension of the sediment in the 186-Basin, however, would not prevent the accumulation of sediment in the L-Reactor heat exchangers and secondary cooling piping and might improve the habitat for the Asiatic clam.

4.4.4.6 Comparison of alternatives

None of the alternatives described above would have an impact on L-Reactor restarts following a scheduled extended shutdown. The "batch discharge to Steel Creek" and "continuous sediment suspension" alternatives would have no land use requirements, but could contribute to delta growth in the Savannah River swamp. The "borrow pit application" alternative would be limited to the number and capacity of retired borrow pits on the SRP.

The "batch discharge to Steel Creek" alternative would not require funds for construction activities, while the other three alternatives would require funds for construction, equipment procurement, maintenance, and additional operating expenses.

DOE has selected the batch discharge to Steel Creek as its preferred alternative. Batch discharge is presently allowed by the SRP NPDES permit issued by the South Carolina Department of Health and Environmental Control. This permit requires the performance of a 1-year study to determine the potential environmental effects of batch discharge. TC

4.4.5 Moderator detritiation

The possibility of a detritiation plant to remove tritium from heavy-water moderators in all SRP reactors is being studied. The moderator detritiation plant (MDP) would reduce moderator tritium content by a factor of ten to 1.7 curies per liter.

Tritium is formed in the heavy-water moderator by neutron irradiation of deuterium. Tritium reaches the environment through both liquid and gaseous pathways. Table 4-60 presents data for reactor tritium releases from all SRP operations. Operation of an MDP is expected to reduce reactor releases, including the contribution from L-Reactor operation, to 13 percent of the tabulated values.

Evaluation of the MDP is underway. The concept envisions the use of a central facility processing water from all four SRP reactors. The process being considered is based on catalytic exchange between heavy-water feed and detritiated deuterium gas. Tritium is extracted into the deuterium gas stream, which is cryogenically distilled to separate the tritium from the deuterium. The purified deuterium gas stream is returned to the catalytic exchange.

Two process variations are under consideration. In the first, which has been demonstrated and operated since 1972 on a scale about 1/7 of that required for SRP, a vapor phase exchange is employed. The heavy-water feed is first converted to steam, which is then mixed with the deuterium gas in contact with the catalyst. In the second variation, which has only been demonstrated on a laboratory scale, the heavy water is maintained in the liquid phase during contact with the deuterium gas stream in the presence of the catalyst. This latter variation offers the potential for significant cost savings compared to the former.

Table 4-60. Reactor tritium releases from SRP operation

Releases	Curies for 3 reactors (annual)
LIQUID	
Direct reactor releases to river	8,800
Indirect to K-Basin and Par Pond	9,800
From heavy-water rework to river	2,000
Total	20,600
ATMOSPHERIC	
From reactor stacks	146,000
Evaporation from disassembly and seepage basins	6,000
Total	152,000

Current estimates are based on a start of detailed design of the MDP in 1986, start of construction in 1987, and operation in 1992. By 1992, the estimated moderator tritium level will be 9 curies per liter, increasing at a rate of 0.7 curie per liter per year. Tritium releases from L-Reactor will represent about 15 percent of all SRP reactor tritium releases.

Capital costs of the MDP (escalated to the time of expenditure) are estimated to be in the order of $125 million. Estimated annual operating cost for the first year of operation is $6.2 million. These estimates place the cost-benefit of the MDP in excess of $1 million per person-rem exposure averted.

4.5 PREFERRED ALTERNATIVES*

This section presents the potential environmental effects of L-Reactor operation with the implementation of the preferred mitigation alternatives (described in Section 4.4). This alternative is discussed in more detail in Appendix L.

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

4.5.1 Preferred mitigation alternatives

4.5.1.1 Safety-system alternative

The existing confinement system is the preferred alternative. The safety-system alternatives discussed in Section 4.4.1 would mitigate the potential consequences from hypothetical reactor accidents, which have a very low estimated probability of occurrence and associated risk. Based on benefit, cost, and technical feasibility, the reference-case confinement system has been identified as the preferred safety-system alternative.

Of the six alternatives, including the reference case, only three were found to be technically feasible. Two of these feasible systems were associated with very large costs per person-rem averted, based on a postulated 3-percent core-melt accident. Again, the existing system is the preferred safety-system alternative.

As agreed in the Memorandum of Understanding between DOE and the State of South Carolina of April 27, 1983 (Congressional Record, July 14, 1983, p.S1000), DOE will, within the limits of classification, provide the State a discussion paper describing the differences between SRP production reactors and commercial power reactors and the reasons why a containment is neither feasible nor necessary on the existing SRP production reactors.

4.5.1.2 Cooling-water alternative

The preferred cooling-water alternative of the Department of Energy is to construct a 1000-acre lake before L-Reactor resumes operation, to redesign the reactor outfall, and to operate L-Reactor in a way that assures a balanced biological community in the lake as specified in an NPDES permit to be issued by the State of South Carolina.

The lake will require at least 3 to 5 years to establish and develop a balanced biological community. Initially, L-Reactor will be operated to maintain 32.2°C or less in about 50 percent of the lake. Studies will be conducted to confirm the biological characteristics and the cooling effectiveness of the lake. Following the results of these studies, L-Reactor operations will be adjusted as necessary to assure the continued maintenance of a balanced biological community.

This alternative is discussed in Section 4.4.2.2.9; it is one of 33 alternatives analyzed in Section 4.4.2. Based on discussions with the South Carolina Department of Health and Environmental Control, DOE has determined that L-Reactor operation can be modified so the 1000-acre lake would comply with South Carolina water-quality standards. Also, the Corps of Engineers has agreed to construct the embankment to form the 1000-acre lake on a much faster schedule. Because DOE has to restart L-Reactor operation as soon as practicable to produce the needed defense nuclear materials and because the schedule for constructing such environmentally preferable alternatives as a closed-cycle cooling tower cannot be greatly improved (design, construction, and long-lead-time procurement of special pumps), DOE decided to identify the 1000-acre lake as its preferred cooling-water mitigation alternative.

In addition to complying with the NPDES permit, DOE:

- Will comply with provisions of Section 404 of the Clean Water Act with regard to the construction of the cooling lake, including the required SCDHEC 401 certification.

- Will prepare a predictive 316(a) demonstration.

- Will complete a consultation process with the U.S. Fish and Wildlife Service (FWS) on the impacts of the preferred alternative.

- Will, in accordance with FWS personnel, use the Habitat Evaluation Procedures (46 FR 7644) to determine further mitigation needs. Based on this program, DOE will implement additional mitigation measures (depending on Congressional authorization and appropriations).

- Will perform an archeological survey, assessment, and data recovery, if required, of the affected area not previously studied, as required by the National Historic Preservation Act.

- Will perform safety analyses of the design of the cooling lake.

4.5.1.2.1 Description

The 1000-acre lake would be about 1200 meters wide at its widest point, would average approximately 600 meters wide, and would extend about 7000 meters along the Steel Creek valley from the embankment to just beyond Road B (Figure 4-44). The normal pool elevation of the lake would be 58 meters above mean sea level (MSL); the present elevation of Steel Creek at the dam site is 35 meters. The storage volume at the normal pool elevation would be about 31 million cubic meters.

The embankment for the 1000-acre lake would be at the same location as that for either the 500- or the 1300-acre lake. Figure 4-45 shows the relationships between these lake designs. The embankment would be approximately 800 meters upstream from the Seaboard Coast Line Railroad Bridge across Steel Creek or 1700 meters upstream from Road A. It would be 1200 meters long at the crest (Figure 4-46). The main embankment would be a maximum of about 26 meters high, 12 meters wide at the top, and 200 meters wide at the base. The elevation at the top of the embankment would be 61 meters above mean sea level to allow 3 meters freeboard for flood pool, wave action, and earthquake settlement.

An outlet structure with gates would control the discharge from the lake to a conduit running 220 meters under the embankment. This conduit would discharge into a stilling basin to reduce the velocity before the water is released into Steel Creek (Figure 4-47).

4.5.1.2.2 Lake temperatures

L-Reactor would be operated at the highest allowed power level consistent with the maintenance of the balanced biological community in the lake, as specified in the NPDES permit that is expected to be issued by the State of South Carolina. Initially, L-Reactor would be operated to maintain 32.2°C or less in about 50 percent of the lake.

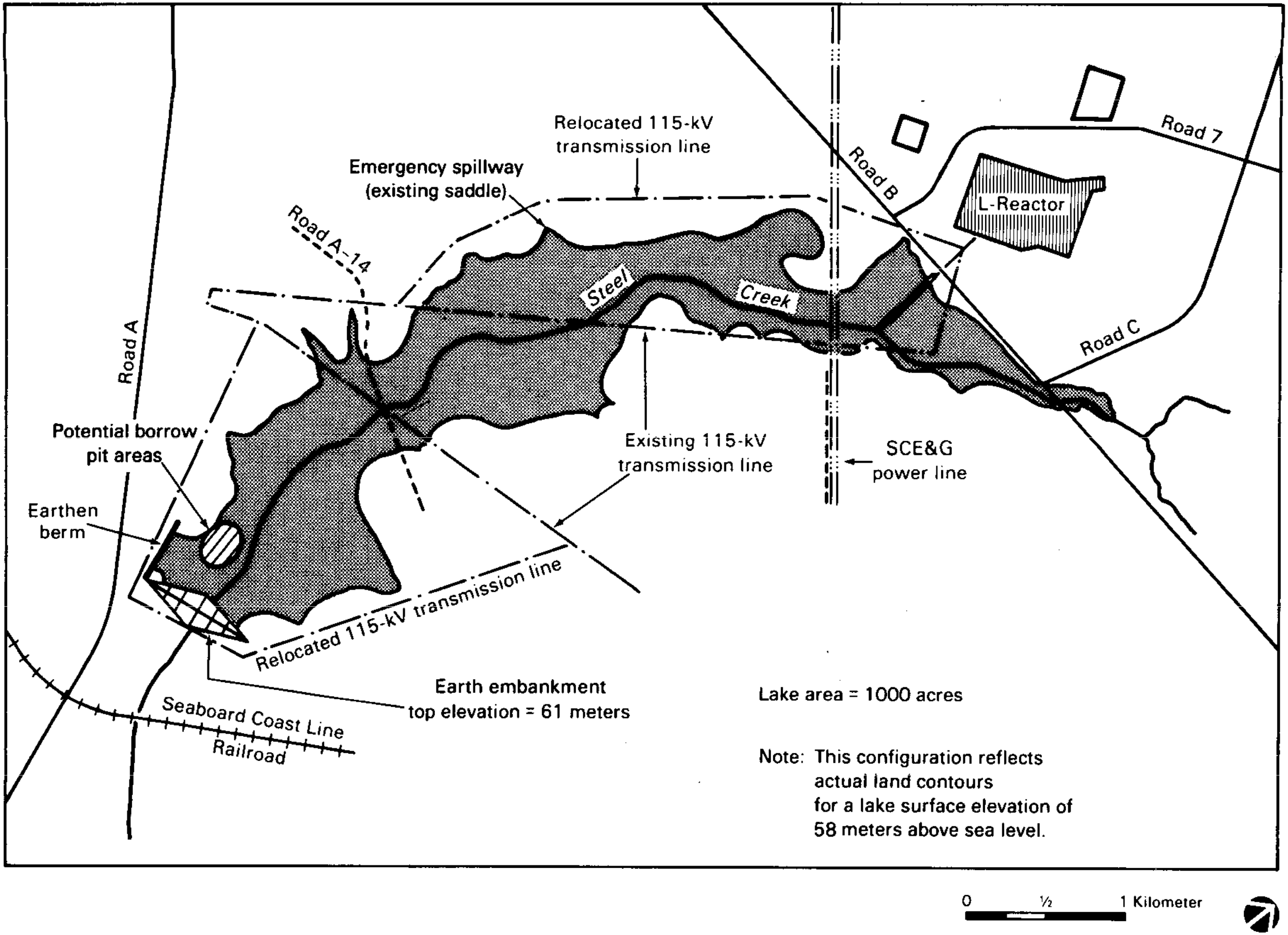


Figure 4-44. Conceptual design for 1000-acre lake on Steel Creek.

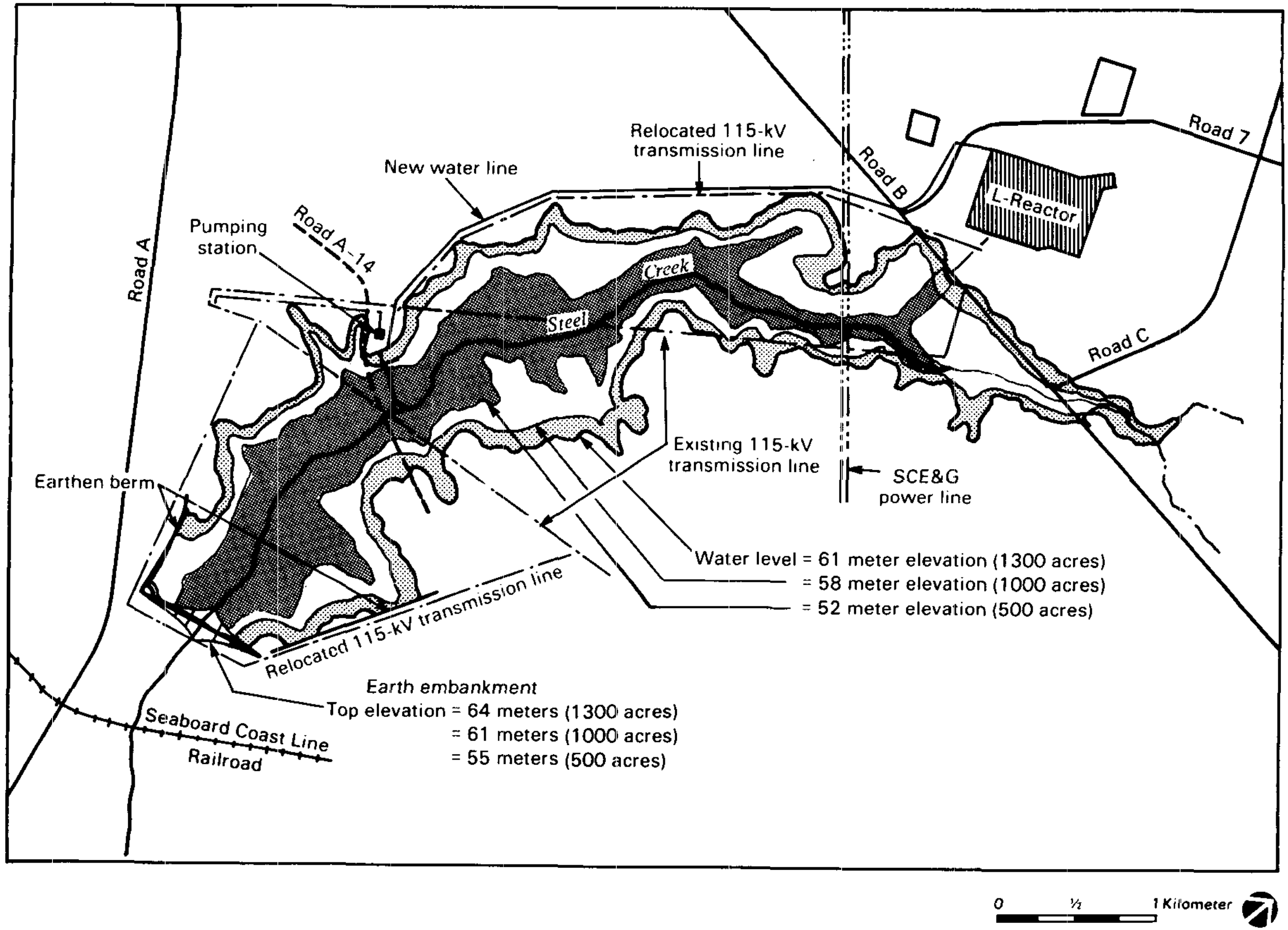


Figure 4-45. Relationship of 1000-acre lake to 500-acre lake and 1300-acre lake.

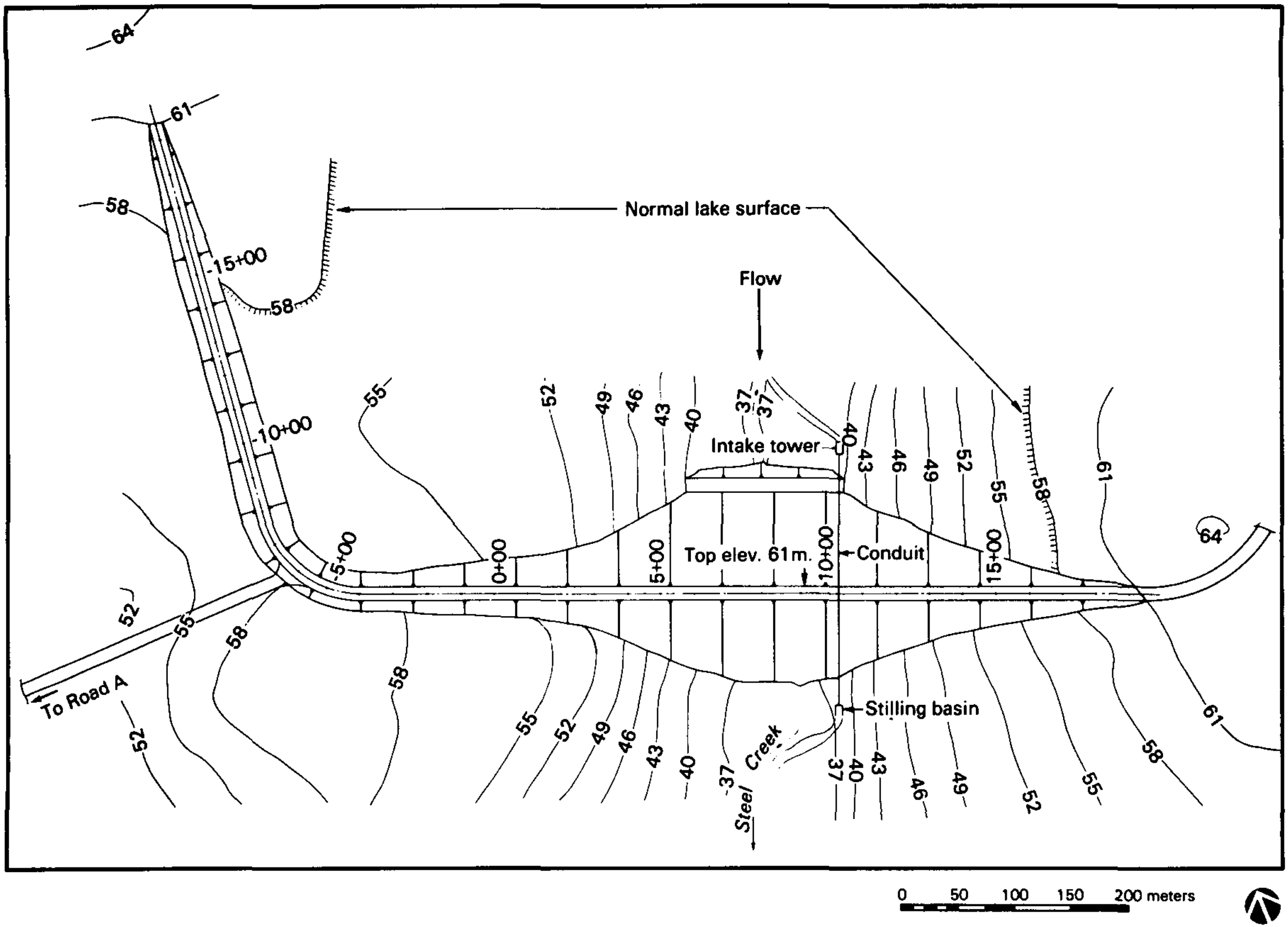


Figure 4-46. Steel Creek embankment (top view).

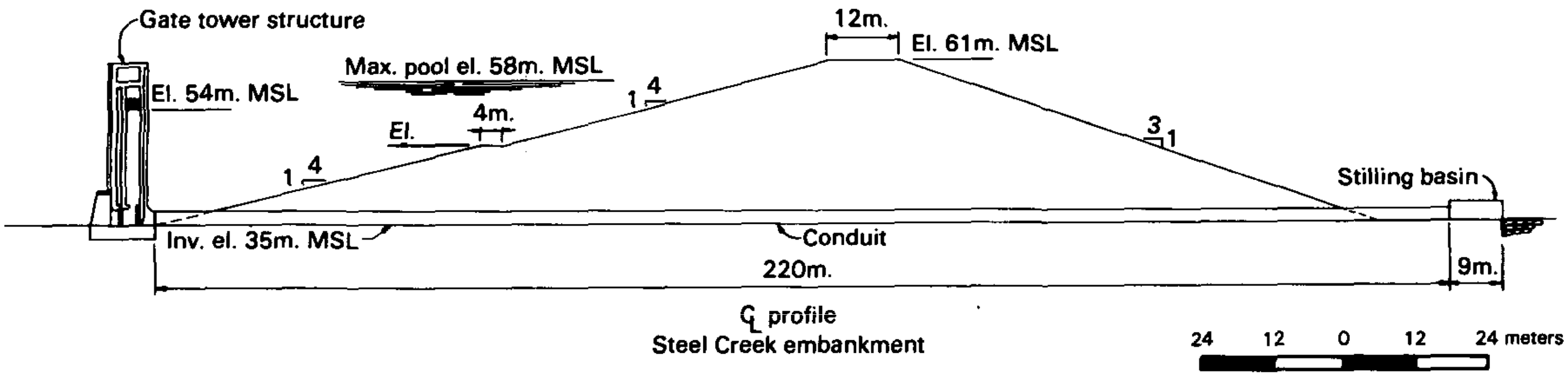


Figure 4-47. Steel Creek embankment (side view).

Hourly meteorological data for the years 1953 through 1982 and the cooling-lake thermal performance model described in Section L.2.2.1 was used in an iterative fashion to determine reactor power levels that would be required to meet the temperature criterion. The resulting average reactor power reduction was approximately 7 percent.

