ture uses of the streams. DOE would maintain the stream water quantity and quality. Section 3.3 discusses reasons for restarting the River Water System.

4.2.7 AESTHETICS

4.2.7.1 Affected Environment

Most of the streams on the SRS flow through or originate in the Upper Coastal Plain and are tributaries of the Savannah River, which flows through the Lower Coastal Plain. The topographical relief of this area is slight with narrow flat-bottomed valleys and rolling areas between stream valleys. Fourmile Branch, Pen Branch/Indian Grave Branch, Steel Creek, and Lower Three Runs flow through the Site in a generally southerly direction toward the river. The streams are narrow at their headwaters, broadening into wide swampy deltas where they empty into the river. Section 4.2.5 describes the flora and fauna of the streams. Figure 4-30 shows Lower Three Runs from just below the Par Pond Dam on Road B. Figure 4-31 shows Steel Creek from just below the dam on L-Lake. At the time the photograph was taken on July 31, 1996, flow was 30 cubic feet (0.9 cubic meter) per second (USGS 1996).

The only stream users are SRS personnel engaged in chemical, physical, and biological monitoring; frequency of use varies depending on location and sample type. There are sampling stations along the entire length of these streams, including offsite locations. Hunting and fishing along the streams on the Site is strictly prohibited; the number and frequency of offsite users are unknown.

4.2.7.2 Aesthetic Impacts

4.2.7.2.1 No Action

Under the No-Action Alternative, DOE would continue to pump water from the Savannah River through the River Water System to the K- and L-Area 186 basins which would discharge to Indian Grave Branch and L-Lake. The aesthetic settings of the streams would not change and there would be no visual impacts.

4.2.7.2.2 Shut Down and Deactivate

Under this alternative, DOE would shut down the River Water System, thereby supplying no water to Steel Creek, Lower Three Runs, and the other onsite streams. L-Lake would recede and could return to its original stream conditions; both Steel Creek and Lower Three Runs would receive average flows of approximately 10 cubic feet (0.28 cubic meter) per second, which could support biological communities similar to those that existed prior to the creation of the lake. Because the Steel Creek channel would continue to flow through the L-Lake bed and, because the stream would be associated with a receding lake, this alternative would adversely affect stream aesthetics. Figure 4-15 shows Steel Creek (where it broadens into L-Lake) as the lake begins to recede. This alternative would not affect the other streams.

4.2.7.2.3 Shut Down and Maintain

Aesthetic impacts under this alternative would be the same as those noted for the Shut Down and Deactivate Alternative, except DOE could restart the River Water System if necessary. Section 3.3 contains possible reasons for restarting the system.

4.2.8 OCCUPATIONAL AND PUBLIC HEALTH

4.2.8.1 Affected Environment

4.2.8.1.1 Public Health

DOE collects water samples from the Savannah River and SRS streams on a continual basis throughout the year to determine the effects of the Site's effluents on the river water. In addition, SRS stream sampling locations monitor below the process areas to detect and quantify radioactivity levels in liquid effluents being
TE | transported to the river. Table 4-43 lists radio-

Table 4-43. Average water concentrations of radioactivity in the Savannah River and Savannah River Site streams for 1995 (microcuries per milliliter).[a] TE

Location	Alpha	Gross beta	Tritium
Savannah River			
River Mile 120	8.20×10^{-11}	1.98×10^{-9}	1.28×10^{-6}
River Mile 140	1.96×10^{-10}	2.33×10^{-9}	1.54×10^{-6}
River Mile 150	1.42×10^{-10}	1.98×10^{-9}	1.74×10^{-6}
Vogtle discharge	1.73×10^{-10}	1.94×10^{-9}	7.90×10^{-6}
River Mile 160	8.30×10^{-11}	2.19×10^{-9}	2.09×10^{-7}
Edisto River (offsite control)	7.67×10^{-10}	1.58×10^{-9}	2.22×10^{-7}
SRS Streams			
Tims Branch	1.47×10^{-9}	2.39×10^{-9}	9.66×10^{-7}
Upper Three Runs	1.30×10^{-9}	1.27×10^{-9}	2.21×10^{-6}
Fourmile Creek	2.81×10^{-10}	1.03×10^{-8}	2.28×10^{-4}
Pen Branch	1.07×10^{-10}	1.25×10^{-9}	6.89×10^{-5}
Steel Creek	8.40×10^{-11}	1.62×10^{-9}	6.97×10^{-6}
Lower Three Runs	3.25×10^{-10}	1.84×10^{-9}	9.88×10^{-7}
Upper Three Runs (site control)	2.12×10^{-9}	1.59×10^{-9}	5.08×10^{-7}

a. Source: Arnett, Mamatey, and Spitzer (1996).

activity measurements from selected locations along the river and SRS streams.

