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DPST-82-950-TL

CC: R. Maher, SRP

December 7, 1982

"Authorized by R.L. Collins 8/10/01"

UNCLASSIFIED

Mr. C. G. Halsted
Savannah River Operations Office
U. S. Department of Energy
P. O. Box A
Aiken, South Carolina 29808

Dear Mr. Halsted:

DISPOSITION OF DEPLETED URANIUM OXIDE (UO_3)

You requested[1] that SRL study methods of disposition for the growing depleted uranium oxide UO_3 stockpile at SRP. A letter[2] was sent to you indicating that UO_3 storage or disposal would be studied and recommendations would be made. The study is detailed in the enclosed memorandum by J. T. Prendergast and G. F. O'Neill.

Potential for sale of the depleted UO_3 is very limited and there are cheaper sources of depleted uranium than SRP UO_3. Burying the UO_3 causes problems both from the radioactivity and the "heavy metal poison" characteristics of the material so disposal in this way is expensive. However, the depleted uranium is a resource that should be kept for its potential use as fertile material in fast breeder reactors. Storage for many years will be required. We recommend that new storage buildings be erected as needed. This entails in the near term, construction of a new storage building in F area. Storage until the advent of breeders will cost about $0.50/lb undiscounted and $0.09/lb discounted.

Yours very truly,

J. L. Crandall for TLC

J. L. Crandall
Program Manager
Planning

GFO:pph
Att.

1. Letter, C. G. Halsted to S. Mirshak, August 4, 1982.
2. Letter, J. L. Crandall to C. G. Halsted, August 31, 1982.

FOREWORD

The purpose of this document is to summarize environmental information which has been collected up to June 1983 since publication of the previous Environmental Information Document (DPST-81-241) in April 1982, and the L-Reactor Environmental Assessment (DOE/EA-0195) in August 1982. Information presented here will also be further updated in the L-Reactor Environmental Impact Statement to be issued in the fall of 1983.

Of particular interest in the document is an updating of dose estimates from lower cesium transport estimates from Steel Creek and new sports fish consumption data for the Savannah River. The results of the first six months of new fisheries surveys on the Savannah River are also presented, plus an update of results from the continuing studies by the Savannah River Ecology Laboratory (SREL) in the wetlands of the Steel Creek area. Future monitoring and mitigation plans are briefly summarized. Finally, the various permitting requirements are discussed.

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1. EXECUTIVE SUMMARY

The resumption of the operation of L-Reactor is planned at the Savannah River Plant (SRP). Currently L Reactor is being upgraded and renovated to bring it to the same operational status of C, K, and P Reactors on SRP. Nearly all of the major capital projects are nearing completion. This document summarizes environmental information which has been collected up to June 1983 since the publication of the previous Environmental Information Document[1] in April 1982 and the L-Reactor Environmental Assessment[2] in August 1982.

Of particular interest is an updating of dose estimates from changes in methodology of calculation, lower cesium transport estimates from Steel Creek, and new sports fish consumption data for the Savannah River. The results of the first six months of new fisheries surveys on the Savannah River are also presented, plus an update of results from the continuing studies by the Savannah River Ecology Laboratory (SREL) in the wetlands of the Steel Creek area. Future monitoring and mitigation plans associated with L-Reactor restart are briefly summarized. Finally the status of various permitting requirements are discussed.

1.1 Radiation Doses

1.1.1 Atmospheric Releases

A reassessment of the potential radiation doses to people living in the vicinity of the SRP from routine atmospheric releases of radionuclides by L Reactor was made. The annual doses to the hypothetical maximally exposed individual and the population within 50 miles are calculated from the estimated average and maximum annual releases. More realistic and less overestimative meteorological data and assumptions than in the Environmental Information Document were used in calculating doses. Furthermore, the estimated average and maximum release rates of the radionuclides are calculated primarily from stacks except for several small ground-level releases. In the previous assessment,[1] all of the releases were treated as being from ground level, which resulted in overestimation of the doses.

With respect to offsite exposure due to reactivation of L Reactor, the most important radionuclide is tritium (H-3), which will account for more than 70% of the total body doses via the inhalation and ingestion pathways. External exposure to noble gases, especially Ar-41, will also be an important pathway. The maximum annual total-body dose commitment to the 50-mile population is 16.5 man-rem per year of operation. This 16.5 man-rem compares to 63,000 man-rem received by the same population from natural background. Inhalation, ingestion, and external exposure to noble gases account for 44%, 40%, and 15% of this total-body dose rate; radionuclides contributing more than 10% are tritium (81%) and Argon-41 (10.1%).

The maximum individual average-annual dose rate to the total body is 0.41 millirem per year, 59% by ingestion, and 25% from external exposure to noble gases; tritium (H-3) contributes 71% of the dose rate. This 0.41 millirem compares to 93 millirem received by an individual near SRP from natural background.

1.1.2 Liquid Releases

During routine operations, radioactive materials will be discharged in liquid effluents from L Area and its support facilities. The principal radionuclide released will be tritium. In addition, a small amount of Cs-137 and Co-60 will be remobilized from Steel Creek to the Savannah River and downstream water users. The maximum individual dose from routine releases is calculated at 0.12 mrem, primarily from tritium. The population dose is estimated at 2.06 man-rem.

Combined cesium-137 and cobalt-60 remobilization from Steel Creek will result in an estimated maximum individual dose of 3.48 mrem during the first year, primarily from the fish pathway, decreasing during subsequent years. The calculated population dose is estimated to be about 9.13 man-rem the first year, again primarily due to the fish pathway. These estimated doses are slightly less than previously calculated for the L-EID.[1]

1.2 Wetlands - Flora and Fauna

1.2.1 Wetlands

NASA Landsat data was used to estimate the acres of wetlands along the Savannah River floodplain and on the SRP. There are approximately 130,000 acres of wetlands in the 179,400 acres of Savannah River floodplain between Augusta, GA (River Mile 195) and Ebenezer Landing, GA (River Mile 45). The Environmental Assessment[2] (EA) estimated 39,000 acres of wetlands for SRP and the Landsat data analysis estimated 39,870. The EA estimated that the impacted area in the Steel Creek corridor would be 580 acres. The Landsat data estimated that 792 acres of bottomland hardwood exists along the Steel Creek corridor. The Environmental Information Document (EID) estimated the impact area as 725 acres along the corridor. The EID estimated about 285 acres in the Steel Creek delta and the EA reported 420 acres in the delta. Remote sensing data give the maximum impact area as 307 acres in 1966. The combined total expected impact area in the Steel Creek corridor and delta of about 1000 acres is approximately 2.5 percent of the total SRP wetlands.