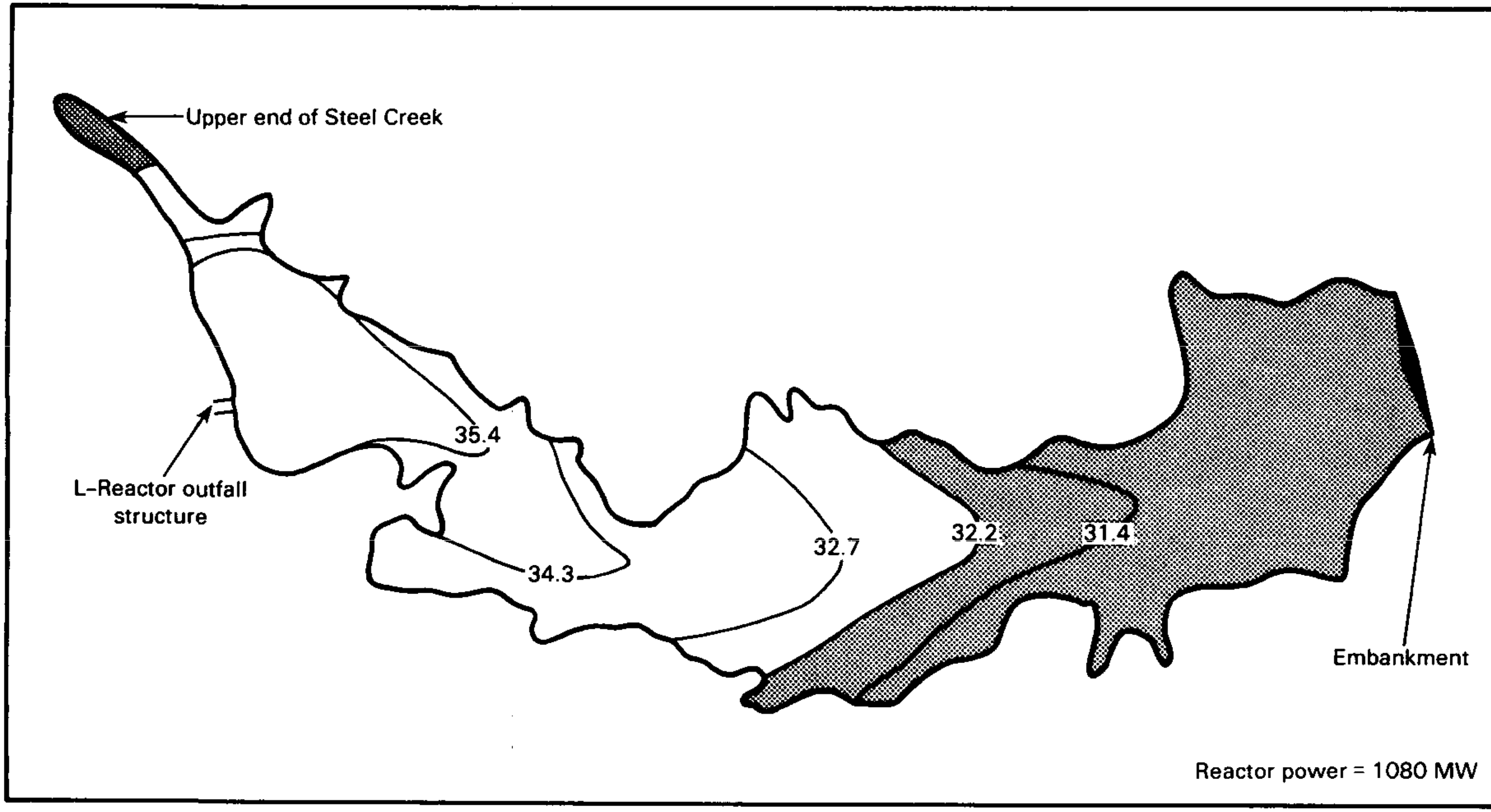
The heated water would be discharged into the lake through a specially designed outfall canal; it would spread over the cooler water present in the lake, enhancing the cooling efficiency (Section L.2.4.4). The surface layer would tend to exist throughout most of the lake due to the relatively small advective transport of the discharge, the depth of the lake, and the large temperature difference (between the influent and the effluent) within the lake. In addition, the discharge into the lake would be accomplished such that mixing of the discharge and resident lake water would be kept low (a desirable condition to maximize the heat flux through the water surface). Based on observations in Par Pond, as well as theoretical considerations, the surface layer in the L-Reactor cooling lake is expected to be about 1.5 meters thick. This layer would be vertically well mixed due to wind-induced turbulence. A cooler sublayer would exist beneath the surface layer. This layer would be fed by lake water returning from the cold end to satisfy the continuity requirements of discharge mixing and lake withdrawal. Accordingly, the temperatures in the deeper portions of the lake would approximate the cold end temperatures. That is, the colder sublayer temperature would range between approximately 17° and 31°C throughout the year (although some winter temperatures might be as low as 14°C, as inferred from the 30-year data base and thermal modeling).

Thermal modeling was also performed to calculate the percentage of the lake surface area having a given temperature for each season of the year. Water in the coldest 50 percent of the lake area is expected to exhibit temperatures that range from about 14°C to 23°C in the winter and from about 31°C to 32°C in the summer. Figure 4-48 shows the estimated summer isotherms in the surface layer of the 1000-acre lake. The shaded zone represents the area of the lake's surface that will be below 32.2°C.

4.5.1.2.3 Lake operation

During construction of the embankment, streamflow would be carried through the work area in a temporary metal conduit laid parallel to the outlet works conduit. An upstream cofferdam, with a crest at elevation 43 meters above mean sea level, would divert the water into the metal conduit and protect the work site. A low downstream cofferdam would protect the site from rising tailwater. This diversion configuration would provide protection from a storm with a recurrence interval of between 25 and 50 years.

Following completion of the reconfigured discharge canal, outlet works, and embankment, the outlet gates would be closed and the pool elevation of the lake would be allowed to rise to the design elevation of 58 meters above mean sea level. Assuming a constant inflow of about 11 cubic meters per second of Savannah River water from L-Reactor, 0.45 cubic meter per second from P-Reactor, and 0.62 cubic meter per second Steel Creek base flow, approximately 30 days would be required to fill the lake. As impoundment of the lake occurred, the response of the embankment would be monitored to verify design. Flow would be maintained down Steel Creek below the embankment during filling. Lake filling would be completed before startup of L-Reactor.



Areas with surface-water temperatures below 32.2°C

Figure 4-48. Estimated isotherms for the 1000-acre lake (summer).

Cooling-water and lake discharge flows, typically entering the outlet works at a depth of 2 to 4 meters below the lake surface, would be managed to maintain a balanced biological community in the lake and in Steel Creek and swamp. Reactor cooling-water flow variations and lake discharge management would restrict water level fluctuations to assure a healthy aquatic macrophyte population in the lake. The development of shoreline refuge areas would also enhance this macrophyte population, which would provide the necessary habitat for growth and reproduction of certain fish and macroinvertebrates necessary to maintain a balanced biological community (see Section L.4.1.1.2).

Downstream flows would be maintained constant throughout reactor operating periods, except during periods of extreme rainfall. During short reactor outages occurring within the spring spawning period, the flow at Road A would be controlled to about 3 cubic meters per second, thereby maintaining good spawning habitat. The remainder of the year, flow in Steel Creek at Road A during shutdown periods would be maintained at about 1.5 cubic meters per second, providing opportunities for fish to move freely from the base of the embankment to the Savannah River swamp.

If long reactor outages should occur during the spawning period, flow would be maintained at a rate of about 3 cubic meters per second. For long outages at other times, only base flow conditions would occur in Steel Creek.

4.5.1.2.4 Relocation of existing facilities

The construction of the 1000-acre lake would require the relocation of a 115-kilovolt electric transmission line belonging to the South Carolina Electric and Gas Company (SCE&G) and two 115-kilovolt electric transmission lines and buried supervisor control and relay cable lines that serve the L- and P-Areas. The SCE&G line could be raised from existing wooden poles onto two new tall towers in its present alignment. However, the two SRP lines would have to be rerouted around the lake because of the buried cable and the width of the lake at those points. Also, two new SCE&G transmission lines presently being designed by that company would be constructed such that they would not interfere with the 1000-acre lake.

Road A-14 would be abandoned wherever it would become inundated by the lake. The access road across the embankment would begin at Road A west of the lake and be extended northeast from the east end of the embankment along a ridge to connect with Road A-14 east of the lake. This road would parallel one of the relocated SRP transmission and buried cable lines. Approximately 600 meters of Road B and 100 meters of Road C would be raised a maximum of 3 meters on their existing roadbeds at their intersection.

4.5.1.3 *Disassembly-basin water purge*

The use of the L-Reactor seepage basin is the preferred alternative. As noted in Section 4.4.3, deionized and filtered purge water from the disassembly basin can be disposed of by discharge to the L-Reactor seepage basin, by evaporation, or by direct discharge to Steel Creek. Another alternative would be to detritiate the moderator (Section 4.4.5). On the bases of person-rem avoided and of the cost per person-rem avoided, the use of the L-Reactor seepage basin is the preferred alternative for the disposal of disassembly purge water. DOE will continue to study and evaluate moderator detritiation.

The use of the L-Reactor seepage basin would result in eventual discharges to the cooling lake, not Steel Creek. The use of the cooling lake is expected to increase the ground-water travel time from about 18 years (direct discharge) to about 21 years. The radiological effects from the discharge of radionuclides, principally tritium (Table 4-11), from the seepage basin to the cooling lake are listed in Table 4-61 and in Section 4.4.6.2.

In accordance with the DOE and State of South Carolina Memorandum of Understanding of April 27, 1983, DOE will, on a continuing basis, provide the State with data showing its compliance with EPA radionuclide standards, and will continue an expanded program of monitoring and study of ground-water impacts at SRP. Sections 6.1.6 and F.6 describe DOE's commitments on SRP ground-water protection, the evaluation of seepage-basin use on a sitewide base, and a separate NEPA review of the SRP ground-water protection plan.

4.5.1.4 186-Basin sludge disposal

Batch discharge to the 1000-acre lake is the preferred alternative. Section 4.4.4 evaluates several methods for the disposal of sediment that settles from Savannah River water as it passes through the 186-Basin at L-Reactor. Methods considered included batch discharge (the reference case), land application, borrow-pit application, and continuous sediment suspension. Batch discharge is the preferred 186-Basin sludge disposal alternative on the basis of cost. It has been used in the past at L-Area and is currently being used at the other operating reactor sites. DOE will continue to study this method, in accordance with the December 15, 1983, NPDES permit issued by the State of South Carolina. During the batch discharge of settled sediment at L-Reactor and other reactor sites, composite samples of the effluent would be measured daily for total suspended sediment concentrations; the results of these measurements would be reported to SCDHEC in early 1985.

In combination with the preferred cooling-water alternative, some suspended sediment from the batch discharge of 186-Basin sludge would settle out and deposit on the bottom of the cooling lake. This deposition is expected to be a small fraction of the sediment that would be deposited in the basin from the stream flow above L-Reactor and from suspended material carried in the cooling water after it has passed through the 186-Basin and reactor heat exchangers. Siltation from these sources is not expected to have appreciable effects on the performance of the cooling lake.

4.5.2 Impacts due to construction and mitigation

This section characterizes the expected effects due to construction of the 1000-acre lake. No construction activities are required by the other preferred alternatives.

Table 4-61. Expected average annual liquid radioactive releases from L-Reactor operation (curies per year)

	1st year of operation				10th year of operation			
Radionuclide	To 1000-acre lake	To seepage basin	To 1000-acre lake from ground water[a]	Total to 1000-acre lake	To 1000-acre lake	To seepage basin	To 1000-acre lake from ground water[b]	Total to 1000-acre lake
H-3	3.6×10^{2}	[c]1.1×10^{3}	--	3.6×10^{2}	3.6×10^{3}	[c]1.1×10^{4}	6.0×10^{3}	9.6×10^{3}
P-32	--	1.2×10^{-3}	--	--	--	1.2×10^{-3}	--	--
S-35	--	9.5×10^{-3}	--	--	--	9.5×10^{-3}	2.9×10^{-8}	2.9×10^{-8}
Cr-51	--	1.8×10^{-1}	--	--	--	1.8×10^{-1}	--	--
Co-58,60	4.5×10^{-2}	3.7×10^{-4}	--	4.5×10^{-2}	4.5×10^{-2}	3.7×10^{-4}	2.1×10^{-4}	4.5×10^{-2}
Sr-89	--	7.0×10^{-5}	--	--	--	7.0×10^{-5}	--	--
Sr-90	1.6×10^{-4}	2.0×10^{-4}	--	1.6×10^{-4}	1.6×10^{-4}	2.0×10^{-4}	--	1.6×10^{-4}
Y-91	--	5.1×10^{-3}	--	--	--	5.1×10^{-3}	--	--
Zr-95	--	1.1×10^{-2}	--	--	--	1.1×10^{-2}	--	--
Ru-106	--	3.4×10^{-4}	--	--	--	3.4×10^{-4}	1.7×10^{-5}	1.7×10^{-5}
Sb-125	--	8.0×10^{-3}	--	--	--	8.0×10^{-3}	2.6×10^{-3}	2.6×10^{-3}
I-131	--	6.9×10^{-3}	--	--	--	6.9×10^{-3}	--	--
Cs-134	--	5.1×10^{-3}	--	--	--	5.1×10^{-3}	--	--
Cs-137	4.1×10^{-4}	4.4×10^{-2}	--	4.1×10^{-4}	4.1×10^{-4}	4.4×10^{-2}	--	4.1×10^{-4}
Ce-144	--	1.9×10^{-2}	--	--	--	1.9×10^{-2}	3.8×10^{-4}	3.8×10^{-4}
Pm-147	--	2.8×10^{-3}	--	--	--	2.8×10^{-3}	8.8×10^{-4}	8.8×10^{-4}
Unidentified beta-gamma[d]	1.1×10^{-1}	8.9×10^{-2}	--	1.1×10^{-1}	1.1×10^{-1}	8.9×10^{-2}	--	1.1×10^{-1}
Unidentified alpha[e]	2.0×10^{-5}	3.2×10^{-4}	--	2.0×10^{-5}	2.0×10^{-5}	3.2×10^{-4}	--	2.0×10^{-5}

[a]Outcrop activities will not occur during the first 4 years of reactor operation; see Table B-19 and Section F.2.10.

[b]Outcrop activities after 15 years of L-Reactor operation. Due to long transport times in ground water, strontium-90, cesium-134, cesium-137, and plutonium-239 do not reach outcrop in the 15-year period.

[c]Thirty percent of this tritium is expected to evaporate.

[d]Assumed to be strontium-90.

[e]Assumed to be plutonium-239.

4.5.2.1 Socioeconomics and land use

For the preferred alternative, an additional 550 temporary construction workers would be required for the earth moving and dam building necessary to construct the 1000-acre lake. This estimate is based on a comparison with similar projects and on the assumption that a normal construction schedule would be followed. Minor impacts to local communities and services could be expected from inmigrating workers; economic benefits are expected to be minor in comparison to those caused by the L-Reactor and the total SRP operating workforce.

The total economic benefit of the L-Reactor restart using the reference case is 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. The preferred cooling-water alternative case would increase these benefits in the short term during embankment construction.

The 1000-acre cooling lake would be entirely within the present SRP area boundaries. Land use within the SRP area would be altered, in that 1000 acres would be inundated to become a cooling lake and the previous land uses as forest land and bottom land would be interrupted. The 1000 acres would include 225 acres of wetlands in the Steel Creek Corridor and 775 acres of uplands. Timber of commercial value would be harvested and removed from the site in accordance with SRP Forest Management Program. An additional area (about 133 acres) would be cleared for road and utility access relocation.

The timber which would be harvested consists of pine saw timber, pine pulp wood, hardwood saw timber, and hardwood pulp wood. The timber value and annual growth are summarized in Table 4-62. The anticipated value from harvesting the timber is $950,000. The annual loss in timber productivity is projected to be $44,000. This impact is not amenable to mitigation.

Table 4-62. Timber value and annual growth

	Present volume/value			Annual growth	
Type of timber	Volume (1000 board feet)	Cords	Value ($1000)	Volume (%)	Value ($1000)
Pine, saw timber	5058	--	715	4	28
Pine, pulp wood	--	4326	102	8	12
Hardwood, saw timber	2550	--	128	3	4
Hardwood, pulp wood	--	3384	5	6	.3
Totals	--	--	950	--	44

4.5.2.2 Relocation of existing facilities

SCE&G would design and relocate its own transmission lines. The design and construction of the relocation of the SRP roads and transmission and control cable lines would be performed by the Du Pont Engineering Department. The U.S. Forest Service would administer all clearing for these relocations as well as clearing for the lake area.

4.5.2.3 Site preparation

Clearing

All areas upstream from the embankment and less than 58 meters above mean sea level would be cleared of second growth pine and hardwood to provide for the 1000-acre lake area. All marketable timber from this area and from the road and transmission corridors would be cut, removed, and sold under the supervision of the Forest Service. Timber and vegetation in any area flooded by Steel Creek waters since 1954 might contain low-level radioactivity and would not be marketable. Procedures for the removal and disposition of such material would be developed and approved before construction started. Underbrush and scrap, except from timber cutting outside the area flooded by Steel Creek since 1954 except around some of the shoreline area would be piled and burned. Stumps would be removed under all embankment areas but not from the area within the lake.

Foundation preparation

Areas to be covered by the embankment, inlet and outlet works, or roadways would be grubbed and stumps would be removed and burned. All topsoil would be stripped and stockpiled for use on the finished grade for turf establishment. It might be necessary to excavate unconsolidated sediments from the area under the dam to a depth of between 3 and 15 meters to expose a tight clay formation to which the embankment could be sealed. Approximately 600,000 cubic meters of unsuitable material could be removed from the embankment site before 1.2 million cubic meters of borrow fill and rip-rap would be placed to form the embankment. Spoil from the surface portion of the embankment foundation in the Steel Creek floodplain, estimated to contain a total of 0.2 curie of cesium-137 and 0.02 curie of cobalt-60, would be separated, contained, replaced outside the jurisdictional wetlands upstream of the embankment, and covered with subsurface spoil to prevent erosion during the construction period. This relocation would have no effect on net cesium transport estimates. All other material would be removed and used for backfill in the borrow areas.

Abandoned well survey and sealing

Research is currently underway to determine how many wells were constructed within the lake area before Government acquisition of the SRP property. All of these wells would be sealed before the lake begins filling to reduce the chance of affecting ground-water quality.

In March 1984, a survey team from the Furman University Department of Geology performed a field survey of this portion of the Steel Creek watershed. Twenty old possible well sites were identified in this area, 11 of which were found to lie within the boundaries of the 1000-acre lake. The sites vary from shallow open depressions to deep cased and screened wells. Several of these might be grave sites or archeological sites rather than wells.

Each site identified, as well as any others drilled or located during construction of the 1000-acre lake, would be sealed by filling from bottom to top with sand-cement or concrete in accordance with the South Carolina Primary Drinking Water Regulations, Section R 61-58.2 C (14), "Permanent Well and Test Hole Abandonment." All information relative to each site (e.g., exact plant coordinate location, depth, diameter) would be recorded and submitted to SCDHEC.

4.5.2.4 Embankment construction

The construction of the earthen embankment and water diversion system for the lake would cause some temporary increases in suspended solids in Steel Creek. Suitable precautions would be taken (1) during the construction operations necessary to establish a foundation for the embankment, and (2) during emplacement of the fill to ensure that undue silt and debris loads do not move downstream from the construction site. Turbidity screens could minimize impacts to downstream areas.

Borrow pits for similar quantities of suitable materials have been identified in the past for construction at the Savannah River Plant, and have been controlled in an environmentally acceptable manner. About 90 percent of the fill material for the embankment would probably come from a borrow pit that would be submerged when the lake is filled (Section L.2.4.7). A second potential borrow site would not be inundated. A small volume of material might be taken from this location, which would result in the loss of about 5 acres of upland habitat.

The number and routing of access roads for construction have been carefully considered to minimize adverse environmental impacts. An estimated 33 acres of upland habitat outside the area to be inundated would be altered by the construction of access roads. The reconstruction of existing roads would not result in the alteration of any uplands because they would utilize the existing roadbed. The rerouting of powerline and buried cable rights-of-way would cause the loss of an additional 100 acres of upland habitat.

Spoil piles of the size expected for this alternative have been developed for past construction activities at the Savannah River Plant and have met the necessary environmental control requirements. Spoil from any excavation in the former floodplain of Steel Creek would be monitored for radioactive materials; any spoil containing radioactivity would be disposed of as discussed in Section L.2.4.2.2.

4.5.2.5 Ecology

There would be two principal sources of potential impact to the ecology of the area: (1) the construction of the embankment and associated appurtenances, and (2) the inundation by the lake.

The filling of the cooling lake would inundate between 225 acres of wetlands and 775 acres of uplands in the Steel Creek corridor. The vegetation in this area consists primarily of forested (73 percent) and scrub-shrub (24 percent). The wetland areas are classified as Resource Category 2 by the U.S. Fish and Wildlife Service. This 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). TC

4.5.2.6 Water quality

The potential impacts to water quality from construction would be erosion and sedimentation; these potential impacts would be mitigated as described in Section 4.5.2.9.

4.5.2.7 Air quality and noise

About 400 to 550 acres of upland forest would be cleared. Trees of commercial value would be harvested and removed from the site in accordance with the SRP Forest Management Program. Open burning would be employed for disposal of forest slash cleared from the site. Clearing and burning would progress in reasonably sized units of a few acres to minimize local dust and smoke. The nearest roadways to the lake would be SRP Road B (less than 30 meters) and Highway 125 (1 kilometer). Traffic could be rerouted from Road B if necessary during the burning of slash material. Because of its distance from the construction site, Highway 125 would not be affected. Burning would result in some releases of particulates and gases into the atmosphere, but releases would be local and generally short-lived. Offsite effects are not expected since the nearest location to the SRP site boundary from the lake would be approximately 8 kilometers.

Not all the lake would be grubbed and burned. About 200 acres of lake bottom near the shoreline would be maintained with the stumps in place as habitat for aquatic organisms. Other burnable slash might also be used to construct submerged habitat attraction structures, thus reducing the need to burn all material at the site. Temporary construction roads, laydown areas, and spoil areas would be graded, grassed, wetted, or sprayed with tackifiers as needed to reduce local dust. As much as possible, the roads would be designed to become permanent access roads when the project was completed, thus reducing the impacts of temporary haul roads.

The cooling lake construction site is in a forest area that is relatively remote from human habitation. Noise from construction, primarily from tree-cutting and earth-moving equipment, would have insignificant offsite environmental effects because of the remoteness of the site and the muffling effect of intervening forests. Members of the public using SC Highway 125 would not be in the immediate vicinity of noisy equipment and would have only brief exposure. Effects of this exposure would be insignificant. Noise levels from lake-site construction in nearby L-Area, the nearest occupied onsite facility, are expected to be well within clearly acceptable standards (62 decibels). Operators of noisy construction equipment would wear protective equipment in accordance with Du Pont standards (where applicable) and OSHA regulations. Most other workers in the area would be exposed to high noise levels only intermittently, but protective equipment would be provided when the exposure could be expected to be sustained. No impulsive or impact noises in excess of acceptable standards would be expected.