Sediment samples have been analyzed (Arnett, Mamatey, and Spitzer 1996) to measure the movement, deposition, and accumulation of long-lived radionuclides in SRS stream beds and in the Savannah River bed. Because of the continuous deposition and remobilization occurring in the stream and river beds, significant year-to-year differences might be evident, but the data obtained can indicate long-term environmental trends. Sediment samples are collected annually from the River and SRS streams. DOE obtains samples from the top 8 inches (3.2 centimeters) of sediment in areas where fine sediment accumulates and most of the radionuclides concentrate. Table 4-44 lists the results of sediment analyses for 1995 at selected locations on the River and SRS streams. The highest activities were observed in samples from Steel Creek and Pen Branch.

Table 4-44. Measurements of radionuclides in the Savannah River and Savannah River Site stream sediments for 1995 (picocuries per gram).[a] TE

Location	Cobalt-60	Strontium-90	Cesium-137	Plutonium-238	Plutonium-239
Savannah River					
Below Fourmile Branch	(b)	0.00670	0.788	0.000612	0.00289
Below Little Hell Landing	(b)	0.00094	1.49	0.00109	0.00586
Highway 301	(b)	(b)	0.203	0.00130	0.00823
Lower Three Runs mouth	(b)	0.00068	1.43	0.00282	0.00505
Demier's Landing (control)	(b)	0.00083	0.262	(b)	0.001260
SRS Streams					
Fourmile at Road A-7	(b)	0.417	0.954	0.000558	(b)
Pen Branch discharge at swamp	(b)	0.0063	1.39	0.00145	0.0141
Steel Creek at Road B	(b)	0.0077	0.356	0.00136	0.00949
Lower Three Runs mouth	(b)	(b)	(b)	(b)	(b)
Lower Three Runs mouth (control)	(b)	(b)	(b)	(b)	(b)

a. Source: Arnett, Mamatey, and Spitzer (1996).
b. Activity is below the lower level of detection.

4.2.8.1.2 Radioactive Releases of Cesium-137 to Onsite Streams

Since 1954, approximately 563 curies of cesium-137 were generated from reactor operations and released to onsite streams (Cummins, Hetrick, and Martin 1991). Table 4-45 shows the source, receiving stream, and amount of these releases. The following section provides information on the estimated inventory and distribution of cesium-137 remaining in Steel Creek.

4.2.8.1.3 Radiation Levels in Steel Creek

From 1955 to 1973, the SRS released approximately 284 curies of cesium-137 to Steel Creek (DOE 1984). A sharp decrease in the release of cesium-137 occurred during the early 1970s when DOE fitted all reactors with sand filters, demineralized the basin water before release, removed leaking fuel elements from the reactor basin to a safe storage area, and finally discontinued the practice of direct discharge of disassembly basin water to Site streams. The estimated inventory (decay corrected to 1996) of cesium-137 remaining in Steel Creek was 58 curies – 7 curies upstream from L-Reactor, 26 curies between L-Reactor and the Steel Creek delta, 18 curies in the Steel Creek delta, and 7 curies between the delta and the SRS boundary (PRC 1996).

The SRS discharged an estimated 27 curies (15 from L-Reactor and 12 from P-Reactor) of cobalt-60 to Steel Creek (DOE 1984). Most of the cobalt-60 (which has a half-life of 5.26 years) has been eliminated through radioactive decay; however, an estimated 0.5 curie remains in either Steel Creek or L-Lake, or has moved to the Savannah River in a manner similar to that described for cesium.

After their discharge to Steel Creek, the cesium-137 and cobalt-60 became associated primarily with the silts and clays in the 11.2-mile (18.0-kilometer) Steel Creek system before reaching the Savannah River. The sediments and associated radionuclides have been subjected to accumulation in L-Lake and to continued resuspension, transport, and deposition according to the flow regime in the creek above and below L-Lake. Aerial radiological surveys (e.g., EG&G 1992) conducted since 1974 indicate that the radionuclides have remained channeled in a zone that correlates with the historic stream channel and floodplain for Steel Creek.