Examination of past aerial photography of the Steel Creek delta indicates that successional revegetation of the delta is continuing. Willow shrub and a low forest community has overgrown much of the upper part of the Steel Creek delta.

1.2.2 Waterfowl

The SRP Savannah River Swamp contains a wide variety of habitat types and provides excellent habitat for wintering waterfowl. Aquatic habitats ranging from open channels to dense cypress-tupelo forest are present. The Steel Creek Delta area provides excellent waterfowl habitat because several vegetation types (marsh, shrub, bottomland hardwoods, cypress-tupelo) occur in close proximity to one another.

Nine species of waterfowl were observed in the Steel Creek Delta area between mid-September 1981 and March 1982. Wood ducks are present throughout the year, but a substantial turnover of individuals occurs seasonally. Wintering populations are larger than summer populations because of the influx of migratory wood ducks. In general, the remaining species are present only during the fall and/or winter months, although hooded mergansers may occasionally breed on the SRP.

Waterfowl use Steel Creek Delta for both feeding and roosting. Up to 300 mallards, 200 wood ducks, 50 green-winged teal, 25 American wigeon, and 20 hooded mergansers were seen flying into the Steel Creek Delta roost. This roost area is characterized by a dense growth of buttonbush that provided good overhead protection from predators. Waterfowl also fed extensively in the cypress-tupelo forest surrounding the Steel Creek Delta area.

Nest boxes have been used to estimate the pattern of wood duck use of the Steel Creek area since the early 1970's. The results of the nest box surveys indicate that while portions of the Steel Creek habitat are still of value to nesting wood ducks, other parts of the Steel Creek Delta and the floodplains of the upper reaches of the stream are becoming progressively less appropriate for duck nesting. This decline in usage occurs as normal successional processes replace the open areas created by earlier thermal reactor effluents where dense stands of young woody vegetation limit access to nest cavities.

Although the quality of habitat in Steel Creek Delta is declining with respect to wood duck nest box use, studies indicate that the delta still provides excellent brood habitat and that use in nearby wetlands has remained stable. An expanded nest box program is under way to provide for additional wood duck nesting near the Steel Creek corridor in other suitable habitats.

1.2.3 Wood Stork

The wood stork has been proposed for listing as an endangered species by the U.S. Fish and Wildlife Service. Individuals and small groups of this species have been observed in recent years roosting and feeding in the Steel Creek Delta area during 1981 and 1982. No nesting has been reported on the SRP; the nearest rookery is located 28 miles southwest of the SRP at Millen, GA within feeding range of the species.

The sightings of wood storks in Steel Creek Delta correspond with wood stork activity at the Millen Rookery. In 1980, 400 wood storks were present at this rookery in early July and over 20 wood storks were seen at one time over Steel Creek Delta. In 1981, wood storks at the Millen rookery did not complete the nesting cycle and few birds were seen at SRP. In 1982, however, about 115 to 130 adult wood storks were present at Millen and nests were observed to contain feathered young. Wood storks were sighted on numerous occasions at SRP during 1982. These preliminary survey results together with the observation of both juvenile and adult wood storks during August and September of 1982, may suggest that the Steel Creek Delta could represent feeding habitat for wood storks from the Millen rookery.

Since the thermal effluents resulting from L Reactor will eliminate potential feeding habitat for this wading bird in the Steel Creek Delta, an intensive study program of the Millen rookery wood stork population and the use of the Steel Creek area by wood stork is under way.

1.2.4 American Alligator

Studies of the American alligator through the winter of 1981-1982 using radio-telemetry indicated that this species remains active throughout the winter at SRP, rather than undergoing an inactive period in subterranean dens. A male alligator changed locations repeatedly throughout the winter, travelling distances of several kilometers. While female alligators also remain active, the range of movement for females is much smaller than for males. It appears that the availability of shallow water areas (<50 cm deep) is important for the species during periods when temperatures are sufficiently cold to freeze the surface water. Census efforts indicated that 25 to 35 alligators occur in the Steel Creek drainage with the highest densities in backwater lagoons in the vicinity of Highway 125 (SRP Road A) and Steel Creek. The only clear evidence of recent successful reproduction was also observed at the SRP Road A lagoon. A mitigation program approved by the U.S. Fish and Wildlife Service is under way to protect these lagoons.

1.3 Fisheries

1.3.1 Savannah River Fisheries Program

A new Savannah River Fisheries Program was started in March 1982 to evaluate the impact of SRP, particularly L-Reactor restart, on the Savannah River fisheries. Results from the first six months of the three-year program indicate that entrainment and impingement patterns are generally similar to that in previous studies undertaken in 1977; however, differences have been observed.

A total of 10,205 fish eggs and larvae were collected in 2138 meroplankton samples from the Savannah River and tributary streams between March 11 and August 29, 1982. The 5176 fish larvae collected were primarily blueback herring and shad. Unidentified minnows and spotted suckers were also very abundant. The 5029 fish eggs collected were primarily American shad. Striped bass and blueback herring eggs were very abundant during a short period of time.

Peak spawning activity occurred in May. In May and June the abundance of fish eggs and larvae was significantly higher in nighttime collections than in daytime collections. Striped bass spawning, which previously had not been recorded from the Central Savannah River Area, was noted on two occasions in May and one occasion in July. Fifteen sturgeon larvae also were collected including both the Altantic and shortnose sturgeon. Upper Three Runs and Steel Creeks were productive areas for fish spawning, whereas Four Mile Creek was not used for spawning.

Entrainment of ichthyoplankton by SRP cooling water intake was calculated to be approximately 17.9 x 10^6 fish larvae per year, and 18.1 x 10^6 fish eggs per year. Larval fish entrainment in 1982 was very similar to entrainment in 1977 while egg entrainment was about two and one-half times higher. Entrainment of fish eggs and larvae is dependent on several factors including: (1) the density of organisms in the river, (2) the amount of spawning in the intake canals and (3) in the case of the 1G intake, on the density of organisms in Upper Three Runs Creek.