4.5.2.8 Historic/archeological

Four historic sites and one prehistoric site in the Steel Creek terrace and floodplain system (Figure 3-3) have been determined to be eligible for inclusion in the National Register of Historic Places. No direct impacts are expected to the prehistoric site or to three of the historic sites because they would be below the embankment and outside the area affected by high-water flow conditions. One historic site area would be inundated when the lake was filled. These impacts would be mitigated as described in Section 4.5.2.9.

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 would be affected. As of May 7, 1984, two potentially significant sites had been identified. DOE is developing data recovery plans and continuing the consultation process with SHPO and ACHP. 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 would be completed prior to restart (Hanson, 1984). The study results, determination of the eligibility of potential sites, and the development of a mitigation plan are being coordinated with the SHPO and ACHP.

4.5.2.9 Construction impact mitigation

Historic/archeological site mitigation

A monitoring and mitigation plan has been developed to ensure the preservation of the resources at the four sites below the dam, and the plan has been approved by the South Carolina State Historic Preservation Officer (SHPO) (Du Pont, 1983).

A resource recovery plan has been developed by the University of South Carolina Institute of Archeology and Anthropology for the one historic site (38 BR 288) located within the proposed lake area. This mitigation plan has been approved by the SHPO and the Advisory Council on Historic Preservation (ACHP) (Lee, 1982), which concurred that this mitigation plan would result in no adverse impacts to National Register properties.

Ecological mitigation

The Department of Energy is working with the Department of the Interior to perform a Habitat Evaluation Procedure (HEP). The HEP will identify the value of habitat to be gained or lost with 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, dependent on Congressional authorization and appropriation.

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. Feeding occurs in the swamp away from the proposed lake; it could be affected by raised water levels of the Steel Creek delta if the L-Reactor cooling-water flow is discharged through the proposed lake. DOE initiated informal consultation with the Fish and Wildlife Service (FWS) in July 1983 and in March 1984 as required by Section 7 of the Endangered Species Act. DOE has also initiated the formal consultation process by providing a Biological Assessment to FWS for a Biological Opinion (Sires, 1984a). While DOE concludes that the operation of L-Reactor would affect foraging habitat near the Steel Creek delta, the construction activities associated with Phase II of the NPDES permit to control the acidity of releases from the 400-area powerhouse ash basins would improve the quality of the foraging habitat in the Beaver Dam Creek area, assuring the continued availability of this habitat. Therefore, the loss of foraging habitat in the Steel Creek area would not jeopardize the continued existence of the wood stork. Any additional mitigation measures needed would be determined either as part of the HEP study or as part of this consultation process.

Water-quality mitigation

The lake construction activity would include an Environmental Protection Plan, which would include several measures designed to mitigate water-quality impacts.

Earthwork brought to final grade would be protected as soon as practicable. All earthwork would be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas and waste material areas, these areas would not initially be cleared in total. Clearing of such areas would progress in reasonably sized increments as needed.

Such methods as necessary would be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

1. Retardation and control of runoff. Runoff from the construction site would be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses.

2. Sediment basins. Sediment from construction areas would be trapped in temporary or permanent sediment basins in accordance with design plans. The basins would accommodate the runoff of anticipated storms. After each storm the basins would be pumped dry and accumulated sediment would be removed as necessary to maintain basin effectiveness.

Overflow would be controlled by paved weir or by vertical overflow pipe, draining from the surface. The collected topsoil sediment would be reused for fill on the construction site, and/or conserved (stockpiled) for use elsewhere. Effluent quality monitoring programs would be required.

Temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching would be used until permanent drainage and erosion control facilities were complete and operative.

Borrow areas and spoil-storage areas would be managed to minimize erosion and to prevent sediment from entering nearby water courses or lakes. Temporary excavations and embankments for work areas would be controlled to protect adjacent areas from despoilment.

Solid wastes (excluding clearing debris) would be placed in containers which would be emptied on a regular schedule. All handling and disposal would be conducted to prevent contamination. Chemical waste would be stored in corrosion-resistant containers, removed from the work area, and disposed of in accordance with Federal, State and local regulations.

Construction activities would be kept under surveillance, management, and control to avoid pollution of surface and ground waters. The following special management techniques would be implemented to control water pollution: (1) wastewaters derived from construction activities would not be allowed to leave the site; these wastewaters would be collected in retention ponds where suspended material could be settled out or the water evaporated so pollutants would be separated from the water; (2) the operation would be planned to minimize adverse impacts of dewatering, removal of cofferdams, and excavation, and to limit the impact of water turbidity on the habitat for wildlife and impacts on water quality for downstream use; (3) stream crossings would be controlled during construction; crossings would provide for movement of materials or equipment which do not violate water pollution control standards of the Federal, State, or local government; (4) all water areas affected by construction activities would be monitored; (5) construction activities would be kept under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife.

<u>Air emissions and noise control</u>

The construction Environmental Protection Plan would also require measures to mitigate air emissions and noise. Construction activities would be kept under surveillance, management, and control to minimize pollution of air resources. All activities, equipment, processes, and work performed would be in strict accordance with applicable requirements.

The following special management techniques would be implemented to control air pollution by the construction activities:

1. Dust particles, aerosols, and gaseous byproducts from all construction activities, processing and preparation of materials would be controlled at all times, including weekends, holidays, and hours when work is not in progress.

2. Particulates that could cause the air pollution standards to be exceeded or that could cause a hazard or a nuisance would be controlled at all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries. Sprinkling, chemical treatment of an approved type, light bituminous treatment, or other methods would be utilized to control particulates in the work area. Sprinkling would be repeated at such intervals as to keep the disturbed area damp. Particulate control would be performed as the work proceeded and whenever a particulate nuisance or hazard occurred.

3. Hydrocarbons and carbon monoxide emissions from equipment would be controlled to Federal and State allowable limits at all times.

4. Odors would be controlled at all times for all construction activities, processing and preparation of materials.

5. Air at all areas affected by the construction activities would be monitored.

Construction activities would be kept under surveillance and control to minimize damage to the environment by noise. Methods and devices would be used to control noise emitted by equipment to the levels shown in the COE, Savannah District Safety Manual (COE, Savannah District, 1981a).

4.5.3 Nonradiological impacts due to normal L-Reactor operation

This section characterizes the expected nonradiological and radiological effects due to the normal operation of L-Reactor with the system of preferred mitigation alternatives. Nonradiological effects include those that might result from changes in land use, an increased workforce, the withdrawal and discharge of cooling water, the discharge of liquid and atmospheric chemical effluents, and the disposal of solid nonradioactive wastes. Radiological effects include those that might result from airborne and liquid radionuclide releases, the disposal of radioactive wastes, and the resuspension and transport of radiocesium and cobalt-60 in Steel Creek.

4.5.3.1 Land use and socioeconomics

The resumption of L-Reactor operation with the preferred alternatives is not expected to produce any additional land-use impacts. 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 workforce at the Savannah River Plant (Du Pont, 1982b). Essentially all the operating workforce for L-Reactor has been hired and resides in the SRP area; therefore, no additional impacts are expected to local communities and services due to in-migrating workers.

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 would 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 would 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 would help offset the small increase in demands for local services that it generates.

A supplement to the approved mitigation plan protecting the four historic and one prehistoric sites shown in Figure 3-3 will be developed by DOE and submitted to the SHPO and ACHP for approval. This supplement would protect new sites eligible for nomination to the National Register of Historic Places.

4.5.3.2 Surface-water usage

With the 1000-acre once-through cooling lake, L-Reactor operation would withdraw about 11 cubic meters of water per second from the Savannah River. This would be less than 4 percent of the average flow and 7 percent of the 7-day, 10-year low flow of 295 and 159 cubic meters per second, respectively. Because little L-Reactor cooling water would be consumed, essentially all water withdrawn from the river would be returned to the river after passing through the L-Reactor heat exchangers and the Steel Creek system. According to Neill and Babcock (1971), the estimated consumptive water use by L-Reactor is expected to be about 1.25 cubic meters per second.

Withdrawal of cooling water for L-Reactor operation would affect the aquatic ecology of the Savannah River by (1) the entrainment in the cooling water of aquatic organisms (predominantly fish eggs and larvae) smaller than the screen mesh in the intake system, and (2) the impingement of aquatic organisms (primarily fish) on the intake screens. The impacts due to entrainment are estimated to be 7.7×10^6 additional fish eggs and 11.9×10^6 additional fish larvae annually. The impingement impact is estimated to be 16 fish per day (Section 4.1.1.2).

4.5.3.3 Ground water

The withdrawal of ground water for L-Reactor would be about 0.94 cubic meter per minute. The ground-water withdrawal from the Tuscaloosa is projected to decrease when L-Reactor operation resumes (excluding incremental pumping in support of L-Reactor) compared to 1982 pumping; water levels are expected to rise as a new equilibrium piezometric surface is established at SRP and neighboring areas. At Jackson and Talatha, water levels are projected to increase by about 0.5 and 0.4 meter, respectively, if sitewide pumping decreases to 20.5 cubic meters per minute. However, pumping at L-Area would draw down the water in the Tuscaloosa locally, and thereby reduce the upward head difference between the Tuscaloosa and Congaree to about 1.4 meters beneath the L-Reactor seepage basin. The withdrawal of ground water from the Tuscaloosa will not affect water levels in overlying aquifers because of the thick Ellenton clay unit and the basal Congaree clay. Important clay layers, principally the green clay, beneath the L-Reactor seepage basin will tend to protect the Congaree and Tuscaloosa Aquifers; any contaminants that might reach these aquifers would flow beneath the SRP to the Savannah River in 76 to 250 years, respectively, and will not affect offsite ground-water users (Section 4.1.1.3).

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 about 18 years 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 confining unit separates 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.

Due to the sandy soil in the area of the natural saddle that would serve as the emergency spillway (Figure 4-44), some seepage could occur from the 1000-acre lake to Pen Branch. A cut-off wall would be constructed in this area if seepage is a problem.

4.5.3.4 Thermal discharge

Thermal discharge from the reactor would flow into the 1000-acre lake at temperatures of 73°C or less, depending on reactor power and river intake temperatures. Reactor power, in turn, would be established by lake temperatures and meteorological conditions. As noted in Section 4.5.1.2.2, L-Reactor would be operated at the highest allowable power level consistent with the maintenance of a balanced biological community, as specified in the NPDES permit expected to be issued by SCDHEC. Initially, L-Reactor would operate to maintain 32.2°C or less in about 50 percent of the lake. Isotherms calculated for summer conditions and an average reactor power level of 1080 megawatts are shown in Figure 4-47. Similar diagrams for the other seasons are presented in Appendix L. The expected composition of the balanced biological community is described in Appendix L.

Table 4-63 lists the estimated temperatures in Steel Creek below the lake's discharge structures for summer, spring, and winter. 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 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 and 9°C above historical 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.

Table 4-63. Temperatures (°C) downstream in Steel Creek below the 1000-acre lake

Location	Summer[a]	Spring[b]	Winter[b]
Discharge temperature[c]	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]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.

[b]Based on 30-year average values for meteorological conditions and actual power of an operating reactor.

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

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. Impacts on the American alligator, mallard, and wood duck are expected to be minimal. A delta growth rate of about 1 to 2 acres per year is anticipated.

Of the 4800 breeding pairs of wood storks sighted in the United States in 1980, approximately 100 pairs were observed at the Birdsville Rookery near Millen, Georgia. The Steel Creek delta area is one of the 50 foraging sites used by the wood stork; in 1983, 100 wood storks were observed feeding in the delta, which is an important foraging habitat (Meyers, 1984). Higher water levels at the delta could potentially make this area less desirable as a foraging habitat. The total elimination of the Steel Creek delta area as a foraging habitat for the wood stork would represent the displacement of food required for fledglings. As observed in 1983, when the delta area was not available for foraging, the wood storks moved to other available foraging habitats; 1983 was a successful year for the Birdsville Rookery wood storks. The Department is going through the consultation process with the U.S. Fish and Wildlife Service, as required by the Endangered Species Act (Sires, 1981). The biological opinion to be issued by the Fish and Wildlife Service will indicate the needed mitigation measures and should agree with DOE's conclusion that the operation of L-Reactor would not affect the continued existence of this species.

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.

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 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, because all but one of the species collected has been reported in thermal refugia (backwater or tributary stream areas) peripheral to reactor effluent streams on SRP, it is anticipated that the fish populations in upper Steel Creek would be capable of maintaining their present status in the 3- to 4-kilometer reach that would, when the reactor is operating, be isolated above the cooling lake. There would, however, undoubtedly be shifts in patterns of relative abundance. For example, the thermally tolerant mosquitofish would probably increase in abundance, and those species that prefer or can utilize lake habitats could thrive in the upper portions of the lake, where temperatures would be moderated by the inflow from Steel Creek.

4.5.3.5 Wastewater discharges

Liquid effluent discharges

With the preferred alternatives, liquid effluents to the Savannah River would have chemical characteristics similar to those of the river and would, therefore, produce no impacts.

Sanitary discharges

Sanitary wastewater would be chlorinated at a packaged treatment plant and discharged through the L-Area wastewater sewer to Steel Creek. The sanitary wastewater-treatment plant is designed for a maximum flow of 132 cubic meters per day. The treatment-plant size was selected to be adequate for the expected operating workforce. The discharge would meet NPDES permit (Du Pont, 1981a) requirements and would have not major impact on Steel Creek (Du Pont, 1982b). Sewage sludge would be transported to an existing basin near the Central Shops. Samples of sludge from similar treatment facilities indicate that it is not hazardous (Du Pont, 1982b).

Cooling-water reservoir (186-Basin)

The 95-million-liter cooling-water processing basin (186-Basin) would be cleaned annually during periods of reactor shutdown to remove accumulated solids. About 110 metric tons of the 5530 metric tons of suspended solids that would enter the 186-Basin annually would be deposited in the basin. This sediment would be flushed to Steel Creek over a period of several days. During flushing, the suspended solids concentrations in the effluent would be about 60 to 160 parts per million. This annual operation has been performed many times at the other reactors with no evidence of detrimental impact. Most of the suspended solids released from the 186-Basin would settle in the streambed before reaching the swamp (Kiser, 1977; Geisy and Briese, 1978; Du Pont, 1981a; Ruby et al., 1981). When L-Reactor discharges resume (at about 11 cubic meters per second), the resuspension of some of this settled sediment could contribute a small amount of material to the delta, which is expected to grow at a rate of about 1 to 2 acres per year with direct discharge.

During the flushing of the sediment from the basin, the concentrations of total suspended solids would be monitored and reported to SCDHEC in accordance with the NPDES permit.

4.5.3.6 Atmospheric releases

Nonradiological pollutants emitted into the atmosphere as a direct result of the operation of L-Reactor would come primarily from the K-Area coal-fired steam plant and the diesel generators at the L-Area. The steam demands for L-Reactor would require an additional 6400 metric tons of coal to be burned annually at the K-Area steam plant. Emissions of particulates, sulfur oxides, nitrogen oxides, carbon monoxide, and volatile organic compounds from the steam plant would increase 15 percent, as illustrated in Table 4-7.

Fourteen emergency diesel generators are located in L-Area; six would operate continuously. The estimated annual diesel fuel consumption rate would be 940 cubic meters for all generators. The emissions from these generators are listed in Table 4-7.

The operation of the L-Reactor would not violate any ambient air quality standard.

4.5.3.7 Solid wastes

Solid nonradioactive wastes generated by the resumption of L-Reactor operation would consist of trash and sanitary waste sludge. Trash would be generated at a rate comparable to those experienced by other SRP reactors; it would be disposed of in the SRP sanitary landfill. This landfill will be expanded from about 0.04 to 0.13 square kilometer. This expansion, which will occur in any event, ensures an adequate capacity for SRP operation, including L-Reactor, for many years (Du Pont, 1982b). Ten wells monitor the effluent from the landfill to the ground water of the McBean Formation. Quarterly analyses of water from these wells have shown little impact on the McBean ground water.

Periodically, treated sludge would be pumped from the sanitary waste treatment plant sludge holding tank to a mobile tank and transported to the sludge pit near the Central Shops area. Approximately 48,000 liters (50 percent water) of the sludge from L-Area would be disposed of in the sludge pit annually. No impact is expected on the operation of the sludge pit.

4.5.3.8 Noise

During the normal operation of L-Reactor with the preferred alternatives, any noise external to buildings would be associated primarily with the movement of motor vehicles; it would be undetectable at the nearest offsite residence, about 10 kilometers away.

4.5.4 Radiological impacts of normal L-Reactor operation

4.5.4.1 Atmospheric releases of radioactivity

Table 4-64 lists the atmospheric releases from L-Reactor operation with the reference case system. For the preferred alternatives, tritium, which otherwise would be discharged to Steel Creek from L-Reactor (directly or via a groundwater path from the L-Reactor seepage basin), would be released to the cooling lake. Evaporation and molecular exchange are expected to increase the releases to the atmosphere and thus, decrease liquid releases to the Savannah River. Tritium releases to the atmosphere are expected to increase by about 1 percent on the first year and about 3 percent in the tenth year in relation to those from the reference case, direct discharge.

Table 4-64. Expected annual atmospheric releases from L-Reactor operation[a] (curies per year)

Radionuclide	1st-year operation	10th-year operation
H-3[b]	5,540	56,500
C-14	12	12
Ar-41	19,500	19,500
Kr-85m	600	600
Kr-87	540	540
Kr-88	790	790
I-131	0.00414	0.00414
Xe-133	1,700	1,700
Xe-135	1,400	1,400
Unidentified beta-gamma[c]	0.0002	0.0002
Unidentified alpha[d]	0.000001	0.000001

[a]The expected annual average concentrations at the SRP site boundary would be well within the DOE concentration guides for uncontrolled areas (DOE, 1981b).

[b]Includes evaporative and molecular losses at ground level from the disassembly basin, the seepage basin, and the cooling lake.

[c]Assumed to be strontium-90.

[d]Assumed to be plutonium-239.

4.5.4.2 Wastewater discharges of radioactivity

Table 4-61 lists wastewater discharges of radioactivity for the reference case. For the preferred alternatives, tritium releases to the Savannah River are less (because the atmospheric releases cover more); they are expected to comprise about 85 percent of the values for the reference case.

4.5.4.3 Cesium-137 and cobalt-60 remobilization

Section 4.1.2.4 describes the estimated cesium-137 and cobalt-60 releases due to the remobilization of these materials in the Steel Creek channel and floodplain. Most of this radioactivity is cesium-137. It is conservatively estimated that the remobilization of cesium-137 and cobalt-60 would be no more than 4.4 ± 2.2 curies and 0.25 ± 0.13 curie, respectively.

4.5.4.4 Offsite dose commitments

The maximum individual and population dose commitments for the preferred alternatives are presented in Table 4-65. These doses are nearly identical to those of L-Reactor operation under the reference case (see Table 4-17). However, the tenth-year population doses within 80-kilometers are slightly higher and the population doses to downstream water users are slightly lower than those in Table 4-17, because of the greater vaporization of tritium from the 1000-acre lake surface.

Table 4-65. Summary of total-body dose commitments from the operation of L-Reactor (preferred alternatives)

Source of exposure	1st-year dose	10th-year dose
MAXIMUM INDIVIDUAL ADULT DOSE (millirem per year)		
Atmospheric release	0.052	0.22
Liquid releases	0.0066	0.072
Radiocesium and cobalt transport	3.5	0.31
Total	3.6	0.60

Source of exposure	Dose within 80 kilometers of SRP: 1st year	Dose within 80 kilometers of SRP: 10th year	Port Wentworth and Beaufort-Jasper dose: 1st year	Port Wentworth and Beaufort-Jasper dose: 10th year
REGIONAL POPULATION DOSE (person-rem per year)				
Atmospheric releases	3.0	13.9	--	--
Liquid releases	0.0087	0.017	0.66	10.8
Radiocesium and cobalt transport	9.0	0.80	0.80	0.067
Total	12.0	14.7	1.5	10.9

4.5.4.5 Health effects

For the preferred alternative, there would be a maximum of 0.001 and 0.002 excess cancer fatality in the population within 80 kilometers of the SRP from the first- and tenth-year operation, respectively, and 0.003 and 0.004 genetic disorder from the first- and tenth-year operation. Similarly, for the downstream Savannah River water-consuming populations at Port Wentworth and Beaufort-Jasper, either alternative is projected to result in a maximum of 0.0004 excess cancer fatality from the first year and 0.002 from the tenth year, and 0.004 genetic disorder from the first year and 0.003 from the tenth year.

A panel of experts, including representatives of the Centers for Disease Control and the South Carolina Department of Health and Environmental Control, is reviewing the results of ongoing health effects and epidemiological studies (see Section 6.1.5). DOE will conduct public hearings on the panel's findings and initiate any required epidemiological study as a result of this process. In addition, DOE will take appropriate mitigative actions on an implementation schedule that is mutually agreed on with the State, if further study indicates such actions are warranted (Memorandum of Understanding of April 27, 1983).

4.5.4.6 Occupational dose

Occupational doses would be the same for the preferred alternatives and the reference case; the doses are expected to be similar to those experienced in the past in P-, K-, and C-Areas, as listed on Table 4-66.

Table 4-66. Total doses to workers in P-, K-, and C-Areas

Year	Dose (person-rem)
1976	217.2
1977	231.2
1978	202.0
1979	184.4
1980	203.7
Average	207.7
Average per reactor-year	69.2

4.5.4.7 Solid radioactive waste

Low-level solid radioactive waste (about 570 cubic meters annually) would be generated by either the reference case or the preferred alternatives. These wastes would be buried in the SRP low-level waste burial ground. Offsite radiological effects of these operations would be negligible.

4.5.5 Accidents

4.5.5.1 Reactor accidents

The two types of reactor accidents of primary concern at SRP are a release of fission products or other radionuclides from irradiated reactor fuel and targets, and a release of activation tritium from the reactor moderator. The release of fission products is most likely to occur due to fuel or target melting, which might result from either power surges or cooling-system failures.

The release of activation tritium from the reactor heavy water is most likely to occur from spills or pipe breaks.

The principal hazard of these accidents is that the released radionuclides become airborne and are carried either to the onsite plant worker or to the offsite population. Radionuclides can also be dispersed by the reactor liquid effluent streams, but the hazards of such dispersal are several orders of magnitude lower than those of airborne dispersal in an accident situation.

Because the principal hazards are derived from possible airborne releases and because the existing confinement system is both the reference case and the preferred alternative safety system, therefore, the potential effects of reactor accidents will be the same for both cases. To provide a perspective on the overall accident risk of L-Reactor operation, Figure 4-49 shows the annual probability of an individual living at the SRP site boundary receiving more than a certain dose from postulated accidents. Additional details are provided in Section 4.2 and Appendix G.