4.2.8.2 Environmental Impacts

L10-09 As previously discussed in Section 4.2.2.1, tritium levels in Steel Creek, Lower Three Runs, Fourmile Branch, and Pen Branch are expected to increase under the No Action Alternative from the 1996 levels due to removal of the

TE **Table 4-45.** Releases of cesium-137 to onsite streams from reactor operations.[a]

Source	Receiving stream	Release (curies)
C-Area	Castor Creek[b]	33
K-Area	Indian Grave Branch[c]	24
L- and P-Areas	Steel Creek	284
R-Area	Lower Three Runs[d]	222
Total		563

a. Source: Cummins, Hetrick, and Martin (1991).
b. A tributary of Fourmile Branch.
c. A tributary of Pen Branch.
d. Total release to Par Pond, R-Reactor Canals, and Lower Three Runs.

River Water System discharges. These incremental increases in tritium levels are presented in Table 4-26. As shown by the values in this table, Pen Branch would be expected to have the largest incremental increase in tritium levels (52.2 pCi/ml). In addition, for Steel Creek under the Shut Down and Deactivate and Shut Down and Maintain Alternatives, an increase in contaminated sediments is likely during periods of heavy rainfall. Therefore, for these alternatives the sediment loss has been calculated based on stabilized steady state condition and added to the flow in Steel Creek in the form of increased contaminant concentrations in shoreline sediments and surface water. The following sections describe the impacts of these increased contaminant concentrations.

4.2.8.2.1 No Action

Public Health

Radiological and nonradiological impacts from atmospheric and liquid releases to members of the public under the No-Action Alternative would not change appreciably from the baseline impacts described in Section 4.1.8.1.1. This is true for atmospheric releases because although additional sediments in the stream beds may be uncovered and allowed to dry and be dispersed by the wind, these sediments typically have relatively low concentrations of contaminants (DOE 1984) and would not affect the total airborne release appreciably. Similarly, although concentrations for some contaminants (tritium) would increase in the affected streams, the total release of these contaminants would remain constant. Therefore, incremental changes in impacts under the No-Action Alternative would be very small and this EIS does not calculate them.

Occupational Health

Under the No-Action Alternative, the increased tritium concentrations would have an incremental risk to the involved workers due to increased exposure to tritium through incidental ingestion of sediment and dermal contact. The resulting dose and risk values are presented in Table 4-46. Doses to the uninvolved workers would not change appreciably because volatilization of tritium from the streams would remain essentially constant from the baseline conditions.

4.2.8.2.2 Shut Down and Deactivate

For the Shut Down and Deactivate Alternative, DOE would discontinue pumping to the reactor areas and flows (in SRS streams that currently receive flows from the River Water System) would revert to natural levels. Because most contaminants reside in the upper regions of the stream floodplains, the alternatives would not expose additional sediments. However, additional sediment would be lost from the L-Lake bed during periods of heavy rainfall. The following paragraphs describe the impacts of this sediment loading on Steel Creek.

Public Health

Radiological and nonradiological impacts resulting from atmospheric and liquid releases would be essentially unchanged from those for the No-Action Alternative with the exception of increased sediment loading in Steel Creek. The impacts of this increased sediment loading are described in Section 4.1.8.2.2 (aqueous releases in Table 4-21). The remaining incremental doses and impacts to members of the public would be very small and this EIS does not calculate them.

TE **Table 4-46.** Worker radiological doses associated with the Shut Down and Deactivate Alternative and resulting health effects.[a]

Receptor	No-Action Alternative		Shut Down and Deactivate Alternative	
	Dose (rem)	Probability or number of fatal cancers[b]	Dose (rem)	Probability or number of fatal cancers[b]
Average involved worker (current use)				
Annual[c]	4.9×10^{-10}	2.0×10^{-13}	4.5×10^{-8}	1.8×10^{-11}
Lifetime[d]	6.6×10^{-9}	2.6×10^{-12}	2.0×10^{-7}	8.1×10^{-11}
All involved workers[e] (current use)				
Annual[c] (person-rem)	3.4×10^{-8}	1.4×10^{-11}	3.1×10^{-6}	1.3×10^{-9}
Lifetime[d] (person-rem)	4.6×10^{-7}	1.8×10^{-10}	1.4×10^{-5}	5.7×10^{-9}
L10-09 Average involved worker (future use)				
Annual[c]	1.1×10^{-8}	4.3×10^{-12}	9.7×10^{-7}	3.9×10^{-10}
Lifetime[d]	1.5×10^{-7}	5.8×10^{-11}	1.6×10^{-5}	6.4×10^{-9}
All involved workers[e] (future use)				
Annual[c] (person-rem)	7.6×10^{-7}	3.0×10^{-10}	6.8×10^{-5}	2.7×10^{-8}
Lifetime[d] (person-rem)	1.0×10^{-5}	4.1×10^{-9}	1.1×10^{-3}	4.5×10^{-7}
Uninvolved worker[f]	No impact			