Impingement of fishes was low with a maximum of 44 fish impinged in a 24-hour period. A total of 228 fish in 22 species were collected in 13 samples or an average of 17.5 fish per sample.

Electrofishing was conducted in August 1982. A total of 407 fish in 32 species were collected. The results were consistent with electrofishing efforts by the Georgia Game and Fish Division. No fish were collected in Four Mile Creek, although the collection from the area below Four Mile Creek was not different from the other areas.

1.3.2 Steel Creek Area

Studies of fish populations in the Steel Creek delta-swamp system by SREL showed a high species diversity. Fifty-five of the 79 fish species known to occur on the SRP were found in this area. The highest abundance and diversity of fish occur in deepwater areas where the tree canopy was eliminated during previous reactor operations and the vegetation is currently dominated by submergent and emergent macrophytes. The use of the Steel Creek delta-swamp area by anadromous fish species (e.g., American shad and blueback herring) was minimal during 1982. The appearance of American shad in Steel Creek was late and the numbers were quite small. However, it appears that the shad spawning run in the Savannah River was smaller than in previous years. Large year-to-year variations in abundance of anadromous fish species are quite common. Ichthyoplankton sampling in lower Steel Creek revealed no evidence of reproduction by shad or blueback herring in the Steel Creek area during 1982. Future surveys will continue to determine if 1982 was a typical year.

1.3.3 Savannah River Sports Fishing

The Fisheries Section of the Georgia Department of Natural Resources recently published the results of a fisheries study conducted on the Savannah River during the period July 1981 through June 1982. Data on fishing effort, harvest, species sought, habitat or location fished, and angler origin were collected from sports fishermen.

Approximately 4,600 anglers fish in the freshwater section of the Savannah River. Georgia residents comprise 68.2% of these anglers. The anglers fish in both the mainstream (58.2%) and oxbows, creeks, and lakes (41.8%) of the Savannah. Freshwater anglers spend the most time (43.8%) trying to catch bream - i.e., bluegill, redbreast sunfish, warmouth, redear sunfish, and spotted sunfish. Bream accounted for 73% of the fish caught. Largemouth bass is the next most popular species (38% of the time); however, success is low (2.5% of the fish caught). About 90,000 kilograms of freshwater sports fish are harvested from the lower Savannah River annually.

1.3.4 *Expanded Fisheries Studies*

In February 1983, the original fisheries program was expanded to include all SRP tributaries to the Savannah River and to collect samples of fish eggs and larvae from the river and its major tributaries from Augusta to near Savannah. The expanded program will examine the relative importance of the SRP area to the fisheries on the Savannah River. Nearfield stations are located in Upper Three Runs, Beaver Dam, Four Mile, Steel, and Lower Three Runs creeks, and in the 1G and 3G SRP river pumphouse intake canals. Farfield stations are located in 28 additional creeks and at 10-mile intervals in the river from Augusta to Savannah. Collections have started at both the nearfield and farfield locations.

1.4 Regulatory Status

Many of the permits necessary for the operation of L Reactor have been received. These include construction permits for domestic wells and water treatment plant, the sanitary waste treatment plant, air permits for the oil-fired boiler, emergency generators, and F-, H-, and M-Area process releases.

Consultation with the United States Fish and Wildlife Service on the American alligator was completed in February 1983. Mitigation plans for the protection of alligator habitat in two backwater lagoons near Highway 125 and Steel Creek are in place. Additional consultation is planned with the change in startup schedule.

The wood stork has been proposed for protection under the Endangered Species Act. Studies are ongoing to support preparation of a Biological Assessment and formal consultation with the USFWS on this species. A Biological Assessment is in preparation for the federally endangered shortnose sturgeon.

DOE issued a wetlands notice in the Federal Register in July 1982, and a notice of wetlands determination appeared a month later. The notice concluded that, because of cost and a startup schedule in October 1983, no practicable alternative exists to once-through cooling for the reactor with direct discharge of the secondary cooling water to Steel Creek.

A monitoring and mitigation plan has been agreed upon by DOE and the State Historic Preservation Officer for the five archeologically important sites along Steel Creek.

The South Carolina Department of Health and Environmental Control (SCDHEC) issued to SRP in 1982 two draft NPDES permits in response to the SRP permit application in early 1982. The second draft permit mandated the application of South Carolina Class B stream criteria including temperature limitations to the discharge of cooling water from L-Reactor to Steel Creek. This draft likewise did not allow for a mixing zone below the mouth of Steel Creek in the Savannah River as allowed under the previous SRP NPDES permit. A third draft permit was received in May 1983 which would allow for interim releases of once-through cooling water to Steel Creek and a mixing zone in the Savannah River. The conditions of the latest draft permit are under negotiation.

DOE published an Environmental Assessment and a Finding of No Significant Impact (FONSI) in the Federal Register in August 1982. The FONSI was challenged in late 1982 by several environmental groups, principally the Natural Resources Defense Council (NRDC), in a suit filed by NRDC in the Federal District Court for the District of Columbia. Following congressional action and court action in July 1983, DOE is preparing an Environmental Impact Statement for L-Reactor startup.

1.5 References

1. Environmental Information Document L-Reactor Reactivation. E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC 29808, DPST-81-241 (April 1982).

2. DOE. Environmental Assessment L-Reactor Operation Savannah River Plant, Aiken, SC. DOE/EA-0195 (August 1982).

2. STATUS OF L-REACTOR REACTIVATION

This chapter summarizes the project status of the reactivation of L Reactor at SRP. The status of the major construction and test activities necessary to support the reactor reactivation is discussed as of late summer 1983.

2.1 Project Status

Renovation, restoration, and upgrading of L-Area facilities has been under way since 1980. Renovation and restoration projects have included capital improvements and general maintenance and repair activities. Capital and repair projects are to be completed by fall 1983 and the reactor will be in operational status. Associated L-Area facilities are shown in Figure 2.1-1.

2.2 Major Construction Milestones

A brief summary of the status of construction projects with potential for environmental effects both inside and outside L Area in support of the reactivation is presented below. Table 2.2-1 summarizes the current status of these activities.

2.2.1 Inside L-Area

2.2.1.1 Water Plant and Wells

Two deep wells of 500 gpm each were drilled in 1982 to supply L-Area water needs in addition to the two deep wells previously in operation.

The L-Area water treatment plant is in the process of being replaced. Facilities necessary for degasification and chlorination have been included in the new water plant. At present, the water plant is operating manually. The automatic chemical injection system is expected to be operational by September 1983.