4.5.5.2 Non-nuclear hazards and natural phenomena

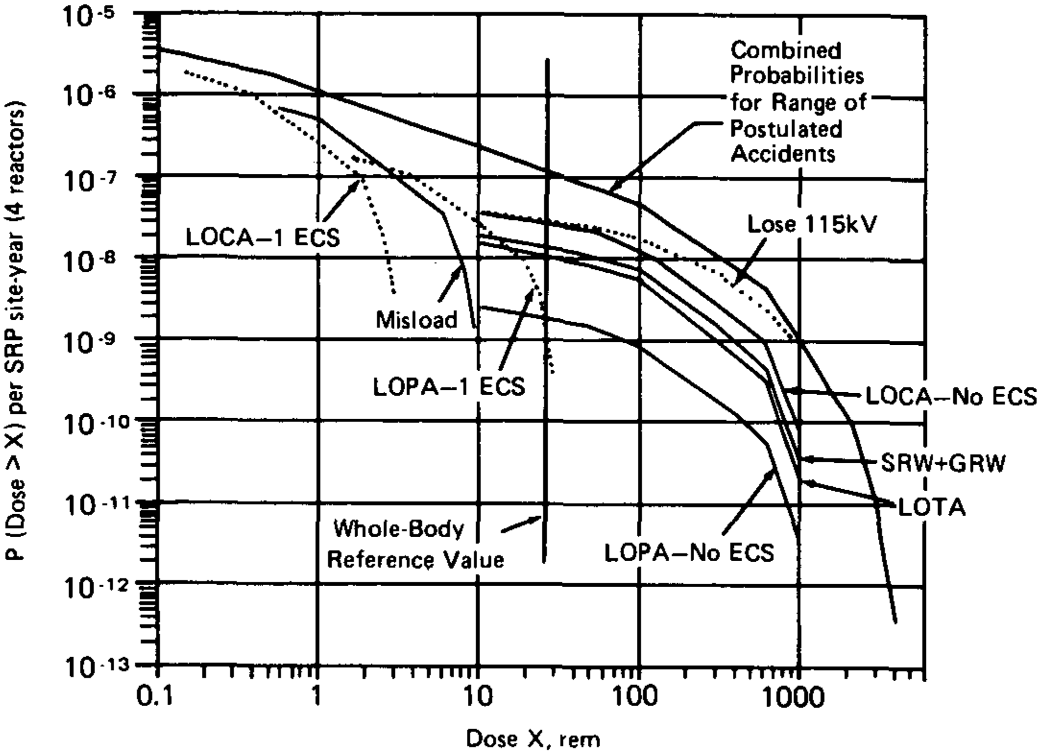
Risks associated with (1) toxic-gas release, (2) fire, (3) earthquakes, (4) tornados and hurricanes, and (5) floods are considered in relation to the reference case (in Section 4.2.2); in all instances the risks are small both in terms of technical assessment and judgment and in terms of experience.

The preferred alternatives include a 1000-acre lake behind an embankment; there would be, therefore, the very small risk of dam failure due to non-nuclear hazards and natural phenomena.

The probability of an embankment failure is extremely low. As indicated in Section L.2.3.2, a conservative approach to earthquake design has been used. Similarly, the embankment, outlet works, and emergency spillway are 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 would be 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 would be 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



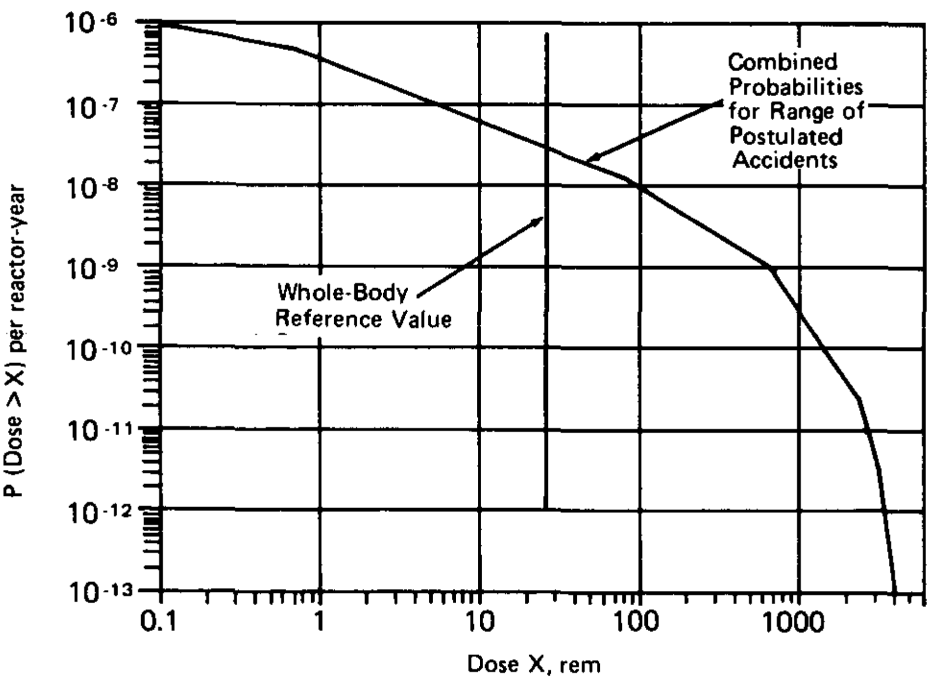


Figure 4-49. Total probability (P) per SRP site-year (upper) and reactor year (lower) that the whole body dose to a person on the plant boundary will exceed a specified value, X rem .

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 broke and scattered 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.

4.6 NO-ACTION ALTERNATIVE

This section describes the expected nonradiological and radiological effects due to maintaining L-Reactor in a ready-for-operation standby mode. Nonradiological effects include those that might result from a decreased work force, the periodic withdrawal and discharge of water for hydraulic testing and flushing of the secondary cooling system, the discharge of liquid and atmospheric effluents, and the disposal of solid nonradioactive wastes. Radiological effects include those that might result from the resuspension and transport of radiocesium in Steel Creek as a result of the periodic hydraulic testing and flushing of the secondary cooling system.

Maintaining L-Reactor in a standby mode would have no direct land-use impacts. A work force of only about 100 would be required to maintain L-Reactor, thus necessitating the loss of approximately 300 jobs.

The four historic sites and one prehistoric site in the Steel Creek terrace and floodplain system that are eligible for inclusion in the National Register of Historic Places have shown erosion effects from high-water flow conditions during periodic hydraulic testing and flushing of the secondary cooling system. Phase 2 of the Archeological Mitigation Plan is being implemented to protect these sites. TC

Direct expenditures on materials and services to maintain L-Reactor in a standby mode ($10-12 million) would be less than the expenditures for operating of L-Reactor. Contributions to the local economy would also be less than those from L-Reactor operation.

The secondary cooling system, a once-through cooling-water system, would be hydraulically tested and flushed approximately 1 day per month; flow rates as high as 6.2 cubic meters per second would be experienced. During hydraulic testing, about 6.2 cubic meters per second of water would be withdrawn from the

Savannah River, about 2 percent of the average river flow and 4 percent of the 7-day, 10-year low flow of 295 and 159 cubic meters per second, respectively. Essentially all of the water withdrawn from the river would be returned to the river after passing through the secondary cooling system and the Steel Creek system.

Based on the results of 1982 and 1983 studies and predicted L-Reactor water withdrawal rates during periodic testing and flushing of the secondary cooling system, fewer than 1.2×10^5 fish eggs and 2.0×10^5 fish larvae would be entrained during the spawning season and an additional 9 fish would be impinged per day of testing and flushing.

Two deep wells in L-Area would continue to provide a total of 0.94 cubic meter per minute from the Tuscaloosa Formation; however, there would be no pumping at other facilities in support of L-Reactor. The total drawdown near the center of the cone of depression is estimated to be about 4.3 meters. The upward head differential between the Tuscaloosa and Congaree Formations in L-Area is about 3.7 meters. Thus, near the center of the cone of depression, the head differential would be approximately 0.6 meter downward. The withdrawal of ground water from the Tuscaloosa aquifer in L-Area would not be expected to affect the quality of the ground water.

TC

No liquid thermal effluents would be discharged from L-Area into the Steel Creek system. There would be no thermal impact on the Savannah River; however, during periodic hydraulic testing and flushing of the secondary cooling system, water would be discharged to the Steel Creek system at the ambient river water temperature at approximately 6.1 cubic meters per second. Flooding and minor amounts of siltation associated with the discharge would be expected to temporarily modify the aquatic habitat in the Steel Creek floodplain and delta. These discharges would also temporarily eliminate the feeding habitat for the wood stork and other waterfowl that have been observed in the Steel Creek delta.

The nonthermal liquid effluent from L-Area would have chemical compositions that are similar to those from other SRP reactor areas. Some of the chemicals discharged to Steel Creek would originate from the Savannah River during the periodic hydraulic testing and flushing of the secondary cooling system. Sanitary waste water would be chlorinated at a package treatment plant and discharged through the L-Reactor sewer to Steel Creek. No impacts on the water quality of the swamp or the Savannah River would be expected.

The L-Area cooling-water basin (186-Basin) would be cleaned annually to remove accumulated solids. This sediment would be flushed to Steel Creek over a period of several days, and would settle in the streambed before reaching the swamp. A variance on total suspended solids from the NPDES permit might be required for this activity.

Nonradiological pollutants would be emitted from the K-Area coal-fired steam plant (used to supply L-Area with steam) and the L-Area diesel generators.

Solid nonradioactive wastes would consist of trash and sanitary sewage sludge. Trash would be disposed of in the SRP sanitary landfill, which is operated in accordance with guidelines of the South Carolina Department of Health and Environmental Control. Sewage sludge would be disposed in an existing sludge basin near the Central Shops.

Technological improvements would be incorporated into the L-Reactor concurrently with similar improvements made for the other SRP reactors.

The periodic hydraulic testing and flushing of the secondary cooling system would resuspend and transport only a very small amount of the radiocesium and radiocobalt presently in the Steel Creek system to the Savannah River and the swamp. The resulting maximum individual dose per day of testing/flushing would be approximately 0.003 millirem, the dose per day of testing/flushing to the regional population within 80 kilometers of Savannah River Plant would be 0.008 person-rem, and the dose to the the water consumers in the Port Wentworth, Georgia, and Beaufort-Jasper Counties, South Carolina, areas would be 0.0007 person-rem per day of testing/flushing of the secondary cooling-water system.

4.7 DECONTAMINATION AND DECOMMISSIONING

Whether it is restarted or not, L-Reactor will ultimately be subject to decontamination and decommissioning. The decontamination and decommissioning plan adopted will be subject to environmental and public review before implementation. The options listed below are based on the following studies:

1. NRC Program Status Paper (Calkins, 1980)
2. The decommissioning description for the Defense Waste Processing Facility (DOE, 1981a)
3. The Decommissioning Handbook (Manion and LaGuardia, 1976)
4. The decommissioning plan for the 100-F production reactor at Hanford (DOE, 1979)
5. The shutdown plan used for L-Area in 1968

Three basic decommissioning options are defined according to the NRC Program Status Paper (Calkins, 1980). These options are DECON, SAFSTOR, and ENTOMB. Depending on the results of the later NEPA review, L-Area decommissioning is expected to follow the SAFSTOR option.

DECON is defined as the immediate removal of all radioactive materials to levels that are considered acceptable to permit the property to be released for unrestricted use (NRC, 1981). This option uses a chemical decontamination of the structure and the internals. Decontamination is followed by dismantlement, transportation, and burial of the internals. In a final step, the outer structure is demolished, and the site is restored to its precommissioning status.

ENTOMB is the encasement of the facility in a material possessing long-lived structural integrity until such a time when the dose level is amenable to unrestricted use. This option is intended for sites where the radioactivity will decrease the acceptable limits within a reasonable time period. A reasonable time period for ENTOMB is approximately 100 years (NRC, 1981).

SAFSTOR involves placing a facility in temporary storage within acceptable risk levels for subsequent decontamination and unrestricted facility use. The SAFSTOR option is divided into six major phases:

1. Chemical decontamination
2. Mechanical decontamination and fixing of residual radioactivity
3. Equipment deactivation
4. Preparation for interim care
5. Interim care (surveillance and maintenance)
6. Final dismantlement

Chemical decontamination involves rinsing, chemical cleaning, and flushing of internal surfaces of process lines, vessels, and equipment. External surfaces or process equipment, lines, and structures are sprayed remotely with a series of chemical solutions or steam.

Next, all equipment and systems not needed during this interim-care period are deactivated. Typical activities include final draining of process lines, closing or opening valves depending upon the function, blanking flanges, and disconnecting utilities. Cooling-water systems for diesels are drained and fuel oil is removed from tanks.

During preparation for the interim-care period, security locks are installed on all exterior doors and on doors leading to highly contaminated areas. Intrusion alarms, fire detection systems, radiation monitoring equipment, and ventilation systems are inspected to assure safety during the interim-care period.

During interim care, the facility and the total site are kept inaccessible to the public and unavailable for other than nuclear use. Surveillance, maintenance, certain operations such as ventilation, and security activities are conducted to assure safe confinement of the radioactivity. Scheduled programs of periodic inspections and monitoring are continued.

Final dismantlement begins with a planning phase. The equipment that is necessary for dismantlement but was previously made inoperable is activated and refurbished as necessary. The other phases of final dismantlement are removal of contaminated equipment, mechanical decontamination of structures, demolition of structures, and restoration of the site.

Removal of contaminated equipment involves disconnecting and cutting where necessary for volume reduction; packaging, loading, and transporting the equipment to a waste disposal facility; and final disposal. A remote operational capability is added to accomplish equipment removal where high radiation levels prohibit contact operations.

In the demolition and restoration phase, all above-grade portions of the plant structures are demolished by conventional methods, such as explosive and impact balls. The site is then graded and revegetated.

The impacts from decontamination and decommissioning are very small. Projections of these impacts specific to L-Reactor have not been made; estimates, however, have been made (Marion and LaGuardia, 1976) for the decontamination and decommissioning of commercial power reactors of the PWR design. The estimated population dose for the DECON option was 3.0×10^{-5} millirem per year (lung) during the period of the decontamination and decommissioning operation. Both the ENTOMB and the SAFSTOR were projected to result in an even lower dose.

The decommissioning of currently operating facilities receiving hazardous and radioactive mixed wastes will be discussed in a separate NEPA review of the "SRP Groundwater Protection Implementation Plan" (see Section F.6). DA-3

In the case of the preferred cooling-water alternative, the 1000-acre lake would be left intact as a balanced biological community after the decommissioning of L-Reactor. TC

4.8 SAFEGUARDS AND SECURITY

Safeguards considerations for L-Reactor include physical security and materials control and accountability. The principal requirements are contained in the following DOE orders:

1. DOE Order 5630.1, "Control and Accountability of Nuclear Materials." This order provides guidance in the development of material control and accountability systems for special nuclear material and other designated materials.

2. DOE Order 5630.2, "Control and Accountability of Nuclear Materials, Basic Principles." This order provides specific requirements for the control and accountability of nuclear materials.

3. DOE Order 5632.1, "Physical Protection of Classified Matter." This order prescribes DOE policies and objectives for the physical protection of classified security interests.

4. DOE Order 5632.2, "Physical Protection of Special Nuclear Materials." This order establishes minimum physical protection standards for special nuclear materials.

Access to the site is controlled at primary roads by permanently manned barricades. Other roads are closed to travel by gates or other barriers. The site, except along the Savannah River, is fenced. The entire site is posted against trespass under State of South Carolina and Federal statutes. The operating areas are separately fenced; the fence is continuously patrolled by armed security personnel. Primary responses to safeguards and security incidents are from area patrol personnel who are engaged in roving patrols and/or access control activities. Inter-area security personnel are supplemented by armed responders from other SRP facilities. Responders are equipped with sidearms, shotguns, and automatic weapons. Armored vehicles are assigned to each area and are used in response. Onsite security forces are provided backup by off-duty security personnel and Federal, state, and county law enforcement agencies.

Materials control and accountability procedures are applied to special nuclear materials, such as: enriched uranium, plutonium-239, neptunium, tritium, and deuterium. Stringent controls are used throughout the manufacturing, storage, and shipment cycles to protect against unauthorized diversions of these materials. Proven measurement and analytical procedures and equipment are used as part of the materials control and accountability system at Savannah River Plant.

L-Area is defined as a material balance area; it is, in turn, divided into material balance sections (e.g., reactor section, disassembly section). Similar material balance areas have been established at the other SRP facilities that will handle the special nuclear materials to support resumed L-Reactor operation. Within each material balance area or section, the accountable materials are kept separate, and identifiable material quantities that enter or leave the area are accurately determined; responsibility for the material is assigned to one individual.

REFERENCES

ADL (Arthur D. Little, Inc.), 1983. SRP Cogeneration Study, Arthur D. Little, Inc., Reference 89669, September 30, 1983.

AEC (U.S. Atomic Energy Commission), 1972. Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238.

Alberts, J. J., L. J. Tilly, and T. J. Vigerstadt, 1979. "Seasonal Cycling of Cesium-137 in a Reservoir," Science, Volume 203, pp. 649-651.

ANSP (Academy of Natural Sciences of Philadelphia), 1953. Savannah River Biological Survey, South Carolina and Georgia, June 1951-May 1952, Final Report.

ANSP (Academy of Natural Sciences of Philadelphia), 1957. Savannah River Biological Survey, South Carolina and Georgia, August-September 1955, May 1956, Progress Report.

ANSP (Academy of Natural Sciences of Philadelphia), 1961. Savannah River Biological Survey, South Carolina and Georgia, May-June and August-September 1960.

ANSP (Academy of Natural Sciences of Philadelphia), 1967. Savannah River Biological Survey, South Carolina and Georgia, May-June and September 1965.

ANSP (Academy of Natural Sciences of Philadelphia), 1970. Savannah River Biological Survey, South Carolina and Georgia, May and August 1968.

ANSP (Academy of Natural Sciences of Philadelphia), 1977. Savannah River Biological Survey, South Carolina and Georgia, August 1976.

Ashley, C., and C. C. Zeigler, 1981. Environmental Monitoring at the Savannah River Plant, Annual Report - 1978, DPSPU-80-302, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina. AW-1, DA-8

Ashley, C., C. C. Zeigler, and P. A. Culp, 1982. Releases of Radioactivity at the Savannah River Plant, 1954 Through 1980, DPSPU 81-25-1, E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina. EN-44

Buckner, M. R., D. W. Hayes, and J. R. Watts, 1975. Emergency Response Capability for Pollutant Releases to Streams and Rivers, DP-MS-75-73, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Calkins, G. D., 1980. Thoughts on Regulations Changes for Decommissioning, draft, Rev. 2, USNRC Report NUREG-0590, Office of Standards and Development, Washington, D.C.

Carlson, D. C., A. J. Garrett, D. D. Gay, C. E. Murphy, and J. E. Pinder III, 1982. "Comparison of Simulated to Actual Plutonium Deposition at the Savannah River Plant," Proceedings of Fourth International Conference on

Precipitation Scavenging, Dry Deposition and Resuspension, Santa Monica, California, sponsored by American Nuclear Society.

Cherry, D. S., R. K. Gathrie, J. H. Rogers, Jr., J. Carins, Jr., and K. L. Dickson, 1976. "Response of Mosquitofish (Gambusia affinis) to Ash Effluent and Thermal Stress," Transactions of the American Fisheries Society, Volume 105(6), pp. 686-694.

Church, J. P., 1983. Risk Estimates for SRP Production Reactor Operation, DPST-83-717, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Clarke, R. K., et al., 1976. Severities of Transportation Accidents, SLA-74-0001, Sandia National Laboratories, Albuquerque, New Mexico.

COE (U.S. Army Corps of Engineers), 1952a. Geologic Engineering Investigations, Savannah River Plant, Waterways Experiment Station, Vicksburg, Mississippi.

COE (U.S. Army Corps of Engineers), 1952b. Foundation Grouting Operation, Savannah River Plant, Waterways Experiment Station, Vicksburg, Mississippi.

CRC Press, 1972. Handbook of Environmental Control; Volume I, Air Pollution, pp. 328-340; T.B. 174.B65.

DOE (U.S. Department of Energy), 1979. Surplus Facilities Management Program-Plans for Decommissioning of Department of Energy Radioactively Contaminated Surplus Facilities, Report RLO/SFM-79-4, prepared by Rockwell International for the Office of Nuclear Waste Management, Washington, D.C.

DOE (U.S. Department of Energy), 1981a. Final Environmental Impact Statement-Defense Waste Reprocessing Facility - Savannah River Plant, Aiken, S.C., Report DOE/EIS-0082D, Office of Nuclear Waste Management and Fuel Cycle Programs, Washington, D.C.

DOE (U.S. Department of Energy), 1981b. Environmental Protection, Safety, and Health Protection Program for DOE Operations, DOE 5480.1a.1, Washington, D.C.

Du Pont (E. I. du Pont de Nemours and Company), 1968. Earthquake Criteria for the Savannah River Plant, DPE-2383, Wilmington, Delaware.

Du Pont (E. I. du Pont de Nemours and Company), 1980. Preliminary Safety Analysis, Defense Waste Processing Facility, DPST-80-250, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1981a. Savannah River Plant NPDES Permit Applications for System Permit Number SC0000175, compiled for the U.S. Department of Energy, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1981b. Environmental Monitoring in the Vicinity of the Savannah River Plant--Annual Report for 1980, DPSPU-81-30-1, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1982a. Update of Seismic Design Criteria for the Savannah River Plant, Vols. 1 and 2, DPE-3699, Wilmington, Delaware.

Du Pont (E. I. du Pont de Nemours and Company), 1982b. Environmental Information Document, L-Reactor Reactivation, DPST-81-241, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1982c. Environmental Monitoring in the Vicinity of Savannah River Plant--Annual Report for 1981, DPSU-82-30-1, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983a. Safety Analysis of Savannah River Production Reactor Operation, DPSTSA-100-1, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983b. Environmental Information Document, L-Reactor Reactivation, Supplement Number 1, DPST-83-470, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983c. Environmental Monitoring in the Vicinity of the Savannah River Plant--Annual Report for 1982, DPSPU-82-30-1, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983d. Thermal Impact of Different Cooling Options on the SRP Site, DPST-83-1070, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983e. Support Calculations for L-Reactor Cooling Water Study, DPST-83-1077, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983f. Alternative Cooling Water Systems for L-Reactor, DPST-83-1076, Savannah River Laboratory, Aiken, South Carolina.

Du Pont (E. I. du Pont de Nemours and Company), 1983g. Letter from J. E. Walls/E. T. Powers to F. J. McCrosson, October 12, 1983.