a. Supplemental information provided in Tables C-25, C-26, C-31, and C-32 in Appendix C.
b. For the exposed individual worker, probability of a latent fatal cancer; for the worker population, number of fatal cancers.
c. Annual individual worker doses can be compared with the regulatory dose limit of 5 rem (10 CFR 835) and with the SRS administrative exposure guideline of 0.8 rem. Operational procedures ensure that the dose to the maximally exposed worker will remain as far below the regulatory dose limit as is reasonably achievable. The
TE 1995 average dose for all site workers who received a measurable dose was 0.019 rem (see Table 4-16).
d. Based on 5 years of exposure for current workers and 25 years of exposure for future workers; doses are corrected for radioactive decay.
e. Estimated to be 70 workers.
f. L-Area.

Occupational Health

Additional sediments from L-Lake would appear in Steel Creek during periods of heavy rainfall. This increased sediment loading would result in increased concentrations in the surface water and eventually higher concentrations in shoreline sediments in the Steel Creek corridor and delta. These higher concentrations would result in increased exposure to constituents that would result in incremental impacts from direct exposure (e.g., dermal exposure) pathways. The following paragraphs describe these impacts.

Radiological Health

Radiological doses and resulting impacts associated with the Shut Down and Deactivate Alternative would be due to sediment losses from
TE the L-Lake bed. Table 4-46 lists these doses

and resulting impacts. As listed, the probability that the average involved worker would develop a fatal cancer sometime as the result of a single year's exposure to radiation under the current land use scenario would be 1.8×10^{-11}. For the total involved workforce, the collective radiation dose could produce up to 1.3×10^{-9} additional fatal cancer as the result of a single year's exposure; over a 5-year career, the involved workers could have 5.7×10^{-9} additional fatal cancer as a result of exposure. TE

Under the future land use scenario, the probability that the average involved worker would develop a fatal cancer at some time as the result of a single year's exposure to radiation would be 3.9×10^{-10}. For the total involved workforce, the collective radiation dose could produce up to 2.7×10^{-8} additional fatal cancer as the result of a single year's exposure; over a 25-year career, an involved worker could have 4.5×10^{-7} additional fatal cancer as a result of exposure. TC

Nonradiological Health

Nonradiological health impacts (hazard index and cancer risk) were calculated under the current and future land use scenarios for the involved worker. The exposure pathways and exposure times would be the same as those discussed in Section 4.1.8. Table 4-47 lists the results. As listed, the calculated hazard indexes for the maximally exposed involved worker under the current and future land use scenarios (8.6×10^{-5} and 1.8×10^{-3}, respectively) would be a small fraction of 1. Therefore, there is a very low probability that these individuals would experience adverse health effects. TE TC

4.2.8.2.3 Shut Down and Maintain

For the Shut Down and Maintain Alternative, DOE would discontinue pumping to the reactor areas and flow would revert to natural levels in SRS streams as described for the Shut Down and Deactivate Alternative. Therefore, the impacts to workers and members of the public under Shut Down and Maintain would be the same as the impacts under Shut Down and Deactivate.

Table 4-47. Worker nonradiological, noncarcinogenic hazard indexes and cancer risk associated with the Shut Down and Deactivate Alternative.[a] TE

Receptor	Total hazard index	Annual (lifetime) latent cancer risk[b]
Involved worker (current use)	8.6×10^{-5}	7.9×10^{-12} (3.9×10^{-11})
Involved worker (future use)	1.8×10^{-3}	1.5×10^{-10} (3.6×10^{-9})
Uninvolved worker[c]	No impact	No impact

TC

a. Supplemental information is provided in Tables C-33 and C-34 in Appendix C.
b. Resulting from exposure to beryllium and arsenic in sediments.
c. Steel Creek bed remains saturated and therefore no atmospheric releases to L-Area.