2.2.1.2 186-Basin Cleaning

Cooling water drawn from the Savannah River for L-Reactor is delivered to the L-Reactor cooling water reservoir, which is known as the 186-Basin (25 million gallon basin, Figure 2.1-1). There are three separate sections in the basin.

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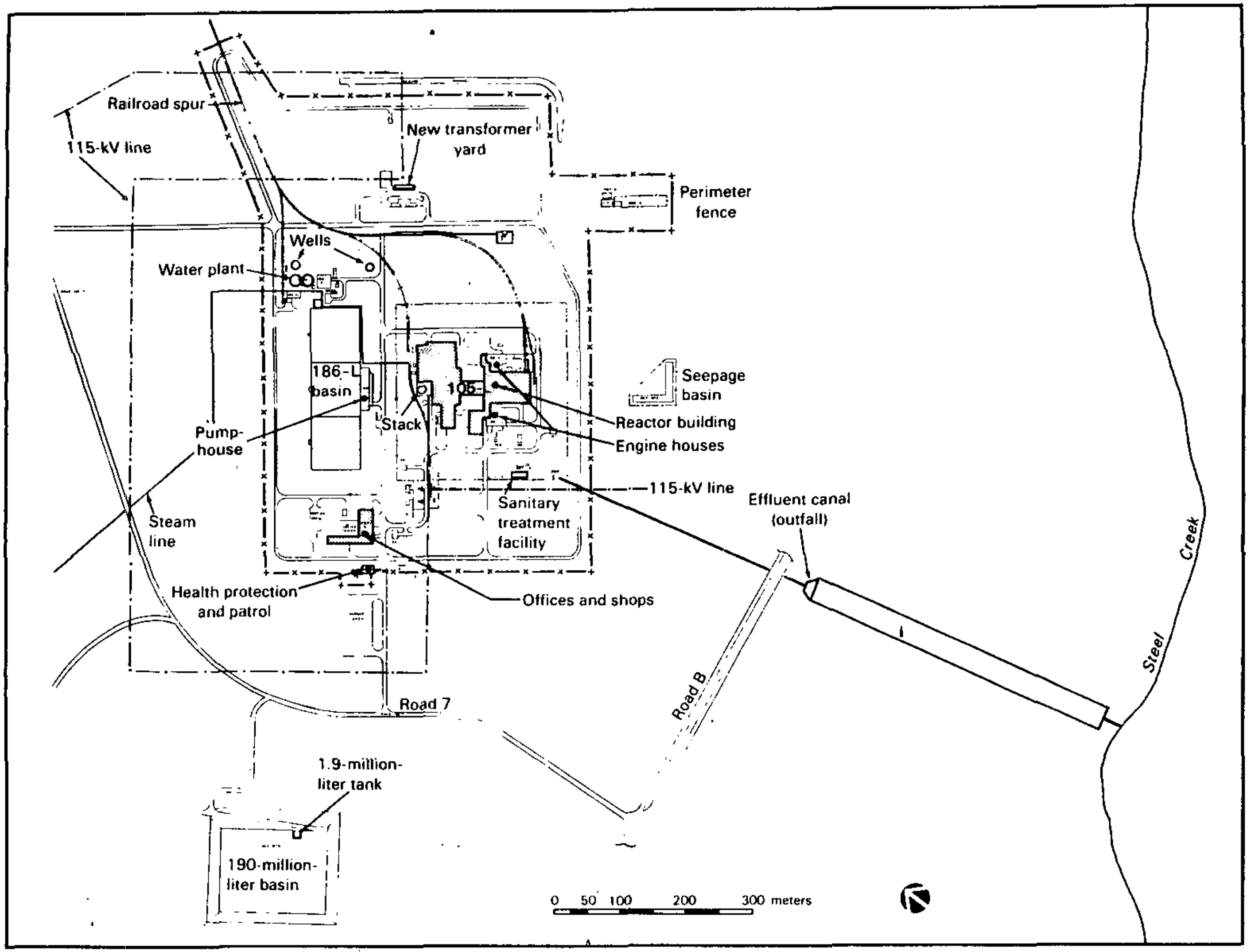

Figure 2.1-1. L-Area construction activities

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TABLE 2.2-1

Major L-Area Construction Milestones

Activity	Current Status
Inside Area	
1. Water Plant and Wells	
(a) additional deep wells	completed 1982
(b) chemical-injected water system	completed
2. 186 Basin Cleaning	
(a) Basin 1	completed early 1983
(b) Basin 2	completed May 1983
(c) Basin 3	completed May 1983
3. Sanitary Waste Treatment Plant	
(a) 1st phase	completed
(b) 2nd phase	completed May 1983
4. Electric Power	
(a) new tie line	completed
(b) new substation	completed
5. Backup Boiler	out-of-service 2/83
6. Seismic Bracing	
(a) actuator tower	completed 1981
(b) stack	completed 1982
(c) process water equipment	completed
Outside Area	
1. Steam Line: K Area to L Area	completed May 1983
2. Rubble Pit	
(a) pit near railroad track	full, covered, closed
(b) pit near Pen Branch	closed
3. Meteorological Tower	
(a) construction	completed
(b) operational hook-up	in progress
4. Cooling Canal Renovation	
(a) clear and cutting	completed
(b) riprap additions	completed
(c) headwall improvements	completed

TABLE 2.2-1, Contd

Activity	Current Status
Outside Area, Contd.	
5. 50-Million-Gallon Basin	
(a) repair of basin floor	completed 1981
(b) 500,000 gallon tank in basin	completed 1983
(c) replacement of piping to basin	completed 1983
6. Railroad Track Spur to L Area	
(a) reworking of grade crossing	near completion
(b) signal gear refurbished	near completion
(c) rail tie replacement	near completion
7. River Pumphouse	
(a) restart of two retired pumps	completed

In March 1981, the 186-Basin was drained and cleaned. The residue in the bottom of the basin was flushed to Steel Creek and the basin was refilled following the restoration of underwater equipment. A second draining, cleaning, and inspecting of each of the basins began in mid-February 1983 and was completed in May 1983.

2.2.1.3 Sanitary Waste Treatment Plant

A new, packaged sanitary waste treatment plant will handle domestic sewage from L-Area work force. The new system (Figure 2.2-1) was fully operating by May 1983.