Du Pont (E. I. du Pont de Nemours and Company), 1983h. Technical Summary of Groundwater Quality Protection at the Savannah River Plant, Volume I, "Site Geohydrology--Solid and Hazardous Waste" (draft) and Volume II, "Radioactive Waste," G. J. Christensen (ed.), DPST-83-829, Savannah River Laboratory, Aiken, South Carolina. AW-1

Durant, W. S., et al., 1966. Activity Confinement System of the Savannah River Plant Reactors, DP-1071, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Durant, W. S., and R. J. Brown, 1970. Analysis of Postulated Core Meltdown of an SRP Reactor - Final Report, DPST-70-433, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

ECS (Environmental and Chemical Sciences, Inc.), 1983a. Final Report on the Preliminary Biological Measurement Program in the Savannah River, March 1 through August 31, 1982, Report No. ECS-SR-2 to E. I. du Pont de Nemours and Company, DPST-83-439, Savannah River Plant, Aiken, South Carolina.

ECS (Environmental and Chemical Sciences, Inc.), 1983b. Interim Report on the Adult Fisheries Study in the Savannah River October 1982 and January 1983, Volume 2, Report ECS-SR-4, E. I. du Pont de Nemours and Company, DPST-83-738, Savannah River Plant, Aiken, South Carolina.

AY-7 ECS (Environmental and Chemical Sciences, Inc.), 1983c. Final Report on the Preliminary Biological Measurement Program in the Savannah River, 1 March through 31 August 1982, Report No. ECS-SR-3 to E. I. du Pont de Nemours and Company, DPST-83-736, Savannah River Plant, Aiken, South Carolina.

EPA (U.S. Environmental Protection Agency) Office of Programs, 1976. Final Environmental Statement, Environmental Radiation Protection Requirements for Normal Operation of Activities in the Uranium Fuel Cycle, 40 CFR 190, EPA 52014-76-016.

Falke, J. D., and M. H. Smith, 1974. "Effects of Thermal Effluents on Fat Content of Mosquitofish," in J. W. Gibbons and R. R. Sharitz (eds.), Thermal Ecology, AEC Symposium Series (CONF-730505), pp. 100-108.

Ferens, J. C., and T. M. Murphy, 1974. "Effects of Thermal Effluents on Regulations of Mosquitofish," in J. W. Gibbons and R. R. Sharitz (eds.), Thermal Ecology, AEC Symposium Series (CONF-730505), pp. 237-247.

Garrett, A. J., 1981. "Comparison of Observed Mixed-Layer Depths to Model Estimates Using Observed Temperatures and WINDS, and MOS Forecasts," J. Appl. Meteor. 20, 1277.

Garrett, A. J., M. R. Buckner, and R. A. Muller, 1983. "The Weather Information and Display Emergency Response System," Nuclear Technology 60, 50.

Geisy, J. P., and L. A. Briese, 1978. "Trace Metal Transport by Particulates and Organic Carbon in Two South Carolina Streams," Veh. Internat. Verein. Limnology, Volume 20.

Georgia Power Company, 1982. Studies of Postulated Millett Fault, report submitted to the U.S. NRC, Docket Nos. 50-424 and 50-425, Construction Permit Nos. CPPR-108 and CPPR-109, Vogtle Electric Generating Plant.

Geotechnical Engineers, Inc., 1979. Evaluation of Dynamic Soil Properties and Liquefaction Potential, Building-221-H, Savannah River Plant, Aiken, South Carolina, unpublished report.

Gibbons, J. W., and R. R. Sharitz, 1974. "Thermal Alteration of Aquatic Ecosystems," American Scientist, Volume 62, pp. 660-670.

Gladden, J. B., 1979. Radiocesium Exchange Among Components of a Coastal Plain Bottomland Stream Ecosystem, Ph.D. dissertation, Emory University, Atlanta, Georgia, 191 pp.

Hayes, D. W., 1981. Data Report Summarizing Water Quality and Cs-137 Transport in Steel Creek During a P-Area Discharge in November 1980, DPST-81-482, Savannah River Laboratory, Aiken, South Carolina.

Hayes, D. W., 1983. Cs-137 Transport in Steel Creek, DPST-83-671, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Hayes, D. W., and J. R. Watts, 1983. Co-60 Transport from Steel Creek as a Result of L-Reactor Restart, DPST-83-673, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Jarriel, J. L., and J. B. Price, 1979. Energy Recovery with Hydraulic Turbines, DPST-79-509, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Kantelo, M. V., and R. C. Milham, 1983. Cesium-137 and Cobalt-60 Concentrations in Water from the Savannah River and Water Treatment Plants Downstream of SRP, DPST-83-693, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Kiser, D. L., 1977. "Modeling of Sediment Transport in Reactor Effluent Streams," in T. V. Crawford (compiler), Savannah River Laboratory Environmental Transport and Effects Research, DP-1455, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Langley, T. M., and W. L. Marter, 1973. The Savannah River Plant Site, DP-1323, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Lee, C. E., 1982. Determination of No Adverse Effect on Five Archaeological Sites Along Steel Creek, Savannah River Plant, Barnwell County, South Carolina, letter to R. L. Morgan, U.S. Department of Energy, Manager, Savannah River Plant (May 21, 1982). TC

List, J. A., 1969. Seismic Resistance of the Savannah River Reactors, DPST-69-566, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Manion, W. J., and T. S. LaGuardia, 1976. An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternative, Atomic Industrial Forum, AIF/NESP-009, -009SR.

Marine, I. W., 1965. "Tank Farm Hydrology Program," memorandum to C. A. Konwinski, Chief, Projects Engineering Branch, U.S. Department of Energy, Savannah River Operations Office, dated June 1, 1965. AW-1, DA-8

Marine, I. W., and K. R. Routt, 1975. "A Ground Water Model of the Tuscaloosa Aquifer at the Savannah River Plant," Paper 14 in T. V. Crawford (compiler), Savannah River Laboratory Environmental Transport and Effects Research Annual Report, 1974, USERDA Report DP-1374, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Marshall, S. J., and J. H. Leroy, 1971. "Iron, Manganese, Cobalt and Zinc Cycles in a South Carolina Reservoir," in Nelson, D. J. (ed.), Radionuclides in Ecosystems, ERDA Symposium Series, pp. 465-473.

TC Marter, W. L., 1970. Savannah River Water Quality Studies, 1965-1969, DPST-70-445, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Matthews, R. A., 1982. Biological Surveys on the Savannah River in the Vicinity of the Savannah River Plant (1951-1976), DP-1531, Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina.

McFarlane, R. W., 1976. "Fish Diversity in Adjacent Ambient, Thermal, and Post Thermal Fresh-water Streams," in G. W. Esch and R. W. McFarlane (eds.), Thermal Ecology II, ERDA Symposium Series 40 (CONF-750425), pp. 268-271.

McFarlane, R. W., 1982. The Occurrence of American Shad Eggs in the 1G Cooling Water Canal, DPST-82-969, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

McFarlane, R. W., R. F. Frietsche, and R. D. Miracle, 1978. Impingement and Entrainment of Fishes at the Savannah River Plant, DP-1494, Savannah River Laboratory, Aiken, South Carolina.

TC Meyers, J. M., 1984. Wood Storks of the Birdsville Colony and Swamps of the Savannah River Plant, SREL-15, UC-66e, Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina.

Murphy, T. M., 1981. The Population Status of the American Alligator on the Savannah River Plant, South Carolina, SRO-NERP-4, U.S. Department of Energy, Savannah River Plant, Aiken, South Carolina.

EL-2 Neill, J. S., and D. F. Babcock, 1971. The Dissipation of Reactor Heat at the Savannah River Plant, DP-1274, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Nomm, E., and H. P. Olson, 1977. Reliability of Improved Discharge Machine Cooling System, DPST-77-498, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

NRC (U.S. Nuclear Regulatory Commission), 1977a. Final Environmental Statement on the Transportation of Radioactive Materials by Air and Other Modes, NUREG-0170.

NRC (U.S. Nuclear Regulatory Commission), 1977b. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Regulatory Guide 1.109, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), 1979. Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants, Regulatory Guide 1.145, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), 1981. Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, USNRC Report NUREG-0586, Office of Standards and Development, Washington, D.C.

Oravetz, C. A., 1983. Letter dated November 1, 1983, to M. J. Sires, Assistant Manager for Health, Safety and Environment, U.S. Department of Energy, Savannah River Plant, from C. A. Oravetz, Chief, Protected Species Branch, United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (F/SER 23:AM:cf). TC

Pendergast, M. M., 1982a. A Computer Code to Assess Dose from Accidental Pollutant Releases, DP-1646, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Pendergast, M. M., 1982b. Effect of Averaging Time on X/Q and Recommendation on 120-Hour Dose, DPST-82-767, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Price, J. B., 1980. Use of Cooling Ponds and Hydraulic Turbines to Save SRP Energy Consumption, DPST-79-531.

Reinhold, T. A., and B. Ellingwood, 1982. Tornado Damage Risk Assessment, NUREG/CR-2944, BNL-NUREG-515-86, Center for Building Technology, National Bureau of Standards, prepared for the Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C.

Root, R. W., Jr., 1983. Numerical Modeling of Ground-Water Flow at the Savannah River Plant, DP-1638, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina. AW-1, DA-8

Ruby, C. H., P. J. Rinehart, and C. L. Reel, 1981. Sedimentation and Erosion Trends of the Savannah River Plant Reactor Discharge Creeks, Research and Planning Institute Report RPI/R/81/7/24-22.

Rulifson, R. A., M. T. Huish, and R. W. Thoesen, 1982. Anadromous Fish in the Southeastern United States and Recommendations for Development of a Management Plan, U.S. Fish and Wildlife Service, Fisheries Resources, Region 4, Atlanta, Georgia.

Rutledge, P. C., 1976. Danger of Soil Liquefaction Caused by Earthquakes at the Savannah River Plant, DPE-3465, E. I. du Pont de Nemours and Company, Wilmington, Delaware.

Sharitz, R. R., J. E. Irwin, and E. J. Christy, 1974. "Vegetation of Swamps Receiving Reactor Effluents," Oikos, Volume 25, pages 7-13. TC

Shure, D. J., and M. R. Gottschalk, 1976. "Cesium-137 Dynamics Within a Reactor Effluent Stream in South Carolina," in Radioecology and Energy Resources, CONF-750503, Dowden, Hutchinson, and Ross, Inc., pp. 234-241.

Siple, G. E., 1967. Geology and Ground Water of the Savannah River Plant and Vicinity, South Carolina, U.S. Geological Survey, Water-Supply Paper 1841, U.S. Government Printing Office, Washington, D.C.

TC Sires, M. J., 1983. Letter dated October 26, 1983 to Warren T. Parker, Field Supervisor, Endangered Species Field Office, U.S. Fish and Wildlife Service from M. J. Sires, Assistant Manager for Health, Safety and Environment, U.S. Department of Energy, Savannah River Plant (NAB 00341).

Sires, M. J., 1984. Biological Assessment for the Wood Stork and Operation of the Savannah River Plant, letter to James W. Pulliam, Jr., Regional Director, U.S. Fish and Wildlife Service, March 29, 1984.

Smith, M. H., R. R. Sharitz, and J. B. Gladden, 1981. An Evaluation of the Steel Creek Ecosystem in Relation to the Proposed Restart of the L-Reactor, SREL-9, Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina.

Smith, M. H., R. R. Sharitz, and J. B. Gladden, 1982. An Evaluation of the Steel Creek Ecosystem in Relation to the Restart of the L-Reactor: Interim Report, SREL-11, Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina.

Tilly, L. J., 1974. "Changes in Water Chemistry and Primary Productivity of a Reactor Cooling Reservoir (Par Pond)," in Howell, F. G., et al. (eds.), Mineral Cycling in Southern Ecosystems, ERDA Symposium Series, CONF-740513, pp. 394-407.

Tudor Engineering Co. (J. Williams), 1980. Report on the Savannah River Plant Hydroelectric Project, prepared for E. I. du Pont de Nemours and Company.

Twisdale, L. A., and W. L. Dunn, 1981. Tornado Missile Simulation and Design Methodology, Volumes 1 and 2, EPRI Report NP-2005, Electric Power Research Institute, Palo Alto, California.

URS/JAB (URS/John A. Blume & Associates, Engineers), 1982a. Modification for Seismic Upgrading of the Exhaust Stack and Actuator Tower of Building 105-L, Savannah River Plant, Report URS/JAB 8127, San Francisco, California.

URS/JAB (URS/John A. Blume & Associates, Engineers) 1982b. Seismic Evaluation by Comparative Analysis of the Confinement Heat Removal Process Water and Modified Cross-Tie Header Piping Systems in the Reactor Building 105-L, Savannah River Plant, Report URS/JAB 8147-01, San Francisco, California.

URS/JAB (URS/John A. Blume & Associates, Engineers), 1982c. Alternative Analysis Criteria for the Seismic Qualification of the Supplementary Safety System in Reactor Building 105-L, Savannah River Plant, Report URS/JAB 8147-02, San Francisco, California.

FK-6 USDOI (U.S. Department of the Interior), 1981. "U.S. Fish and Wildlife Service Mitigation Policy; Notice of Final Policy," Federal Register, Volume 46, Number 15:7644-7663.

USDOI (U.S. Department of the Interior), 1983. "Endangered and Threatened Wildlife and Plants," 50 CFR 17.11 and 17.12.

Ward, D. A., et al., 1980. Extended Service Life of Savannah River Plant Reactors, DPST-80-539, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Yau, W. W. F., and C. W. Zeh, 1976. Tornadic Resistance of 105-Building Disassembly Areas, DPST-76-461, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

5 INCREMENTAL AND CUMULATIVE IMPACTS FROM L-REACTOR OPERATION

5.1 INCREMENTAL IMPACTS FROM L-REACTOR SUPPORT FACILITIES

The resumption of L-Reactor operation would increase the number of operating reactors at the Savannah River Plant (SRP) from three to four. It would also increase effluents and emissions from fabrication (M-Area) and chemical processing (F- and H-Areas) support facilities at SRP by about 33 percent. Actual incremental increases might be less, depending on reactor operating schedules and the number of shifts required to support L-Reactor operation. Other SRP facilities that will be affected by L-Reactor operation include the waste management operations and an onsite steam-generating station in K-Area. This section describes the incremental environmental impacts from the SRP support facilities that would result from the resumption of L-Reactor operation under direct discharge of cooling effluent to Steel Creek (the reference case) and the preferred cooling-water alternative described in Section 4.4.2 and in detail in Appendix L. TC

5.1.1 <u>Nonradiological impacts</u>

The nonradiological impacts from the SRP support facilities associated with the extra support effort due to L-Reactor operation will be fourfold: (1) an increase in the workforce, (2) an increase in water discharges to surface streams and seepage basins, (3) an increase in atmospheric pollutants, and (4) an increase in water usage. These nonradiological impacts are treated individually in Sections 5.1.1.1 through 5.1.1.4.

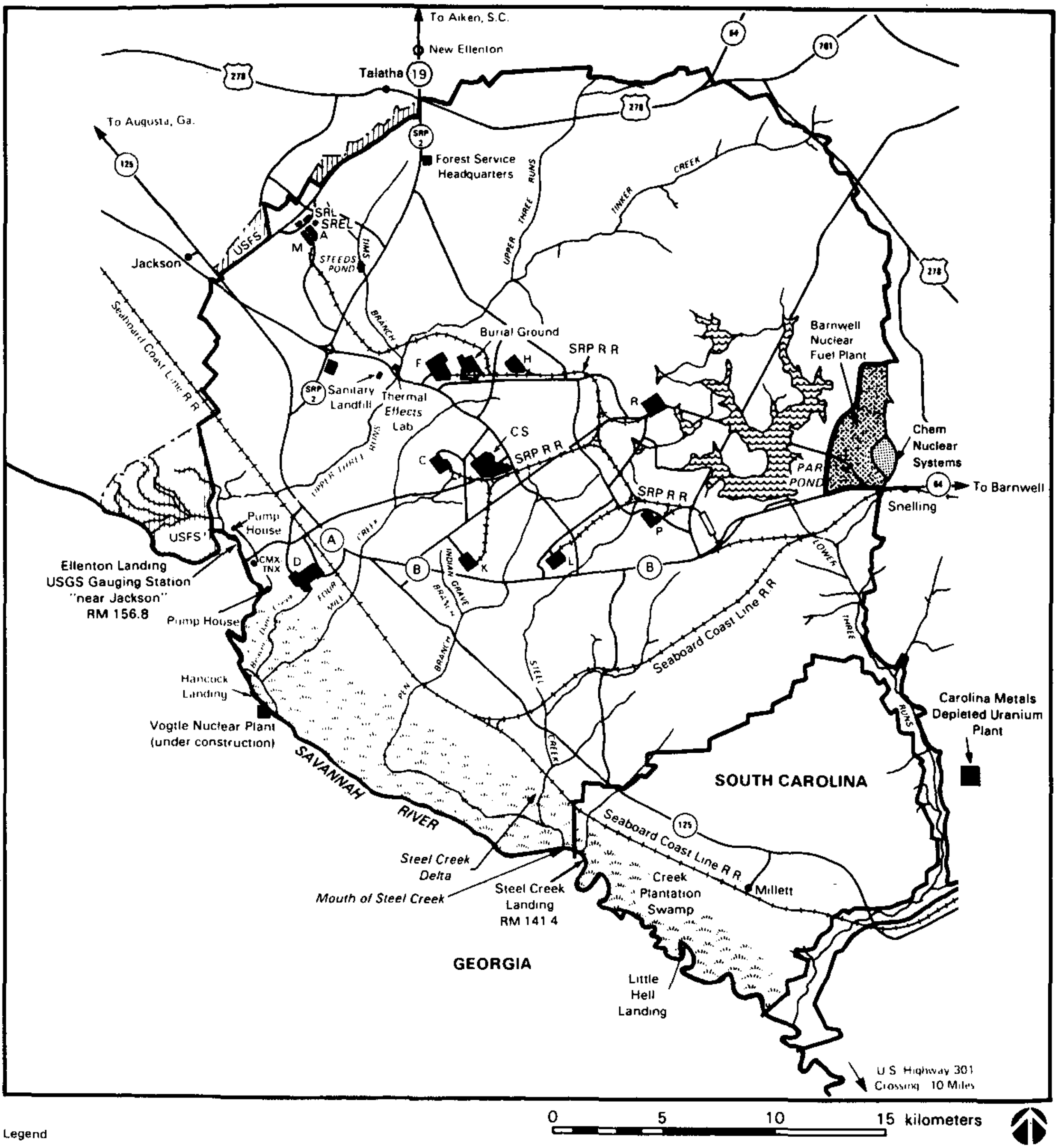
5.1.1.1 Socioeconomics

Approximately 160 employees are expected to be hired by 1984 for existing SRP facilities in support of the resumption of L-Reactor operation. About half have already been hired. Because the number of additional employees to be hired is less than 1 percent of the SRP labor force, and because the inmoving population associated with the potential 80 additional employees is less than 0.05 percent of the indigenous population in the six-county area, no impacts on local communities or services is expected.

5.1.1.2 Effluent discharge

<u>Discharge to seepage basins</u>

<u>Separations Areas</u>--SRP has discharged large volumes of liquids containing nonradioactive chemicals and low levels of radioactivity to the seepage basins in F- and H- (Separations) Areas (Figure 5-1) since 1954 and 1955, respectively. These discharges consist essentially of evaporator condensate from a number of different waste streams, all generated in operations involving radioactive materials. Some of the components in the wastewaters, including mercury,



Legend

C, K, R, L, P	Reactor Areas (C, P, K are operating)
F, H	Separations Areas
M	Fuel and Target Fabrication
D	Heavy Water Production
A	Savannah River Laboratory and Administration Area
CS	Central Shop
RM	River Mile

Road A = Highway 125

Figure 5-1. Savannah River Plant site.

chromium, and nitrate, have been retained in the seepage-basin soils; some have also entered the shallow ground-water system and are migrating through the saturated soil to outcrop zones, principally to wetland areas near Four Mile Creek (Du Pont, 1983c; Fenimore and Horton, 1972; Horton, 1974; Marter, 1977; Appendix F). In intensive ground-water monitoring studies of nitrate levels conducted in 1968 and 1969 at F- and H-Areas, nitrate concentrations ranged from 3 to 300 milligrams per liter (compared to background concentrations of 3 milligrams per liter in natural ground water).

The present discharges to the F-and H-Area seepage basins are not hazardous (under RCRA) except for frequent periods of low pH and infrequent discharges of hazardous levels of mercury and chromium. The mercury levels are associated with the processing of onsite reactor products and radioactive waste management activities; the chromium levels are associated with the processing of offsite fuels, radioactive waste management, and the removal of oxide from onsite target elements. The incremental increases to the F- and H-Area seepage basins from the operation of L-Reactor are not expected to be hazardous except for low pH and occasional discharges of mercury (H-Area only).

Most of the 435 and 1760 kilograms of mercury released to the F- and H-Area seepage basins, respectively, through 1982 has accumulated in the basin soils. Measurements in 1971 indicated that mercury discharged from seepline springs to Four Mile Creek at a rate of 0.36 gram per day; less than 0.1 percent of the DA-5 mercury inventory is believed to have migrated to the creek. The ground-water downgradient from these seepage basins shows mercury concentrations 100 times higher than background levels. Recent quarterly monitoring indicates mean concentrations as listed in Table 5-1 (see tabulated monitoring results in Section F.5.3).

From 1981 through early 1983, about 740 kilograms of chromium were discharged to the H-Area basin. Chromium concentrations in downgradient wells are 1.4 to 2.8 times background levels; in some cases, these exceed drinking-water standards. Large quantities of nitrate and sodium have also been released to these basins. Recent quarterly ground-water monitoring from wells around the F- and H-Area seepage basins indicates mean concentrations of chromium, nitrate, and sodium, as listed in Table 5-1.

The pH of the ground water near the F- and H-Area seepage basins ranges from about 3 to 6 for downgradient wells compared to a range of 5 to 7 for upgradient wells in the area. Appendix F contains additional ground-water monitoring results for the Separations Areas.

The chemical separations of product and waste from the irradiated L-Reactor fuel and target assemblies will result in additional effluent discharges to the seepage basins. During 1982, the average discharge rates were 0.24 and 0.30 cubic meters per minute to F- and H-Area basins, respectively. Because of changes in operating practices, principally by recycling as much as 80 percent of the acid and base drain header flow and rerouting laundry effluent, dis- DA-5 charges to the basins in the Separations Areas have been reduced to 0.13 cubic meter per minute to the F-Area basins and 0.28 cubic meter per minute to the H-Area basins. Projected incremental discharges to these basins in support of L-Reactor operation will be approximately 0.04 and 0.09 cubic meter per minute, respectively. The continued use of these seepage basins is being evaluated on a

Table 5-1. Mean concentrations in F- and H-Area seepage basin monitoring wells (milligrams per liter)

Constituent	Area	Upgradient wells	Downgradient wells[a]	Predicted increase for L-Reactor operation[b]
Mercury	F	0.0002	0.022	0.002
	H	0.0002	0.017	0.001
Chromium	F	0.030	0.041	0.00[c]
	H	0.018	0.051	0.00[c]
Nitrite (as nitrogen)	F	2.0	214.0	15.0
	H	1.4	46.0	3.2
Sodium	F	11.3	141.0	10.0
	H	3.6	60.0	4.2

[a]Average quarterly measurements (see Tables F-13 and F-14) in downgradient well showing greatest constituent concentration.

DA-5 [b]The maximum increase in concentration predicted as the L-Reactor increment is 7 percent; it is stated here in terms of the concentration tabulated for the downgradient well.

[c]The incremental release of chromium from the operation of L-Reactor is calculated to be 0.2 kilogram per year to the H-Area basins only; it is not expected to cause a measurable increase of the concentrations in the conterminous plume.

sitewide basis (see Sections 6.1.6 and F.6). Contingent on Congressional authorization and approval of a FY 1986 funding request, DOE plans to operate an effluent-treatment facility by October 1988 to process the wastewater being discharged to these basins.

Based on past experience, about 8.5 kilograms per year of mercury, about 0.2 kilogram per year of chromium, and larger quantities of other chemicals, listed in Table 5-2, are expected to be discharged to seepage basins in the Separations Areas due to the operation of L-Reactor (ERDA, 1977; Horton and Carothers, 1975).

The reduction of flow rates to the seepage basins is expected to reduce the amount of nitric acid (nitrate ion) released to the basins. In addition, the amount of mercury released to the basins has decreased since the early and mid-1970s. Before 1972, approximately 7.9 and 9.4 kilograms of mercury were released per reactor to the F- and H-Area basins, respectively (Du Pont, 1983c). From the mid-1970s to 1982, the average contribution per reactor has been about 0.7 and 2.1 kilograms, respectively. Incremental releases of mercury from L-Reactor to these basins are expected to be 0.5 and 8.0 kilograms per year, respectively (Table 5-2). The addition of a second evaporator to process radioactive waste in the H-Area waste tanks has caused an increase in the amount of mercury added to the H-Area seepage basins.

Table 5-2. Estimated incremental nonradioactive releases to seepage basins, the separations areas, and the fuel/target fabrication area

Cation/anion	F-Area seepage basins (kg/year)	H-Area seepage basins (kg/year)	M-Area seepage basin (kg/year)
Ammonium	16	8	--
Calcium	110	620	--
Magnesium	50	220	--
Sodium	630	6,880	26,500
Iron	310	190	20
Copper	10	40	3
Aluminum	40	570	9,400
Lead	40	160	0.5
Zinc	100	400	--
Carbonate	0	3,270	--
Chlorine	30	570	260
Nitrite	5	90	50
Nitrate	15,450	34,390	86,400
Sulfate	510	1,530	275
Phosphate	30	4,280	21,700
Chromium	--	0.2	--
Mercury	0.5	8.0	--
Nickel	--	--	8,100
Fluorine	--	--	--
1,1,1 trichloroethane	--	--	6

TC

In 1975 approximately 2310 kilograms of chromium were discharged from the Receiving Basin for Offsite Fuels (RBOF) to the H-Area seepage basins (ERDA, 1977); an additional 120 kilograms were discharged to the F-Area basins. From 1981 through early 1983, the discharge rate to the F-Area seepage basins was essentially zero; it was about 295 kilograms per year to the H-Area basins. The operation of L-Reactor is expected to increase the amount of chromium released to the seepage basins in the Separations Area by only 0.2 kilogram per year. Since mid-1982, newly generated chromium waste from the RBOF facility has been processed through a waste evaporator, which greatly lowers the amount of chromium released to the H-Area seepage basins. Almost all the chromium released to these basins since 1982 has come from processing of radioactive waste produced before 1982. After being processed by the waste evaporator, the concentrated fractions are sent to the high-level radioactive waste storage tanks for processing by the Defense Waste Processing Facility. DA-5

Public health and safety will be assured at F- and H-Areas and at the SRP Burial Ground. Section F.6 describes planned remedial actions. A potential intermediate-term problem exists from the use of these facilities, including the increment in support of L-Reactor operation. Contaminants discharged from the seepage basins and the seepage from the burial ground will flow to seepline springs, principally in wetland areas along Four Mile Creek. The radioactive constituents will meet DOE criteria for releases to uncontrolled areas when Four

Mile Creek flows into the Savannah River. The direction of ground-water flow and the ground-water islands make it unlikely that any contaminated shallow ground water will reach offsite users. None of the incremental releases from the support of L-Reactor is expected to reach the Congaree Formation. Beneath the central portion of SRP, the flow directions in the Congaree and Tuscaloosa Formations are toward the Savannah River along paths that remain beneath SRP (see Figures F-25 and F-26). These formations discharge to the alluvium in the DA-5 Savannah River valley. Onsite personnel will be protected by the extensive monitoring program. Monitoring of Congaree and Tuscaloosa wells in the central part of the SRP shows no evidence of contamination (Marine, 1965; Ashley and Zeigler, 1981). Based on water samples obtained (in 1965 and in February 1984) for tritium analysis from the Congaree Formation adjacent to the H-Area seepage basins [well 35-D (Figure F-34)], the green clay has protected the Congaree ground water effectively from contamination that enters the shallow ground-water system from the H-Area basins.

The discharges to the F- and H-Area seepage basins will not affect the heads in the Congaree and Tuscaloosa Formations, and pumping from the Tuscaloosa Aquifer will not affect the heads in the Congaree and overlying formations. The green clay at the base of the McBean Formation will prevent releases to these seepage basins from increasing the head in the Congaree. In addition, the clays in the upper Ellenton Formation and at the base of the Congaree Formation are effective sitewide confining units (see Table F-1); they limit the hydraulic connection between the Tuscaloosa and overlying Congaree Formations. For example, Tuscaloosa cones of depression at A-Area wells are not reflected in water levels in the overlying Tertiary sediments. At F- and H-Areas seepage basins, the changes in water-table elevations are expected to be local and small. Thus, the upward head differential between the Tuscaloosa and the Congaree will not be effected by discharges to the F- and H-Area seepage basins.

As noted above, the green clay is also an important barrier to the downward migration of contaminants from the seepage basin to lower hydrostratigraphic units. In the Separations Areas, the green clay (about 2 meters thick) supports a head difference of about 24 meters between the McBean and Congaree Forma-
DA-8 tions. Water samples obtained for tritium analysis from the Congaree near the H-Area seepage basin (well 35-D; see Figure F-34) in 1965 (Marine, 1965) and February 1984 indicate that the green clay has effectively protected the Congaree ground water from contamination seeping into the ground in the Separations Area. At the Par Pond pumphouse well (Figure F-13), the green clay also supports a large head difference and the water pumped from the Congaree Formation shows no evidence of tritium contamination, even though tritium concentrations in the pond were measured at 27,000 picocuries per liter. Water pumped from the Congaree by the pumphouse well exhibited tritium concentrations of 170 picocuries per liter or less, compared to concentrations of 260 $\pm$ 60 picocuries per liter in offsite well water (Ashley and Zeigler, 1981).

Calculations indicate that incremental nonradioactive releases to seepage basins in the Separations Areas in support of L-Reactor operation will increase the concentrations in the ground-water contaminant plume by about 7 percent. Table 5-1 lists the expected incremental changes calculated for the downgradient monitoring wells exhibiting maximum concentrations of mercury, chromium, nitrate (reported as nitrogen), and sodium. These incremental impacts to the ground water are small.

Contaminants that might enter the shallow ground water from the seepage basins in F- and H-Areas are expected to follow a ground-water path to Four Mile Creek and be discharged along seepline springs to the creek (Du Pont, 1983c; Root, 1983). As a result, concentrations of chloride, nitrate, sulfate, sodium, and calcium are higher in Four Mile Creek upstream from the C-Reactor cooling-water discharge than in Upper Three Runs Creek, but are similar to those in the Savannah River (DOE, 1982a). Tritium and nonvolatile beta activity are also elevated in this stretch of Four Mile Creek (Ashley and Zeigler, 1981); however, they do not exceed DOE concentration guidelines for uncontrolled areas. The expected incremental impacts to the water quality of Four Mile Creek above the C-Reactor outfall due to L-Reactor operation will be small (Table 5-3). The concentrations of pollutants entering Four Mile Creek, when mixed with creek water, are expected to be within drinking-water standards; the water quality of Four Mile Creek below the C-Reactor outfall will remain similar to that of the Savannah River. Tritium and other radionuclides in Four Mile Creek will not exceed DOE concentration guidelines for uncontrolled areas.

Incremental releases caused by L-Reactor operation from the Separations Area seepage basins to Four Mile Creek are expected to have only minor impacts on the ecosystem of the upper reaches of the creek. As listed in Table 5-3, nutrient levels are expected to increase and to result in an increase in the populations of primary producers forming the base of the food web. This will exert some stress on the depauperate fauna found in the creek above the C-Reactor outfall. The depauperate condition of the fauna in this area of the creek might be related to thermal isolation caused by C-Reactor and shading of the overstory (Du Pont, 1981a; McFarlane, 1976). DA-8

The water quality of the Savannah River is expected to meet the criteria for a Class B waterway below Four Mile Creek when the pollutants that enter the river from the F- and H-Area seepage basins are mixed with river water (see Ashley and Zeigler, 1981). The water quality below the SRP is not expected to be adversely affected by SRP effluent discharges (see Table 4-6 and Marter, 1970). Radiological dose commitments from releases seeping from F- and H-Area basins are discussed in Section 5.1.2 and Appendix B. DOE will be conducting studies for the eventual phasing-out of these seepage basins (Section F.6).

In summary, the projected L-Reactor incremental releases to the Separations Areas seepage basins will be 0.04 cubic meter per minute to the F-Area basins and 0.09 cubic meter per minute to the H-Area basins. The chemicals in these releases are expected to increase the concentrations of constituents in the contaminant plume by about 7 percent. The water quality of Four Mile Creek will be degraded as the ground water flows into the creek through seepline springs in low-lying wetland areas. Concentrations of constituents in the creek water will be increased by about 7 percent from F- and H-Area seepage-basin releases to the creek. The average quality of the creek water is expected to be similar to that of the Savannah River above the outfall for C-Reactor, except for pH and nitrate and nitrite solutions.

Fuel and Target Fabrication Area--Waste effluents from production operations in the Fuel and Target Fabrication (M-) Area, shown in Figure 5-1, have been discharged to process sewers since startup in 1952. A seepage basin was put in service in 1958 to settle out and contain uranium discharges from fuel-element production operations. At present very little wastewater seeps from the basin. Instead, most of the water overflows the basin and enters the ground at DA-4, FE-12

Table 5-3. Water quality of the Savannah River and Four Mile Creek above the C-Reactor outfall, and predicted L-Reactor incremental changes in concentrations in Four Mile Creek resulting from incremental discharges to the Separations Area seepage basins

Parameter	Units	Water quality drinking-water standard[a]	Savannah River 1982 average[b]	Four Mile Creek average[c] 1982	1983	Incremental increase at Four Mile Creek
pH	None	6.5 - 8.5 (S)	6.2 - 7.0	6.2 - 7.4	7.2 - 5.8	-0.5
Dissolved oxygen (DO)	mg/liter	>4 (WQS)	9.4	8.8	8.3	NC[d]
Total susp. solids (TSS)	mg/liter	<50 (WQS)	10.0	3.0	4.8	NC
Conductivity	µmohs/cm	--[e]	+[f]	+	7.1	10.0
Chemical oxygen demand (COD)	mg/liter	--	+	7.4	8.7	0.6
Ammonia-N	mg/liter	--	0.2	0.003	<0.02	0.004
Chloride (Cl)	mg/liter	<250 (S)	6.1	4.1	3.4	0.4
Alkalinity ($CaCo_3$)	mg/liter	--	+	9.5	10.0	1.3
Sulfite/sulfate (S)	mg/liter	<250 (S)	7.6	7.5	6.5	1.0
Nitrite/nitrate (N)	mg/liter	<10 (P)	0.52	2.7	1.8	0.4
Total phosphate (PO_4)-P	mg/liter	--	0.19	0.02	0.06	0.008

DA-8

Table 5-3. Water quality of the Savannah River and Four Mile Creek above the C-Reactor outfall, and predicted L-Reactor incremental changes in concentrations in Four Mile Creek resulting from incremental discharges to the Separations Area seepage basins (continued)

Parameter	Units	Water quality drinking-water standard[a]	Savannah River 1982 average[b]	Four Mile Creek average[c] 1982	Four Mile Creek average[c] 1983	Incremental increase at Four Mile Creek
Calcium (Ca)	mg/liter	--	3.8	2.8	+	0.4
Sodium (Na)	mg/liter	--	10.0	9.5	5.6	1.3
Aluminum (Al)	mg/liter	--	1.3	0.9	0.2	0.1
Total iron (Fe)	mg/liter	<0.3 (S)	0.58	0.38	0.83	0.1
Magnesium (Mg)	mg/liter	--	+	+	0.7	0.1
Manganese (Mn)	mg/liter	<0.05 (S)	+	+	0.14	0.02
Chromium (Cr)	mg/liter	<0.05 (P)	+	+	<0.08	0.01
Zinc (Zn)	mg/liter	<5.0 (S)	+	+	<0.02	0.002

DA-8

[a](P) = 40 CFR Part 141; (S) = 40 CFR Part 143; (WQS) = Water-quality standards--Federal Register, Part V, Vol. 45, No. 231, 28 November 1980.

[b]3.6 kilometers above SRP (Du Pont, 1983c).

[c]Water samples obtained at Road A-7, about 5.5 kilometers downstream from the Separations Area.

[d]NC = Little or no change expected.

[e]-- = No standard.

[f]+ = No data.

Lost Lake (see Figure F-35). The waste effluents have included large volumes of volatile organic compounds used as metal degreasing agents. Some of these solvents have evaporated; however, substantial quantities have seeped into the ground from effluent sewer leaks, the seepage basin, overflow to Lost Lake, and other miscellaneous spill sites. This seepage has entered the shallow ground-water system within the Tertiary Coastal Plain sediments. Ground-water samples taken near the seepage basin have exhibited concentrations of organic degreasers no longer used at SRP as high as 220 milligrams per liter in the water-table aquifer. In the Tuscaloosa Formation, concentrations as high as 27 micrograms per liter have been measured in ground-water samples. However, this contamination appears, on the basis of well surveys and contaminant monitoring results (Section F.5.4), to have resulted from the migration of organic degreasers in the Tertiary sediments down the annuli of wells with defective cement grout between the sediment and the well casings (Geraghty and Miller, 1983; Steele, 1983). Approximately 160,000 kilograms of organic degreasers are believed to have entered the ground in M-Area (more details are provided in Appendix F; Du Pont 1982c, 1983c; Geraghty and Miller, 1983; Steele, 1983). However, the discharge of volatile organic compounds in process wastewaters from M-Area operations has been reduced appreciably by recent changes in operating practices.

Effluent discharged to the M-Area seepage basin frequently meets the definition of hazardous waste because of pH. Typically, the waste stream contains 1,1,1-trichloroethane, but not at levels considered to be hazardous (J. D. Spencer letter to G. A. Smithwick dated May 13, 1983). The pH in the upgradient wells (see Table F-15) ranged from 4.5 to 10.6 during recent quarterly monitoring. At the M-Area seepage basin, there are three distinct pH plumes (Du Pont, DA-4, 1982c). The pH lobe that appears to originate at the basin and move in the FE-12 direction of the water-table ground-water flow has a pH range from 9.8 to 11.8. In the ground water beneath the process sewer and the seep area at Lost Lake and between the basin and Lost Lake, the pH ranges between 5.0 and 6.0.

Recent quarterly ground-water monitoring from wells encompassing the M-Area seepage basin and Lost Lake indicate the mean chromium, nitrate, and sodium concentrations listed in Table 5-4.

Currently (February 1984), about 0.48 cubic meter per minute of process and nonprocess effluent is being discharged to the M-Area seepage basin, which overflows to Lost Lake, a nearby Carolina bay. The incremental release associated with L-Reactor is estimated to be 33 percent of the flow rate to the basin (about 0.16 cubic meter per minute at present). Changes in operational practices have reduced the amount of rinse water used in the fabrication of fuel and targets, principally by repiping and rearranging existing rinse tanks and using counter-current and stagnant rinse techniques rather than once-through rinses; these practices are expected to reduce the amount of wastewater discharged to the basin to about 0.05 cubic meter per minute by the end of 1984. The incremental discharge from M-Area that would support the operation of L-Reactor includes approximately 6 kilograms per year of a chlorinated degreasing solvent (1,1,1-trichloroethane) and quantities of other chemicals listed in Table 5-2.

In A- and M-Areas, public health and safety will be protected by the extensive SRP monitoring program and by plume management and remedial action strategies. The sewer line to Tims Branch from M-Area no longer receives process wastewater and the line to the M-Area basin is being repaired. When monitoring first confirmed the presence of chlorinated hydrocarbons in water from A-Area

Table 5-4. Mean concentrations in M-Area seepage basin and Lost Lake monitoring wells (milligrams per liter)

Constituent	Upgradient wells	Downgradient wells[a]	Maximum increase predicted for L-Reactor operation[b]
Chromium	0.016	0.58	0.04
Nitrite (as nitrogen)	2.5	54.7	3.8
Sodium	11.4	86.9	6.1

[a]Average quarterly measurements (see Tables F-13 and F-14) in downgradient well showing greatest constituent concentration.

[b]The maximum increase in concentration predicted as the L-Reactor increment is 8 percent; it is stated here in terms of the concentration tabulated for the downgradient well.

Tuscaloosa wells (Appendix F), the contaminated wells were shut down to protect onsite personnel. Monitoring in A-Area, M-Area, and neighboring municipal water wells has shown that the contaminants have not migrated offsite and that no offsite health risk will exist in the foreseeable future. Contaminants that might reach the Tuscaloosa Formation will be discharged to the alluvium in the Savannah River valley (Section F.2.3.2; Du Pont, 1983c). After they become diluted along the travel path (Figure F-26), these contaminants could be intercepted by some SRP production wells. State and Federal agencies are reviewing plans for impeding the growth of the contaminant plume and the removal of the chlorinated hydrocarbons using recovery wells, and a large air stripper. In addition, the health of onsite personnel will be protected by changes in the water distribution system, which will obtain potable water only from the A-Area Tuscaloosa wells that are unlikely to receive contamination from Tertiary aquifers.

DA-4, FE-12

The high concentrations of chlorinated hydrocarbons found in the A- and M-Area shallow (Tertiary) ground-water system are being removed by both a pilot and a prototype air-stripper unit with capacities of 0.075 and 0.18 cubic meter per day, respectively. These demonstration projects will be phased out as the A- and M-Area ground-water remedial action project (Steele, 1983) is being implemented in August 1984. This project will consist of nine 200-foot-deep interceptor/recovery (I/R) wells and an air stripper with a capacity of 1.5 cubic meters per minute, about three times that of the current discharges to the M-Area seepage basin. It has been designed to prevent chlorinated hydrocarbon contaminants in the shallow ground-water system (within the Tertiary Coastal Plain sediments) from reaching the drinking water of any offsite well or the Tuscaloosa Aquifer. Based on small-scale and prototype systems, the production (I/R) well and air-stripper system is expected to remove about 30 tons of chlorinated hydrocarbons per year for the first few years of operation. Thereafter, the removal rate will decrease as contaminant concentrations decrease. Liquid effluent from the air-stripper column (about 1.1 cubic meters per minute) will be routed to the A-Area powerhouse process-water system or used as nonprocess cooling water in M-Area. In either case, the wastewater would be discharged through an NPDES-permitted outfall.

Use of the M-Area seepage basin is scheduled to be discontinued by April 1985. At that time, M-Area liquid effluent that would normally be sent to the basin will be processed by a wastewater-treatment plant designed to remove about 650 metric tons per year, including the L-Reactor increment and a 20-percent contingency factor. The plant will be composed of (1) a uranium recovery facility, (2) a facility to remove suspended solids, aluminum, nitrates, phosphates, heavy metals, and oil and grease, and (3) a waste solidification facility to concentrate solutions by evaporation and to mix the concentrate with cement and flyash to form a solid-waste form for storage or disposal.

Process wastewater released to the seepage basin after the restart of L-Reactor (before the operation of the M-Area wastewater-treatment plant) will reach the water table in about 10 to 17 years. These waters will be intercepted by the I/R well system. The cone of depression resulting from pumping by the I/R system will be extensive. For example, the area within the 3-meter drawdown isopleth is expected to have an area of several hundred acres and to extend about 180 meters beyond Lost Lake after 10 years of pumping; below the seepage basin, the expected drawdown is 6 meters. Thus, the remedial-action project will readily intercept, recover, and process L-Reactor (and other) releases to the M-Area seepage basin-Lost Lake system that are discharged before the operation of the wastewater-treatment facility in April 1985.

DA-4, FE-12 Incremental pumping from the Tuscaloosa Aquifer in support of L-Reactor will cause an increase in the downward head differential between the Congaree and Tuscaloosa Formations of about 0.75 meter at the M-Area seepage basin. This will tend to increase both the downward migration of contaminants in the ground water and the tendency for migration through the thick, low-permeability lower Congaree and upper Ellenton clay units. After 1 year of pumping by the I/R well system, the expected cone of depression in the Tertiary ground-water system will be nearly coincident with the 100-microgram-per-liter concentration isopleth of the contaminant plume. Appreciable concentrations of contaminants are unlikely to migrate through the clays of the Congaree and Ellenton Formations overlying the Tuscaloosa before the I/R cone of depression reduces the effects of incremental pumping. The I/R cone of depression will grow quickly; it is expected to counter any effect of incremental pumping for L-Reactor. This system is projected to reduce the downward head differential beneath the Lost Lake seepage area by 1.2 meters and 3.6 meters after 1 and 10 years of I/R well operation, respectively.

Nitrate and other contaminants associated with the M-Area process wastewater that reach the water table will be removed by the I/R system and pumped to the air-stripper system during its period of operation (40 years). Chlorinated hydrocarbon concentrations in the feed system to the air stripper are expected to range initially from 38,000 to 115,000 micrograms per liter; nitrate concentrations are estimated to range from a few to about 35 miligrams per liter.

L-Reactor is expected to have a very small impact on the operation of this ground-water remedial project. The incremental seepage from L-Reactor support operations will be not more than 8 percent of the design capacity of the I/R wells, because the increment of 0.16 cubic meter per minute is expected to decrease to about 0.02 cubic meter per minute by the end of 1984. The small incremental discharges will have only a minor and local effect on water-table contaminant concentrations and elevations beneath the M-Area seepage basin and Lost Lake; the effects will be dissipated during the protracted period of seepage to the water table. The thick, low-permeability clay units of the lower Congaree and upper Ellenton Formations will remain effective confining units for the Tuscaloosa Aquifer; this is shown by the fact that the cone of depression from A-Area withdrawal from the Tuscaloosa Aquifer is not reflected in the water levels in the overlying sediments.