Treated sanitary effluents will be chlorinated and monitored prior to discharge to the L-Area cooling water outfall (L-007) to Steel Creek. Periodically, the treated sludge will be pumped from the sludge holding tank to a mobile tank and transported to the sludge pit near Central Shops at SRP.

2.2.1.4 Electric Power

A new 115 kV electric tie line has been installed within L Areato supply power to a new substation from the two previously existing 115 kV power lines which supply electrical power to L Area (Figure 2.1-1). The new tie line within the area was completed in January 1983. Land clearing required for the installation of this power line was minimal.

A new substation was installed in L Area in May 1983 to replace the powerhouse, which was dismantled during the standby period.

2.2.1.5 Backup Boiler

A temporary, oil-fired steam boiler was installed in L-Area to provide steam until the steam line from K Area became operable (Figure 2.1-1). This temporary steam boiler went out of service in February 1983. The steam line from K Area to L Area was completed in May 1983 (Section 2.2.2.1).

2.2.1.6 Seismic Bracing

Bracing has been provided to the reactor building vent stack and the actuator tower to prevent failure in case of an earthquake with an acceleration of 0.2 g. Bracing on the actuator tower was completed in late 1981 and bracing on the stack was completed in May 1982. Seismic bracing to various process water piping and the process water heat exchangers has also been installed.

2.2.2 Outside Area

2.2.2.1 Steam Line

The K- to L-Area steam line was completed and became operational by the end of May 1983. The steam line is necessary to supply L-Area steam needs; the L-Area powerhouse was dismantled and removed shortly after the area was placed on standby in 1968.

Environmental effects from the installation of the K to L-Area steam line are small. Less than twenty acres of land required clearing and the steam line is not expected to interfere with wildlife.

2.2.2.2 Rubble Pits

Since late 1981, two new rubble pits have been established near L Area. These rubble pits have been used for the disposal of concrete and other miscellaneous noncombustible material generated from construction activities. Location of the rubble pits near L Area minimized hauling distance.

The first rubble pit adjacent to the L-Area railroad spur accommodated about 68,000 ft^3 of waste. This pit is full and has been covered with earth. The second rubble pit, located near the steam line, is no longer in active operation. Rubble is being hauled to the SRP sanitary landfill.

2.2.2.3 Meteorological Tower

A 61-meter meteorological tower has been constructed 2000 feet east of L Area. The tower and its equipment are similar to the other seven meteorological towers at SRP and will provide wind data for both emergency response conditions and for routine assessments.

The construction of the meteorological tower is complete, but the system is not as yet operational. The conduit to the tower is complete and associated equipment is being mounted. Operational checkout of the tower is expected by the end of August 1983.

2.2.2.4 Cooling Canal Renovation

Renovation of the L-Area effluent canal (Figure 2.1-1) was part of a 1981/1982 SRP project to improve the cooling water effluent canal to Steel Creek. Renovations to the cooling canal included brush clearing within the canal, headwall improvements, and reinforcement of the canal bed with riprap to prevent future erosion. This project was completed in 1982.

2.2.2.5 50-Million Gallon Basin

Initial improvements to the 50-million-basin at L Area (Figure 2.1-1) were completed in late 1981. This basin is designed to receive radioactive water in the event of a major accident. Trees and brush were removed and the earthen floor was repaired.

1982 renovations to the 50-million-gallon basin included the placement of a 500,000-gallon tank inside the basin to contain initial discharges in case of an accident and the replacement of 3000 feet of piping from the reactor area to the basin.

2.2.2.6 Railroad Track Spur to L Area

The railroad track spur project to L Area to facilitate the transport of large and heavy equipment was delayed in 1982. All equipment to L Area has been transported by truck. The railroad track spur is now scheduled for completion by September 1983. Improvements will include the reworking of the track spur and crossings, the refurbishing of signal gear, and the replacement of rail ties as necessary.

2.2.2.7 River Pumphouses

Two retired pumps at river pumping station 1G will be placed back in service prior to the October restart of L Reactor. With these two pumps returned to service, twenty pumps will be operable, from which fifteen to eighteen pumps will be required with C, K, P, and L Reactors operating. The two retired pumps at station 1G are operational.

2.3 L-Area Cold Water Flow Tests

In preparation of the L-Reactor restart scheduled for October of 1983, L Area has begun the testing, inspecting, and cleaning of various components of the L-Reactor cooling water system. A schedule for the 1983 cold water tests is given in Table 2.3-1. These tests (especially flows) have been modified by Congressional action and may be rescheduled in part until the EIS is completed.

Cooling water for these tests will be pumped from the Savannah River through the system being tested in L Area and then discharged either to Steel Creek or to the 50-million-gallon basin in L Area

(Figure 2.1-1). Cold water effluents to Steel Creek will be returned to the Savannah River via the Steel Creek and swamp system.

Planned cold water tests with discharges to Steel Creek include the draining and inspecting of the 186-Basins, direct-current (D.C.) motor tests, cooling pump tests, full flow tests, and emergency cooling system (ECS) flushes. Planned cold water tests with discharges to the 50-million-gallon basin include spray tests, confinement heat removal (CHR) tests, and special tests.

The maximum environmental impact from planned cold water tests will result from the full flow tests. Flows from full flow tests could reach 180,000 gpm, which represents about ten times the mean Steel Creek flow rate, and over twice the mean annual daily maximum flow rate from rainfall events. The river water for the cold flow tests will be chlorinated up to 1 ppm in order to protect the heat exchangers and other equipment from biofouling and residue problems.

Radiological impacts from Cs-137 remobilization in Steel Creek as a result of the cold water tests are expected to be negligible. The maximum amount of Cs-137 estimated to have been remobilized from Steel Creek as a result of intermittent flow tests in May was about 0.045 Ci and is estimated to be about 0.4 Ci for the full flow tests. These estimations are small when contrasted to the 9.8 Ci predicted to be remobilized in the L-Reactor Environmental Assessment[1] for the first full year of L-Reactor operation or the 4.4 curies in more recent first-year estimates. Resulting Cs-137 concentrations in the Savannah River are about 0.25 pCi/L for both intermittent and full flow tests. The Cs-137 impacts are small with respect to the EPA drinking water standard of 200 pCi/L.

Some impacts upon vegetation and aquatic life in the Steel Creek corridor will occur over that which results from rainfall events. Significant impacts upon the Savannah River are not anticipated.

All planned cold water tests will be monitored by the SRP Health Protection Department. Measurements of physical and chemical parameters, including Cs-137, will be made prior to, during, and after all of the cold water tests.

2.4 Radiological Activities from L-Area Construction

2.4.1 1982 Dose to Construction Force

Occupational Health Protection records from 1982 indicate a total radiological dose of 28.4 man-rem to construction personnel assigned to L Area.

TABLE 2.3-1

L-Area Cold-Water Flow Tests for 1983*

	Start Date	End Date	Flow Rate, GPM**	Duration, days
Steel Creek				
Drain & flush 186-basins	2/14/83	5/31/83	20,000	12
DC motor & Caterpillar engine cooling (PW flushes and CD flow)	4/15/83	9/15/83	5,000	continuing
Cooling pump test	6/1/83	7/1/83	30,000	7
Full flow				
- Intermittent tests			up to 180,000	7
- Preparations for startup			180,000	75% of time
ECS flushes	6/1/83	8/31/83	14,000	6
50 MM Gallon Basin				
Spray tests	6/15/83	7/15/83	2,100	5
CHR tests and flood control	9/25/83	10/15/83	14,000	1
Special tests	9/1/83	9/15/83	14,000	7

Seepage Basin

The disassembly basins were filled by 6/1/83, but no purges to the seepage basins have occurred.

* Congressional action has placed limits on flow testing.
** All flows are additive; maximum flow for a series of tests for any one day is the largest flow rate listed.

2.4.2 L-Area Releases to Steel Creek

Beginning in May 1981, water from miscellaneous sumps and the disassembly basin in L Area was released to Steel Creek. The disassembly basin contained small amounts of radionuclides (primarily tritium, ^{137}Cs and ^{90}Sr) associated with the operation of the L Reactor in past years. The basin was dewatered to allow replacement or repair of all underwater equipment prior to reactivation of this facility.

Prior to release of disassembly basin water to Steel Creek, a continuous water sampler was installed in the L-Area effluent canal for routine monitoring of L-Area releases. Tables 2.4-1 and 2.4-2 summarize radionuclide releases during 1981 and 1982, respectively, from L-Area activities to Steel Creek.

2.4.3 L-Area Low-Level Waste Deposition

The SRP Burial Ground is a 195-acre site between the F- and H-Separations Areas. The burial ground is used for storage and burial of all radioactive solid waste produced by the SRP nuclear complex.

The SRP Burial Ground is divided into sections to accommodate different categories of waste and contained radionuclides. The division facilitates control procedures and post-burial monitoring. Categories of waste include:

- Retrievable transuranium (TRU) alpha waste
- Buried transuranium alpha waste
- Low-level beta-gamma waste
- High-level beta-gamma waste

Records are kept of the general contents, radiation level, radionuclide content, and storage location of each individual package of waste. The low-level radioactive waste removed from L Area and shipped to the burial ground has been classified as fission products, induced activity, and others. The total quantity buried from L Area between January 1980 and February 1983 inclusive was about 435 Ci. Table 2.4-3 summarizes the volume and activity of low-level waste from L Area deposited in the burial ground during this period.

Fission products and others classification accounted for about 0.5 Ci. The remainder of the low-level waste was induced activity, principally Co-60 in stainless steel.

TABLE 2.4-1

L-Area Liquid Radioactive Releases for 1981

	Curies							
	T	Co-60	Sr-90	Cs-134	Cs-137	Other Beta-Gamma	Alpha	Water Volume, Liters
January	-	-	-	-	-	-	-	
February	-	-	-	-	-	-	-	
March	-	-	-	-	-	-	-	
April	-	-	-	-	-	-	-	
May	2.120E+02	-	1.100E-02	-	3.040E-02	1.050E-02	6.400E-05	
June	NA	-	-	-	NA	NA	NA	
July	NA	-	-	-	NA	NA	NA	
August	1.000E+00	6.600E-05	5.700E-05	-	1.763E-02	-	2.500E-06	1.859E+06
September	2.200E+00	1.000E-06	5.960E-04	-	2.627E-03	-	3.000E-06	7.118E+05
October	5.000E+00	-	2.250E-04	-	3.370E-04	2.420E-04	1.000E-06	1.699E+05
November	2.000E+00	4.700E-05	4.320E-04	-	4.360E-04	5.290E-04	2.000E-06	1.456E+05
December	1.580E-01	-	5.000E-05	-	7.600E-05	1.330E-04	-	1.099E+04
Year to Date Total	2.581E+02	1.140E-04	1.236E-02	-	5.521E-02	1.581E-02	9.500E-05	1.192E+07

NA = Data not available by month

TABLE 2.4-2

L-Area Liquid Radioactive Releases for 1982

	Curies							
	T	Co-60	Sr-90	Cs-134	Cs-137	Other Beta-Gamma	Alpha	Water Volume, Liters
January	1.000E+00	-	1.360E-04	-	1.820E-04	-	-	5.699E+04
February	2.000E+00	8.000E-06	2.800E-05	-	3.400E-05	-	-	1.325E+05
March	6.400E+01	5.000E-06	-	-	1.000E-05	-	-	1.500E+04
April	1.000E+00	4.100E-05	1.800E-05	-	1.640E-04	-	2.000E-05	1.152E+05
May	-	9.000E-06	-	-	1.300E-05	-	1.000E-06	4.799E+04
June	-	1.000E-05	-	-	1.420E-04	-	-	1.389E+04
July	-	-	2.000E-06	-	1.400E-05	-	-	8.459E+04
August	-	-	-	-	-	-	-	-
September	-	9.000E-06	-	-	-	-	-	2.499E+04
October	2.200E-02	-	-	-	-	-	-	3.639E+04
November	-	2.100E-05	2.000E-05	-	-	-	-	5.399E+04
December	-	8.000E-06	9.000E-06	-	-	-	-	2.399E+04
Total	6.802E+01	1.110E-04	2.130E-04	-	5.590E-04	-	2.100E-05	6.058E+05
Std. Dev.	±2.818E+01	±1.193E-05	±5.005E-05	-	±7.870E-05	-	±1.343E-05	±4.010E+04

- Less than sensitivity of analyses

TABLE 2.4-3

L-Area Low-Level Waste Deposition to SRP Burial Ground
January 1980 Through February 1983

Year		Volume (ft^3)	Activity (Ci)
1980		1,435	0.18
1981		~25,000	42.4
1982		51,000	367.0
1983	January	4,100	8.4
	February	8,600	17.0
	Total	90,135 ft^3	434.98 Ci

2.5 Status of Hazardous Wastes from L Area

2.5.1 Treatment and Disposal of Polychlorinated Biphenyls (PCBs)

PCBs in L Area that have been disposed consist of the following:

- One transformer containing 260 gallons of oil with 523 ppm PCB
- Eighteen pump motor capacitors with 28 lb PCB
- Six large capacitors with 34 lb PCB
- Two drums of PCB flourescent lamp ballasts.
- Two hundred forty mercury-vapor ballasts.