Without the I/R well system, the incremental discharges to the M-Area seepage basin would have only a small impact on concentrations of contaminants in the plume. Calculations indicate that these releases will increase concentrations by about 8 percent. Table 5-2 lists the expected incremental changes calculated for the downgradient monitoring wells that exhibit maximum concentrations of chromium, nitrate (expressed as nitrogen), and sodium.

Small quantities of uranium in the M-Area process wastewater will become associated with the clay materials in the subsurface, such as the green clay (if present), because of uranium's relatively high distribution coefficient (K_d). Ultimately, this material will probably reside in the basal Congaree and upper Ellenton clay units, which are effective confining units throughout the SRP.

DA-4, FE-12

In summary, the current project L-Reactor incremental liquid releases to the Fuel and Target Fabrication Area seepage basin are 0.16 cubic meter per minute; by the end of 1984, they will be 0.02 cubic meter per minute. The small incremental discharges will have only a minor and local effect on contaminant levels in the Tertiary ground-water system beneath the seepage areas; the effects will be dissipated during the protracted period of seepage to the water table. The thick, low-permeability clay units of the lower Congaree and upper Ellenton Formations will remain effective confining units for the Tuscaloosa, and incremental releases to the M-Area basin will not contaminate the ground water within this formation.

The A- and M-Area ground-water remedial action project is scheduled to be operating by August 1984. The I/R wells, which will have a capacity of at least 9 times the incremental release, are expected to intercept seepage from the basin and Lost Lake areas when it reaches the water table in about 10 to 17 years. Until the I/R system has been fully operational for about 1 year, the tendency for contaminants in the Tertiary contaminant plume to move downward will be increased as the result of incremental pumping for L-Reactor. Thereafter, the I/R system should counter the effects of incremental pumping. Appreciable concentrations of contaminants are unlikely to migrate through the clays confining the Tuscaloosa from L-Reactor restart until the I/R system has been pumping for 1 year. Use of the M-Area seepage basin is scheduled to be discontinued by April 1985, when a wastewater-treatment facility will be in service.

Ash basin

Additional discharges of coal ash will be sluiced (mixed with water and discharged) to the K-Area ash basin for disposal as a result of the production of steam for L-Reactor operation. The additional burning of coal with an ash content of about 13 percent will produce approximately 815 metric tons of ash per year. Incrementally, this ash will increase the K-Area steam-plant discharge to the ash basin by about 15 percent. A proposed project would adjust the pH of the sluicing water so the water is within discharge limits (SCDHEC, 1979). Leachate from the ash basin will enter the shallow ground-water system of the Barnwell Formation, from which it will migrate to Pen Branch. Little impact is anticipated.

Effluent treatment processes

Alternatives to the discharge of process wastewaters to the seepage basins in the fuel and target fabrication and chemical separations areas are being investigated, with the intent that these basins will be closed and that decommissioning activities will begin in 1985 and 1988, respectively.

In the fuel and target fabrication area, an integrated system is being designed for the treatment of all M-Area process effluents except clean (non-
DA-7 contact) cooling water. This facility, which is scheduled for operation by April 1985, will utilize precipitation, evaporation, cation exchange, electrodialysis, and water purification (rinsing) techniques to remove chemicals from the wastewater and allow discharge to Tims Branch through an NPDES-permitted outfall.

For the Separations Areas seepage basins, a waste-treatment facility is being developed to remove radioactive isotopes, hazardous heavy metals, and other dissolved and undissolved solids; direct discharge to Four Mile Creek will be used, through an NPDES-permitted outfall. Unit operations of filtration, reverse osmosis, and ion exchange will be utilized to clean up the process
DA-7 effluent. Operation of this facility is scheduled for October 1988. DOE will submit a FY 1986 funding request to Congress for approval.

Releases to surface streams

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

In general, at the outfall these releases already meet the State of South Carolina release requirements for Class B streams (SCDHEC, 1981). However, the pH of these discharges will occasionally exceed standards and require treatment.

5.1.1.3 Atmospheric releases

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

Table 5-5. Expected incremental effluent concentrations from chemical separations areas (F and H) to surface streams[a]

Constituent	F-Area cooling water/process sewer outfall to Four Mile Creek[b]	H-Area cooling water/process sewer outfall to Four Mile Creek[b]	H-Area mfg. bldg. outfall to Four Mile Creek[b]	1982 Mean concentrations in Four Mile Creek at Road A-7	Drinking water standards or water quality criteria[c]
Incremental increase in effluent discharged (liters/min)	890	650	390	-	-
pH	5.3-6.9	5.9-6.8	2.9-7.8	6.2-7.4	6.5-8.5 (S)
BOD	<2	<2	2	-	-
Total suspended solids (TSS)	10	32	6	3	-
Oil and grease	<10	<10	<10	-	-
Lead (Pb)	<0.001	0.004	0.006	<0.5	0.05 (P)
Mercury (Hg)	<0.0002	0.0011	0.0007	-	0.002 (P)
Nickel (Ni)	0.006	0.014	0.02	-	0.013 (WQS)
Silver (Ag)	<0.001	<0.0003	<0.0003	-	0.05 (P)
Zinc (Zn)	0.034	0.063	0.084	-	5 (S)
Chloride (Cl)	<0.1	Nb[d]	6.6	4.1	250 (S)
Fluoride (F)	<0.1	<0.1	<0.1	-	1.4-2.4 (S)
Nitrite/nitrate-N(NO_2/NO_3)	0.35	<0.05	0.19	2.71	10 (P)
Phosphate-P(PO_4)	0.05	0.02	0.01	<0.02	-
Cyanide (CN)	<0.02	<0.02	<0.02	-	0.02 (WQS)
Phenols	<0.002	<0.002	<0.002	-	3.5 (WQS)
Copper (Cu)	-[e]	-	-	-	1 (S)
Iron (Fe)	-	-	-	0.38	0.3 (S)
Manganese (Mn)	-	-	-	-	0.05 (S)
Aluminum (Al)	-	-	-	<0.85	-

[a]All concentrations are mg/liter unless otherwise noted. TE
[b]Du Pont, 1982b.
[c]Drinking water standards: (P), 40 CFR Part 141; (S): 40 CFR Part 143; water quality criteria (WQS): Federal Register, Part V, Vol. 45, No. 231, Nov. 28, 1980.
[d]Not detectable.
[e]Data not available.

L-Reactor production will increase the amount of fuel and target material processing in F-, H-, and M-Areas. The main environmental impact of increased operations in these facilities will be the added release of NO_x to the atmosphere.

Projected 1985 NO_x releases from F-Area will rise at least two-fold due to both L-Reactor restart and other SRP program changes. NO_x emissions from H-Area will decrease by a factor of two. About 25 percent of the total F-, H-, and M-Area emissions in 1985 will result from processing L-Reactor materials (Table 5-6). Air emissions permits for these facilities have been revised to reflect process changes.

Table 5-6. Summary of air pollutant releases from L-Reactor support facilities

Area	Projected 1984-1985 emission tons/yr		
	SO_x	TSP	NO_x
K-Area coal	130	28	45
L-Area diesels	4	4	59
F	<1	<1	197
H	<1	<1	28
M	<1	<1	26
Total SRP[a]	10,000	2500	5500

[a]Based on adjusted values in ERDA (1977).

NO_x releases resulting from L-Reactor operations are higher than other air pollutant emissions increases (Table 5-6). Overall, L-Reactor restart will increase future SRP NO_x emissions by about 5 percent. Sulfur dioxide and total suspended particulate releases will add about 1 percent. Releases related to L-Reactor operation will contribute 1.1 micrograms per cubic meter NO_x to the ambient air at the SRP boundary. This compares to 15 to 23 micrograms per cubic meter NO_x estimated from all other SRP sources in 1985. Total sulfur dioxide and total suspended particulate releases from L-Reactor restart will add less than 1 gram per cubic meter each.

5.1.1.4 Water usage

Surface water

Only minor amounts of surface water will be used by SRP facilities to support L-Reactor operation, because ground water will be the principal source of process water at these facilities. It is estimated that the K-Reactor steam plant will require about 0.005 cubic meter per second additional water from the

Savannah River to produce steam for L-Reactor (Du Pont, 1981b). Sections 4.1 and 4.4.2 describe surface-water use for L-Reactor; Section 5.2 describes cumulative surface-water use.

Ground water

Incremental ground-water pumping from the Tuscaloosa Formation, required to support the resumption of L-Reactor operation, will occur in five areas on the SRP: K-Area (steam plant), the central shops, and F-, H-, and M-Areas (Table 5-7). The incremental drawdowns listed in Table 5-6 represent the best estimates based on the recommended drawdown curve (Siple, 1967; Section F.4.2). At F-Area, the incremental pumping will be about 1.13 cubic meters per minute. After the F-Area powerhouse is placed in standby status in September 1984, the total ground-water withdrawal from the Tuscaloosa in F-Area will be about 4.54 cubic meters per minute, including the increment for L-Reactor. No incremental pumping in support of L-Reactor is expected at H-, A-, and M-Areas, where water conservation and other operational procedures have been instituted. However, if L-Reactor does not restart, ground-water withdrawal at these facilities might decrease by as much as 25 percent. Ground-water withdrawal by A-Area wells could be reduced by 1.1 cubic meters per minute when the wastewater from the M-Area air stripper is used in the A-Area powerhouse to augment the process water flow (Steele, 1983); this potential reduction is not considered in this EIS.

The incremental withdrawal of water from the Tuscaloosa Formation at K-Area will not affect the protection of the Ellenton and Tuscaloosa aquifers afforded by the upward head differential between the Tuscaloosa and Congaree Formations. In the Central Shops and F-Area, this head differential no longer exists at the producing wells, and the downward head differential at these wells will be increased when the incremental pumping for L-Reactor starts. Increased pumping at H-Area has also caused a downward head differential at H-Area wells. However, AW-1, the hydrostratigraphic properties of the overlying units will continue to offer DA-8, protection to the Ellenton and Tuscaloosa aquifers at the pumping wells. At the EN-24 seepage basins the upward head differential between the Tuscaloosa and Congaree Formations will be gradually reduced by drawdown to about 3.7 meters in F-Area. In H-Area the head differential will become about 0.6 meter downward. The head differential in the Central Shops Area will also become downward (Table 5-7).

In A- and M-Areas the hydrostratigraphic characteristics of the subsurface materials are different from those in F- and H-Areas (Table F-1). In addition, the downward head differential between the Congaree and Tuscaloosa Formations will be increased by about 0.75 meter at the M-Area seepage basin as the result of increased pumping to support L-Reactor. This could increase the tendency for contaminants already present in the ground water to move downward. As noted in Appendix F, the ground-water aquifers beneath M-Area have received contaminants contained in M-Area effluents. Current plans call for (1) establishing a series of additional interceptor/recovery wells by August 1984 (Steele, 1983) to remove these contaminants before they migrate offsite or into the Tuscaloosa Aquifer, and (2) discontinuing the use of the M-Area settling basin by April 1985. An extensive monitoring and cleanup program has been initiated. Contaminants that might reach the Tuscaloosa Formation eventually would be discharged to alluvium in the Savannah River valley. After dilution and radioactive decay had occurred along the travel path, these contaminants could be intercepted by some SRP production wells.

Table 5-7. Estimated L-Reactor support incremental ground-water usage and effects[a]

Location	No. wells	1982 Upward head differential at basin (m)	1983 Use (m^3/min)	1983 Drawdown[b] (m)	Estimated L-Reactor increment Use (m^3/min)	Estimated L-Reactor increment Drawdown[b] (m)	Estimated totals Use (m^3/min)	Estimated totals Drawdown at Well (m)[b]	Estimated totals Drawdown at Basin (m)	Comments	
K-Area (steam-plant)	2	7.6	1.13	3-5	0.14	≤0.5	1.27	≤6	1.8	An upward head differential[c] will exist at wells. This and the hydrostratigraphic properties of the formations will tend to protect the Ellenton and Tuscaloosa Formations from contaminants seeping from overlying shallow groundwater units. K-Area seepage, coal, and ash-basin effluents reaching the shallow ground water will be diverted to outcrops along Pen Branch.	TC
Central Shops[d]	3	2.4	0.57	3-4	0.17	≤0.6	0.74	<5	2.7	A downward head differential will exist at wells and beneath basins. The hydrostratigraphic properties of the formations will tend to protect the Ellenton and Tuscaloosa Formations from contaminants seeping from overlying shallow ground-water units.	TC
F-Separations Area	6	7.6	3.41[e]	<6.5	1.13	1.1	6.17	≤8	3.9	No upward head differential will be present at wells, but an upward differential will be present beneath the seepage basins. The hydrostratigraphic properties of the formations will tend to protect the Ellenton and Tuscaloosa Formations from contaminants seeping from overlying shallow ground-water units. Seepage, coal and ash-basin effluents will be diverted to outcrops along Four Mile Creek.	TC
H-Separations[f] Area	5	3.0	7.19	≤9	1.80	0.90	7.19	≤9	3.6	No upward head differential is present at wells or seepage basins. The hydrostratigraphic properties of the formations will tend to protect the Ellenton and Tuscaloosa formations from contaminants seeping from overlying shallow ground-water units. Seepage, coal and ash-basin effluents will be diverted to outcrops along Four Mile Creek.	TC

Table 5-7. Estimated L-Reactor support incremental ground-water usage and effects[a] (continued)

Location	No. wells	1982	1983		Estimated L-Reactor increment		Estimated totals			Comments
		Upward head differential at basin (m)	Use (m^3/min)	Drawdown[b] (m)	Use (m^3/min)	Drawdown[b] (m)	Use (m^3/min)	Drawdown at Well (m)[b]	Drawdown at Basin (m)	
M-Fuel/ Target Fabrications Area[g]	4	-5.5	6.81	<8	1.70	0.75	6.81	<8	3.0	A downward head differential exists in the neighborhood of A- and M-Areas, and important clay layers are absent in this locality. The Ellenton and Tuscaloosa Formations have received contamints contained in M-Area effluents via wells with faulty construction. Pumping from A-Area wells (which supply M-Area) has the potential for increasing contamination of these aquifers. No offsite contamination has occurred and none is likely to occur in the foreseeable future. Under present plans, use of the M-Area settling basin will be discontinued in 1985.

Total L-Reactor increment = 4.94 m^3/min

[a]1983 conditions and incremental effects based on information presented in Appendix F and Siple (1967).
[b]Estimated drawdown near the center of cone of depression of pumping well, including effects from other pumping areas and neglecting well entrance losses.
[c]Upward head differential between the Tuscaloosa (higher pressure) and Congaree (lower pressure) Formations in meters of water.
[d]Ground-water usage based on Table F-10 in Appendix F; incremental usage take as 1/3 current usage.
[e]Usage in 1984 after F-Area powerhouse is placed in standby status.
[f]Ground-water usage is not expected to increase to accommodate L-Reactor; however, if L-Reactor does not restart, ground-water withdrawal rates might decrease as much as 25 percent.
[g]Ground-water usage is not expected to increase to accommodate L-Reactor, because fuel and target assemblies are being manufactured in M-Area that could be used in L-Reactor. The well field producing water for M-Area is in A-Area (see Figure F-37). If L-Reactor does not restart, withdrawal rates might decrease by as much as 25 percent. TC

Ground-water flow in the Tertiary ground-water system below M-Area is also away from the nearest site boundary and toward the Savannah River (Section F.2.3.2 and Figure F-26; Du Pont, 1982). More recent water-level measurements indicate that the flow direction in the M-Area Tertiary ground-water system is to the south in the lower part of the system; the dominant flow direction in the overlying water-table aquifer is to the west-southwest.

The 1985 projected ground-water consumption from the Tuscaloosa at SRP, including that in support of L-Reactor [0.94 at L-Area + 4.94 total incremental (Table 5-7) = 5.9 cubic meters per minute], is estimated to be 25.4 cubic meters per minute. This represents a 7-percent increase over the 1982 SRP withdrawal from the Tuscaloosa of 23.8 cubic meters per minute, but a 6-percent decrease from the 1983 withdrawal rate of 27.0 cubic meters per minute (Tables 5-7 and F-10).

Computer modeling by Marine and Routt (1975) indicated that the ground-water flux in the aquifer is about 110 cubic meters per minute throughout a study area that includes SRP and nearby users (Figures F-25 and F-31). The current ground-water flux through this study area is estimated conservatively to be 51 cubic meters per minute, which is the lower bound estimate. This flux estimate compares with the projected withdrawal rate of about 36.9 cubic meters per minute (11.5 for neighboring offsite users + 25.4 projected SRP usage, including L-Area and support facility incremental use; see Section 5.2.3 for a discussion of cumulative ground-water withdrawal). The SRP projected pumpage rate of 25.4 cubic meters per minute compares with 37.8 cubic meters per minute, which Siple
AW-1, (1967) concluded could be pumped at the SRP with no adverse effects on the pump-
DA-8, ing capabilities of existing 1960 wells, particularly additional wells if spaced
EN-24 to minimize interference between wells. In 1960, SRP pumpage from the Tuscaloosa was about 18.9 cubic meters per minute (Siple, 1967).

Calculations were performed to evaluate the relationship between ground-water withdrawal and water levels in the Tuscaloosa Aquifer (see Section F.4.2). They showed that water levels in municipal wells near SRP would decrease slightly (0.0 to 0.4 meter) from the 1982 level when pumping at SRP increases (after September 1984) to 25.4 cubic meters per minute (which includes pumping at L-Area and incremental pumping in support of L-Reactor operations). Table 5-8 lists the declines calculated for wells near SRP. These drawdowns reflect rapid (about 100 days; Mayer et al., 1973) adjustments in equilibrium levels rather than aquifer depletion. These declines, calculated for municipalities and other users that would probably experience the greatest impacts from pumping at SRP, are less than half the increase in water levels experienced in Tuscaloosa wells in 1973 in response to an appreciable increase in water precipitation (see Figure 3-11). Long-term cyclic changes of 2 meters have been observed in water levels of the Tuscaloosa Aquifer in wells near SRP (see Figure F-12). In addition, drawdown calculations showed that the declines in water levels at monitoring wells P7A, P54, and P3A since 1974 were related primarily to increased ground-water withdrawal at SRP. Because pumpage will be relatively stable over the next 6 years (see Section 5.2.3), the 0.16-meter-per-year decrease reflected in monitoring well P7A (Figure 3-11) is expected to be arrested (equilibrium water levels are not expected to change appreciably).

The withdrawal of ground water from the Tuscaloosa Aquifer in support of L-Reactor operation is not expected to affect the quality of water.

Table 5-8. Decline in Tuscaloosa Aquifer water levels due to pumping at all SRP facilities[a,b,c]

Offsite Location	Equilibrium declines in water levels from 1982 levels (meters) Incremental pumping (25.4 m^3/min)	Cumulative pumping (26.5 m^3/min)
Beach Island	<<0.1	<<0.1
New Ellenton	<0.1	<0.1
Talatha	0.1	0.1
Jackson	0.4	0.4
SRP boundary opposite A-Area	0.4	0.4
Willinston	<<0.1	<<0.1
Barnwell NFP	<0.1	<0.1

AW-1, DA-8, EN-24

[a]Comparison made to conditions in May and June 1982 using average withdrawal rates at SRP for 1982 (23.8 cubic meters per minute).

[b]Calculations were made using the leaky aquifer model (Siple, 1967) discussed in Section F.4.2.

[c]These drawdowns from incremental and cumulative pumping will occur rapidly; near-equilibrium levels are expected in about 100 days. They have about the same magnitude as changes in water levels in response to short-term changes in winter precipitation (Figure 3-11). Long-term cyclic changes in Tuscaloosa Aquifer water levels of 2 meters have been observed in wells in the SRP area (Figure F-12).

In conclusion, the incremental ground-water withdrawal from the Tuscaloosa Aquifer in support of L-Reactor operation (about 4.94 cubic meters per minute) is expected to have little (less than 0.4 meter) impact on offsite water levels. Beneath the Central Shops and H-Area basins, the head differential between the Tuscaloosa and Congaree is expected to become downward; the differential in A- and M-Areas is expected to become increasingly downward. However, the green clay has a very low permeability and appears to be an effective barrier to the downward migration of pollutants wherever it is present on SRP. The lower Congaree and upper Ellenton clay units act as similar barriers for the Tuscaloosa Aquifer.

5.1.2 Radiological effects of support facilities

The resumption of L-Reactor operation will result in an increase of about 33 percent in radioactive discharges from the support facilities (i.e., central shops area, heavy-water area, fuel fabrication area, and the separations areas). Releases from support facilities associated with L-Reactor operation will build up gradually; during the first year of L-Reactor operation they will be less than 50 percent of the equilibrium values in succeeding years. However, for the purpose of the present analysis, it is assumed that first-year releases are equal to the expected equilibrium annual average releases. This section characterizes the radioactive releases from support facilities and presents the radiological impact of the releases on the maximally exposed individual and on population groups. Appendix B contains the methodology of the calculations and detailed dose results, including tables that provide the doses by age groups, organs, and pathways.

5.1.2.1 Liquid releases

Liquid radioactive releases will increase from the chemical separations areas, the fuel fabrication area, the heavy-water rework area, and the central shops area as a result of the resumption of L-Reactor operation. Tables 5-9, 5-10, and 5-11 list the expected annual average incremental increases in liquid releases from support facilities to surface streams, to seepage basins, and to surface water from the seepage basins, respectively. The values listed for the releases from these areas to surface streams and seepage basins are based on the average releases from the areas for 1978, 1979, and 1980, which were associated with the operation of three reactors. Since the mid-1950s, SRP has discharged large volumes of liquids containing low levels of radioactivity to the F-, H-, and M-Area seepage basins. The seepage basin soils have retained some of the components in the process wastewaters; others have entered the shallow groundwater system and are migrating to outcrop zones along Four Mile Creek (Fenimore and Horton, 1972; Marter, 1977). The migration of L-Reactor-related radioactivity from seepage basins to surface streams will occur approximately 4 years after initial discharge to the basins.

BH-5

5.1.2.2 Atmospheric releases

The restart and operation of L-Reactor will increase the release of radionuclides to the atmosphere from the chemical separation areas, the fuel fabrication area, and the heavy-water rework area. Table 5-12 lists the annual average incremental increase in releases of radioactivity to the atmosphere from L-Reactor support facilities. These incremental releases are based on the annual average release for these facilities for three reactor operations for 1978, 1979, and 1980.