Treatment and deposition of these PCBs are discussed below.

2.5.1.1 PCB Transformer

A transformer containing 260 gallons of oil with 523 ppm PCBs was treated in place in March 1982 by Sun Oil Co. utilizing the EPA-approved PCBX process. The PCBX process chemically destroys PCBs. After 90 days the transformer oil was resampled and Sun Oil recertified the transformer to non-PCB status. All residue generated during treatment was shipped by Sun Oil Co. to an EPA-certified disposal facility in Emelle, Alabama.

2.5.1.2 Pump Motor Capacitors

Eighteen pump motor capacitors containing 28 lb PCB were removed from service on January 21, 1982 and were placed in four PCB drums (Type 17C) approved by the Department of Transportation (DOT) for nonliquid PCB articles. The drums were placed in the onsite PCB storage facility on January 26, 1982, and were subsequently shipped offsite to Emelle, Alabama, for disposal on March 1, 1982.

2.5.1.3 Other Capacitors

Six capacitors containing 34 lb PCB were removed from service on May 1, 1982, and were placed in four DOT-approved PCB drums (Type 17C). The drums were placed in the onsite PCB storage facility on May 11, 1982, and were shipped offsite to Emelle, Alabama for disposal on May 12, 1982.

2.5.1.4 Fluorescent Lamp Ballasts

Two drums of fluorescent lamp ballasts (unknown quantity) were placed in the onsite PCB storage facility on December 10, 1981. The lamp ballasts were packaged in DOT-approved PCB containers (Type 17C) for non-liquid waste. The drums were subsequently shipped offsite to Emelle, Alabama (EPA-certified PCB disposal facility) on January 8, 1982.

One drum of fluorescent lamp ballast (unknown quantity) were placed in the onsite PCB storage facility on May 11, 1982. The drum was shipped to Emelle, Alabama on May 12, 1982 for disposal.

2.5.1.5 Mercury Vapor PCB Ballasts

Twelve drums of 240 mercury vapor ballasts were placed in the onsite PCB storage facility on December 10, 1981 and were shipped to Emelle, Alabama for disposal on January 8, 1982.

2.5.2 *Asbestos-Covered Pipe From L-Area*

The asbestos covered pipe removed from L Area was buried in the C-Area asbestos disposal pit located near C-Reactor Area. The dimensions of the existing pit are 60 feet by 300 feet. The pit consists of an excavation approximately 12 feet deep in a clay-type soil. The asbestos covered pipe was wrapped in heavy polyethylene sheets before burial. Cover is applied to prevent asbestos fibers from becoming airborne. The final cover is a minimum of 4 feet of overburden from the excavated clay soil.

The South Carolina Department of Health and Environmental Control (SCDHEC) reviewed the plans for disposal of the pipe from L Area, inspected the disposal site, and reviewed the work in progress. SCDHEC concurred that the disposal procedures complied with applicable regulations.

2.6 REFERENCE

1. DOE. Environmental Assessment L-Reactor Operation Savannah River Plant, Aiken, SC. DOE/EA-0195 (August 1982).

3. RADIOLOGICAL DOSE ASSESSMENT

3.0 INTRODUCTION

This chapter updates expected individual and population dose estimates from L-Reactor and operation of support facilities. The dose estimates for both air and liquid releases have changed because of new data on cesium-137 transport estimates, inclusion of estimates for expected cobalt-60 remobilization, site-specific Savannah River sports fishery information, and new calculation assumptions for SRP air emissions. Both the new air and liquid dose estimates are smaller than those given in the L-Reactor Environmental Information Document.[1]

3.1 Cesium-137

3.1.1 Steel Creek Transport Estimate

The initial estimate of the expected Cs-137 transport from Steel Creek following L-Reactor restart was based on historical data.[1] Cesium-137 transport was initially estimated at 9.8 Ci for the first year, 7.2 Ci for the second year, and 20% per year decrease thereafter. To improve these estimates of Cs-137 remobilization from the Steel Creek system, Cs-137 transport studies were made during the L-Reactor pumping tests of ambient water from February to April 1982. These tests include flows up to 200 cfs; i.e., flows equal to one-half full reactor flow (400 cfs) (Appendix A.1).

Based on data from these pump tests, the suspended sediment-water transport during the first year is estimated as 2.3 ±1.8 Ci. Values for the other two components of the transport estimate (hot water desorption and biota loss) remain unchanged. Therefore, the revised prediction for the amount of Cs-137 that will be transported during the first year of L-Reactor operation is 4.4 ±2.2 Ci compared to the 9.8 Ci estimated previously. During the second year of operation, 2.3 ±1.8 Ci will enter the Savannah River. Cs-137 transport in subsequent years will decrease by 20% per year. This reassessment reduces the estimated ten year release from 41 to 14.4 Ci (Table 3.1-1).

TABLE 3.1-1

Estimated Cs-137 Transport from Steel Creek

Year	Cs-137 Ci/yr
1	4.40
2	2.30
3	1.84
4	1.47
5	1.18
6	0.94
7	0.75
8	0.60
9	0.48
10	0.39
Total	14.4

3.1.2 Cesium Concentration Estimates for Downstream Water Users

In the L-Reactor Environmental Assessment,[2] the concentrations of Cs-137 in the Savannah River and the water treatment plants below SRP were assumed to be the same as those estimated at Highway 301 (Figure 3.1-1). Highway 301 river concentration of 1.0 pCi/L was estimated using a 9.8 Ci first year release of cesium-137 from Steel Creek, and an average river flow of 9.306 x 10^{12}L (10,420 cfs). Studies made during the 1982 L-Reactor cold water flow tests indicated that 4.4 Ci will be transported from Steel Creek in the first year and 14.4 Ci in the first ten years.