Table 5-9. Estimated incremental releases of radionuclides to surface streams due to operation of L-Reactor support facilities (curies per year)

Radionuclide	Separations areas (F&H)	Fuel fabrication area (M)	Heavy-water rework area (D)	Total
H-3	3.9×10^{1}	--	5.2×10^{2}	5.6×10^{2}
Sr-89, 90[a]	5.8×10^{-2}	--	3.5×10^{-3}	6.2×10^{-2}
Cs-134, 137	1.9×10^{-2}	--	8.0×10^{-5}	1.9×10^{-2}
U-235	--	5.0×10^{-2}	--	5.0×10^{-2}
Pu-239[a]	2.9×10^{-3}	--	7.0×10^{-6}	2.9×10^{-3}

[a]Unidentified beta-gamma releases are assumed to be Sr-90; unidentified alpha releases are assumed to be Pu-239.

Table 5-10. Incremental radionuclide releases to seepage basins from support facilities[a] (curies per year)

Isotope	Separations area (F&H)	Fuel fabrication area (M)	Central shop (CS)	Total
H-3[b]	5.7×10^{3}	--	2.0×10^{-1}	5.7×10^{3}
Cr-51	3.6×10^{-1}	--	--	3.6×10^{-1}
Co-58, 60	5.4×10^{-2}	--	3.0×10^{-6}	5.4×10^{-2}
Zn-65	3.0×10^{-2}	--	--	3.0×10^{-2}
Sr-89, 90	5.9×10^{-1}	--	1.0×10^{-6}	5.9×10^{-1}
Nb-95	8.2×10^{-1}	--	--	8.2×10^{-1}
Zr-95	1.3	--	--	1.3
Ru-103, 106	9.9	--	--	9.9
Sb-124, 125	1.1×10^{-2}	--	--	1.1×10^{-2}
I-131	1.3×10^{-2}	--	--	1.3×10^{-2}
Cs-134, 137	2.4	--	1.0×10^{-6}	2.4
Ce-141, 144	3.0	--	--	3.0
Pm-147	1.2×10^{-1}	--	--	1.2×10^{-1}
Am-241, 243	3.3×10^{-2}	--	--	3.3×10^{-2}
Cm-242, 244	1.0×10^{-3}	--	--	1.0×10^{-3}
U-235, 238	7.3×10^{-2}	3.5×10^{-2}	--	1.1×10^{-1}
Pu-238, 239	2.2×10^{-2}	--	--	2.2×10^{-2}
Other beta, gamma[c]	9.3×10^{-2}	--	5.0×10^{-6}	9.3×10^{-2}
Other alpha[c]	--	--	3.0×10^{-7}	3.0×10^{-7}

[a]Adapted from Du Pont (1982a). TC

[b]Thirty percent of tritium is assumed to evaporate and be released to the atmosphere at ground level.

[c]For calculational purposes, unidentified beta-gamma releases were assumed to be Sr-90; unidentified alpha releases were assumed to be Pu-239.

Table 5-11. Estimated incremental releases of radionuclides to streams from seepage basins due to operation of support facilities (curies per year)

Radionuclide	Central shops area[a]	Fuel fabrication area[b] (M)	Separations areas[c] (F&H)	Total
H-3	1.7×10^{-1}	--[d]	3.2×10^{3}	3.2×10^{3}
Co-60	1.9×10^{-6}	--	3.3×10^{-2}	3.3×10^{-2}
Zn-65	--	--	5.8×10^{-4}	5.8×10^{-4}
Ru-106	--	--	6.9×10^{-1}	6.9×10^{-1}
Sb-125	--	--	4.2×10^{-3}	4.2×10^{-3}
Ce-144	--	--	1.0×10^{-1}	1.0×10^{-1}
Pm-147	--	--	4.4×10^{-2}	4.4×10^{-2}

[a]Conservatively estimated travel time to outcrop equals 3.3 years.

TC| [b]Only uranium isotopes will be released to this basin (see Table 5-10). Due to their adsorption on soils, they will not be discharged from the ground water during L-Reactor operation.

[c]Travel times to outcrop from F- and H-Areas are 6.7 and 1.1 to 3.8 years, respectively. For calculational purposes, the travel time was assumed to be 3.8 years from both areas.

[d]Not detectable.

5.1.2.3 Dose commitments from L-Reactor support facilities operations

Maximum individual dose from liquid releases

The total-body dose to the maximally exposed individual from liquid effluents from the operation of the L-Reactor support facilities was calculated to be 0.022 millirem to an adult in the first year of operation and 0.050 millirem in the tenth year (after seepage-basin contributions start). The maximum organ dose was calculated to be 0.18 millirem to a child's bone in both the first and tenth years.

Population dose from liquid releases

The total-body dose due to liquid releases from L-Reactor support facilities to the population within 80 kilometers of the Savannah River Plant was calculated to be 0.044 person-rem in the first year and 0.048 person-rem in the tenth year. The bone dose was 0.25 person-rem in both the first and tenth

Table 5-12. Estimated incremental annual average releases of radionuclides to the atmosphere from operation of L-Reactor support facilities[a] (curies per year)

Radioisotope	Separations areas (F&H)	Fuel-fabrication area (M)	Heavy-water area (D)	Total
		NOBLE GASES		
Kr-85	2.0×10^{5}	--[b]	--	2.0×10^{5}
Xe-131m	1.9	--	--	1.9
Xe-133	1.0×10^{-1}	--	--	1.0×10^{-1}
		OTHER AIRBORNE		
H-3	8.6×10^{3}	--	7.9×10^{2}	9.4×10^{3}
C-14	8.0	--	--	8.0
Sr-90[c]	1.7×10^{-3}	--	--	1.7×10^{-3}
Zr-95	6.0×10^{-3}	--	--	6.0×10^{-3}
Nb-95	1.2×10^{-2}	--	--	1.2×10^{-2}
Ru-103	1.2×10^{-3}	--	--	1.2×10^{-3}
Ru-106	2.8×10^{-2}	--	--	2.8×10^{-2}
I-129	7.0×10^{-2}	--	--	7.0×10^{-2}
I-131	1.7×10^{-2}	--	--	1.7×10^{-2}
Cs-134	1.1×10^{-4}	--	--	1.1×10^{-4}
Cs-137	1.2×10^{-3}	--	--	1.2×10^{-3}
Ce-141	8.0×10^{-5}	--	--	8.0×10^{-5}
Ce-144	8.0×10^{-3}	--	--	8.0×10^{-3}
U-235	1.7×10^{-3}	--	--	1.7×10^{-3}
U-238	--	8.6×10^{-7}	--	8.6×10^{-7}
Pu-238	1.9×10^{-3}	--	--	1.9×10^{-3}
Pu-239[c]	2.7×10^{-4}	2.6×10^{-6}	--	2.7×10^{-4}
Am-241	3.9×10^{-4}	--	--	3.9×10^{-4}
Cm-244	3.5×10^{-4}	--	--	3.5×10^{-4}

[a]Adapted from Du Pont (1982a). TE

[b]Not detectable.

[c]Unidentified beta, gamma releases are assumed to be Sr-90; unidentified alpha releases are assumed to be Pu-239.

years. The corresponding incremental total-body dose to the populations consuming river water at the Port Wentworth and Beaufort-Jasper water treatment plants was calculated to be 0.95 person-rem in the first year and 5.3 person-rem in the tenth year. The bone dose was 7.9 person-rem in both the first and tenth years.

Maximum individual dose from atmospheric releases

The individual who would receive the highest dose from atmospheric releases from L-Reactor support facilities was assumed to reside continuously on the SRP boundary. The location on the site boundary where this individual resides was selected as the one where the total maximum offsite doses from L-Reactor and support operations are predicted to occur. The total-body dose to the maximum individual from support facility operations was calculated to be 0.074 millirem to a child in the first year and 0.022 millirem in the tenth year. More than 75 percent of the total-body dose is from tritium; the major dose pathways are the ingestion of vegetables and milk. The maximum organ dose was calculated to be 0.56 millirem to an adult's thyroid in the first year and 0.62 millirem in the tenth year. Iodine-129 contributes more than 90 percent of these doses; the ingestion of vegetables and milk are the major dose pathways.

Population dose from atmospheric releases

The incremental total-body dose to the population within 80 kilometers of the Savannah River Plant due to L-Reactor support facilities was calculated to be 2.8 person-rem in both the first and tenth years. More than 70 percent of the total-body dose is from tritium. Inhalation and the ingestion of vegetables are the major dose pathways. The highest organ doses were 96 person-rem to the thyroid and 27 person-rem to the skin. More than 95 percent of the thyroid dose is from iodine-129 with the ingestion of vegetables being the dominant dose pathway; more than 90 percent of the skin dose is from krypton-85 via exposure to the plume of released radioactivity.

5.1.2.4 Summary - offsite dose commitments from support facility operation

Table 5-13 summarizes the maximum individual dose and population dose from L-Reactor support facilities. The numbers listed as totals for individual and population doses are conservative maximums; to receive these doses, the "composite" individual (or population) would have to occupy several locations simultaneously.

The composite maximum individual dose of 0.087 millirem in the first year and 0.072 millirem in the tenth year is less than 0.1 percent of the average dose of 93 millirem (Du Pont, 1982a) received by an individual living near the SRP site from natural sources. The doses this individual receives are well below DOE protection guides of 500 millirem to the total body and 1500 millirem to other organs (DOE, 1981). The maximum population dose of 8.1 person-rem (tenth year) is about 0.007 percent of the dose of about 109,000 person-rem to TC the population living within 80 kilometers of the Savannah River Plant and the Beaufort-Jasper and Port Wentworth drinking water population from natural radiation sources.

Table 5-13. Summary of total-body dose commitments from L-Reactor support facility operation

Source of exposure	1st year Adult	1st year Child	10th year Adult	10th year Child
MAXIMUM INDIVIDUAL DOSE (millirem per year)				
Atmospheric releases[a]	0.050	0.074	0.015	0.022
Liquid releases	0.022	0.013	0.050	0.050
Total	0.072	0.087	0.065	0.072

Source of exposure	Dose within 80 kilometers of SRP 1st year	Dose within 80 kilometers of SRP 10th year	Port Wentworth and Beaufort-Jasper doses 1st year	Port Wentworth and Beaufort-Jasper doses 10th year
REGIONAL POPULATION DOSE (person-rem per year)				
Atmospheric releases	2.8	2.8	--	--
Liquid releases	0.044	0.048	0.95	5.3
Total	2.8	2.8	0.95	5.3

[a]The location of the maximum individual is where the receptor receives the largest total dose from the L-Reactor plus its support facilities; because of the increase in tritium releases from L-Reactor until equilibrium is reached, this location is different in the first and tenth years.

5.1.2.5 Health effects of support facilities operations

Risk estimators used to project health effects were 120 cancers and 257 genetic effects per 1,000,000 person-rem exposure to the population. Using these estimators and the values for regional doses (Table 5-13), the radiation-induced health effects that might occur eventually as a result of operation of support facilities for L-Reactor (from atmospheric and liquid releases) include a maximum of 0.0004 excess cancer fatality and 0.0007 additional genetic disorder in the population within 80 kilometers of the Savannah River Plant from releases occurring in the first or tenth year of operation. Health effects that might eventually occur in the downstream Savannah River water-consuming populations of Port Wentworth and Beaufort-Jasper include a maximum of 0.0003 and 0.0007 fatal cancer as a result of releases in the first and tenth years, respectively. The maximum incidence of genetic disorders to these populations would be 0.0002 and 0.001 as a result of first- and tenth-year releases, respectively.

CT-1

5.1.2.6 Occupational dose

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

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

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

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

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

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

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

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

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

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

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

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

5.1.2.8 Waste-management operations

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

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

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

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

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

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

5.1.2.9 Accident risks in non-reactor facilities

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

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

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

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

5.1.3 Preferred alternatives*

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

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

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

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

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

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

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

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

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

5.1.3.1 Socioeconomics

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

5.1.3.2 Nonradioactive effluent discharge

Discharge to seepage basins

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

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

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

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

Ash basin

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

Effluent treatment processes

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

Releases to surface streams

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

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

5.1.3.3 Atmospheric releases

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

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

5.1.3.4 Water usage

Surface water

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

Ground water

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

5.1.3.5 Radiological effects of support facilities

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

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

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

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

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

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

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

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

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

5.2 CUMULATIVE IMPACTS

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

5.2.1 Socioeconomics

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

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

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

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

The cumulative SRP construction and operational workforce increase by the end of 1984 is not expected to have major impacts in the six-county area. The potential relocating workforce and its associated population is expected to account for less than 1 percent of the projected 1984 population of the area. Minor impacts on housing, schools, and other public services and facilities might occur where existing or projected 1984 demands exceed current service

Table 5-16. Cumulative SRP socioeconomic impact on six-county area

Location	Projected 1984 population	Estimated number of relocating personnel	Cumulative SRP population increase: Total population	Cumulative SRP population increase: Percent of 1984 population	Cumulative SRP school-age children increase: Total population	Cumulative SRP school-age children increase: Percent of 1984 school population
South Carolina						
Aiken	111,775	402	973	0.9	183	0.8
Allendale	11,220	23	55	0.5	11	0.4
Bamberg	18,870	23	58	0.3	11	0.3
Barnwell	21,520	141	336	1.6	66	1.3
Georgia						
Columbia	44,870	35	83	0.2	16	0.2
Richmond	190,180	191	457	0.2	89	0.3
TOTAL	398,435	815	1,962		376	
AVERAGE				0.5		0.5

General Impacts[a]

Land use: Minor impact due to size of potential inmigrating population in relation to total population.

Population and fire protection: Minor impact due to relationship of demand of potential inmigrating population and demand of existing population.

Water and wastewater treatment: Minor impact due to size of demand and current excess capacity in selected existing system.

Roads and traffic: Minor impacts offsite that can be limited through work shift scheduling.

[a]Conclusions based on projected inmigrating population and data in DOE, 1982a.

capabilities; however, the demands placed on these services by the potential relocating workers and their families will be relatively small in relation to the total indigenous demand.

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

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

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

5.2.2 Surface-water usage

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

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

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

5.2.3 Ground-water usage

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

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

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

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

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

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

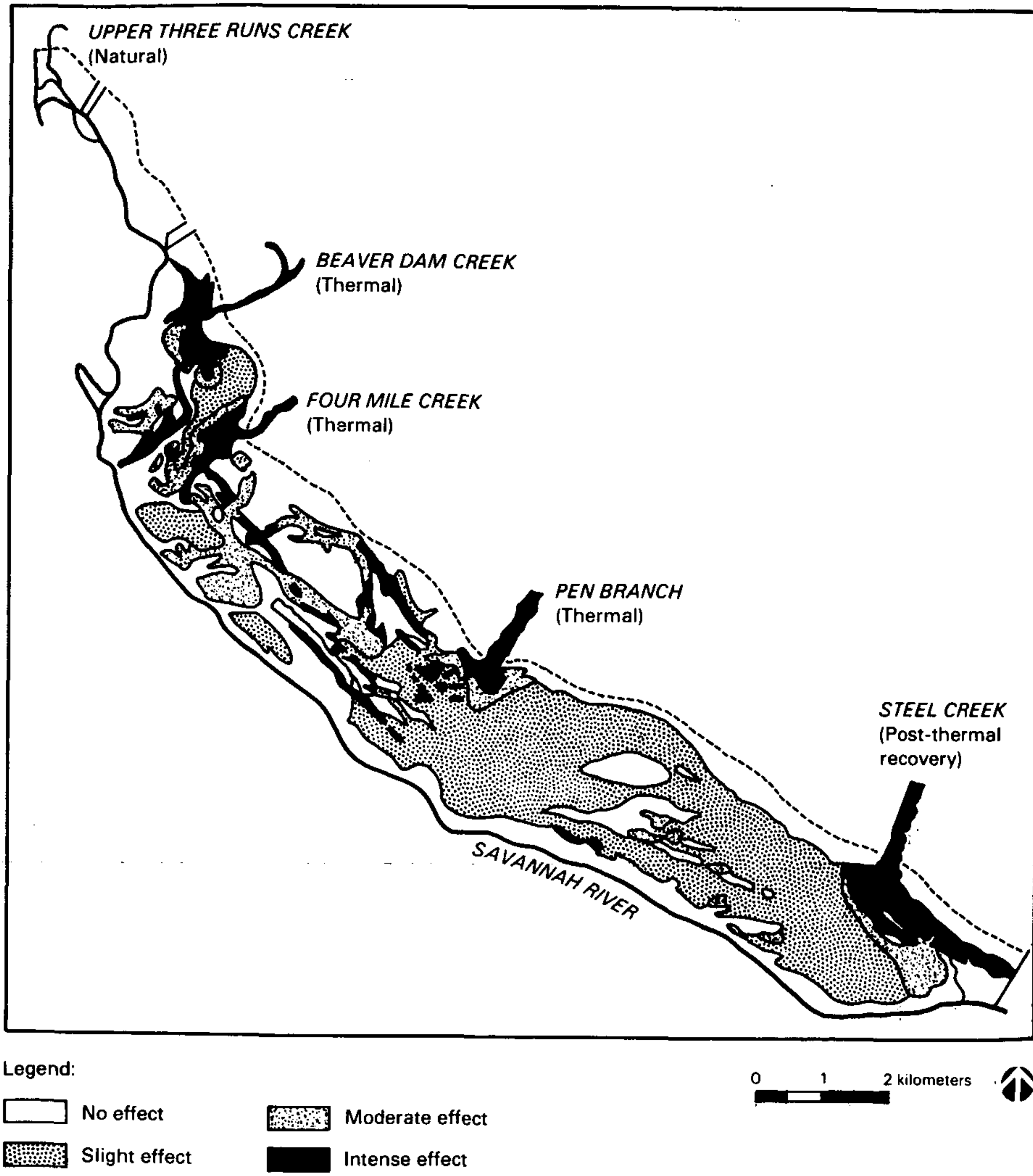
5.2.4 Thermal discharge

5.2.4.1 Wetlands

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

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

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



Adapted from Sharitz et al. (1974).

Figure 5-2. The Savannah River swamp in 1973 after 14 to 19 years of continual thermal loading from reactor discharges.

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

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

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

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

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

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

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

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

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

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

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

Savannah River swamp

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

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

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

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

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

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

5.2.4.2 Savannah River

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

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

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

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

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

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

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

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

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

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

5.2.5 Fisheries

5.2.5.1 Thermal effects

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

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

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

5.2.5.2 Entrainment

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

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

5.2.5.3 Impingement

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

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

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

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

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

5.2.6 Radiological effects

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

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

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

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

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

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

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

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

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

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

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

5.2.7 Health effects

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

5.2.8 Preferred alternatives*

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

5.2.8.1 Socioeconomics

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

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

---

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

Table 5-23. Estimated annual average concentrations of radionuclides in air, milk, and water from routine operating (reference case) releases

Nuclide	Concentration: Co-60 and Cs-137 1st yr	Co-60 and Cs-137 10th yr	L-RX 10th yr	L-SUPP 10th yr	SRP 10th yr[b]	DWPF 10th yr	Vogtle 10th yr	Total 10th yr	
IN MILK FROM ATMOSPHERIC RELEASES (MAXIMUM AT PLANT BOUNDARY), pCi/liter									
H-3	--	--	7.0×10^{2}	5.3×10	3.2×10^{3}	2.2×10^{-1}	--	3.9×10^{3}	
I-131	--	--	1.8×10^{-3}	1.2×10^{-3}	1.1×10^{-2}	--	3.6×10^{-1}	3.7×10^{-1}	DA-48
IN AIR FROM ATMOSPHERIC RELEASES (MAXIMUM AT PLANT BOUNDARY), pCi/m^3									
H-3	--	--	4.4×10	3.3	2.0×10^{2}	1.4×10^{-2}	--	2.4×10^{2}	
C-14	--	--	9.3×10^{-3}	2.5×10^{-3}	3.4×10^{-2}	--	--	4.6×10^{-2}	DA-48
Ar-41	--	--	8.3	--	1.4×10^{1}	--	--	2.3×10^{1}	
IN RIVER WATER BELOW PLANT, pCi/liter									
H-3	--	--	1.0×10^{3}	4.1×10^{2}	3.0×10^{3}	9.2×10^{1}	1.5×10^{2}	4.7×10^{3}	
Co-60	2.7×10^{-2}	8.6×10^{-4}	4.9×10^{-3}	3.6×10^{-3}	2.3×10^{-2}	9.4×10^{-12}	--	3.2×10^{-2}	
Sr-90	--	--	1.2×10^{-2}	6.7×10^{-3}	4.8×10^{-2}	2.5×10^{-6}	1.7×10^{-5}	6.7×10^{-2}	
Cs-137	4.8×10^{-1}	4.2×10^{-2}	4.4×10^{-5}	2.1×10^{-3}	2.4×10^{-2}	5.5×10^{-10}	1.6×10^{-1}	2.3×10^{-1}	
IN PORT WENTWORTH DRINKING WATER, pCi/liter									
H-3	--	--	1.0×10^{3}	4.1×10^{2}	3.0×10^{3}	9.2×10	1.5×10^{2}	4.7×10^{3}	
Co-60[a]	2.7×10^{-2}	8.6×10^{-4}	4.9×10^{-3}	3.6×10^{-3}	2.3×10^{-2}	9.4×10^{-12}	--	3.2×10^{-2}	
Sr-90	--	--	1.2×10^{-2}	6.7×10^{-3}	4.8×10^{-2}	2.5×10^{-6}	1.7×10^{-5}	6.7×10^{-2}	
Cs-137	9.2×10^{-2}	8.3×10^{-3}	8.7×10^{-6}	4.1×10^{-4}	4.7×10^{-3}	1.1×10^{-10}	3.2×10^{-2}	4.5×10^{-2}	
IN BEAUFORT-JASPER DRINKING WATER, pCi/liter									
H-3	--	--	1.0×10^{3}	4.1×10^{2}	3.0×10^{3}	9.2×10^{1}	1.5×10^{2}	4.7×10^{3}	
Co-60[a]	2.7×10^{-2}	8.6×10^{-4}	4.9×10^{-3}	3.6×10^{-3}	2.3×10^{-2}	9.4×10^{-12}	--	3.2×10^{-2}	
Sr-90	--	--	1.2×10^{-2}	6.7×10^{-3}	4.8×10^{-2}	2.5×10^{-6}	1.7×10^{-5}	6.7×10^{-2}	
Cs-137	1.2×10^{-2}	1.0×10^{-3}	1.1×10^{-6}	5.1×10^{-5}	5.9×10^{-4}	1.3×10^{-11}	3.9×10^{-3}	5.5×10^{-3}	

[a]Cs-137 concentrations in Port Wentworth and Beaufort-Jasper water were calculated by applying factors *recommended by D. W. Hayes and A. L. Boni (memorandum from D. W. Hayes and A. L. Boni* to J. C. Corey, "Cs-137 in the Savannah River and the Beaufort-Jasper and Port Wentworth Water Treatment Plants," January 10, 1983). These factors were not applied to other radionuclides.

[b]Represents current operation.