Using the Cs-137 reduction ratios determined from studies made in 1965 (Table 3.1-2 and Appendix A.2) and assuming a first year transport of 4.4 Ci from Steel Creek to the Savannah river, Cs-137 concentrations in finished water at the treatment plants were recalculated (Table 3.1-3). Cs-137 concentrations in finished water could range up to 0.09 pCi/L and 0.01 pCi/L at the Port Wentworth and Beaufort-Jasper plants, respectively. The EPA drinking water guide for Cs-137 is 200 pCi/L. Expected maximum concentrations at Port Wentworth and Beaufort-Jasper are 0.045% and 0.005%, respectively, of the EPA guide.

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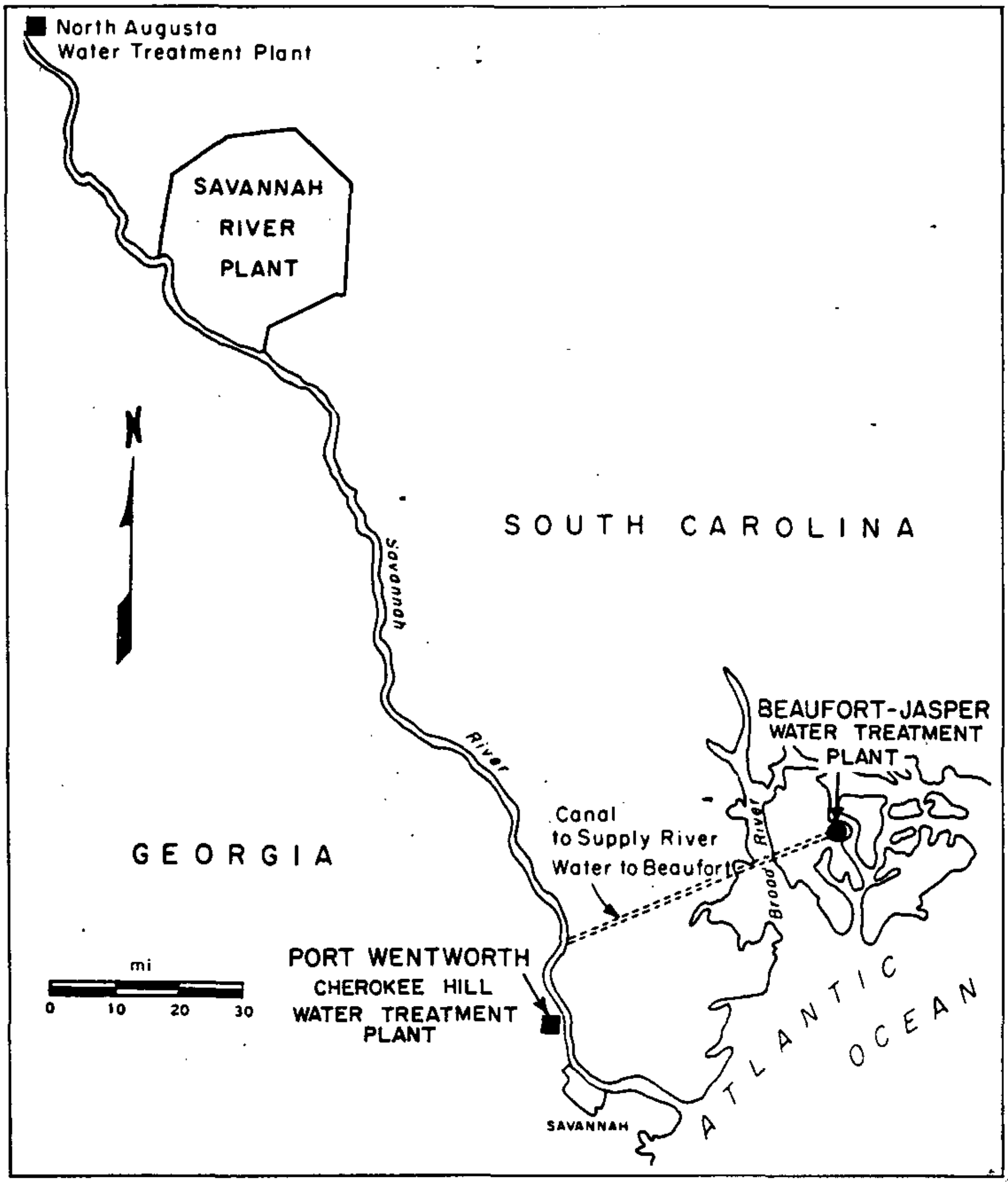

FIGURE 3.1-1. Water Treatment Plants Using Savannah River Water

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TABLE 3.1-2

Cesium-137 Concentrations and Reduction Ratios in the Savannah River and Water Treatment Plants

Location	Date	Cs-137 pCi/L	Percent Reduction*	Removal Reduction Ratio**
Concentration in River				
Augusta, GA	12/10-17/65	0.03		
Highway 301	12/10-17/65	1.47		
Highway 17	12/10-17/65	0.77	47.7	0.523
Concentration at the Water Treatment Plant (Finished Water)				
N. Augusta, SC	12/11-14/65	0.034		
Port Wentworth	12/11-14/65	0.29	79.3	0.197
Beaufort-Jasper	12/11-14/65	0.036	97.5	0.0245

* % reduction = 100 x (1 - (location/Highway 301))
** Removal ratio = (location/Highway 301)

TABLE 3.1-3

Comparison of Cs-137 Concentrations in Drinking and River Water Following L-Reactor Startup with 1965 Measured Data, pCi/L

Concentration in River	1965	L-Reactor Startup*
Highway 301	1.47	0.47
Highway 17	0.77	0.25
Concentration at Water Treatment Plant (Finished Water)		
Port Wentworth	0.29	0.09
Beaufort-Jasper	0.04	0.01

EPA Drinking Water Standard 200 pCi/L

* Assumes 4.4 Ci released the first year

The water treatment plant sludge will contain the suspended solids from the river water and from water treatment chemicals. The highest concentration of Cs-137 expected at the Port Wentworth water treatment plant sludge, if all the Cs-137 remains in the suspended solids, is 17 pCi/g. Similarly, for the Beaufort-Jasper plant the highest Cs-137 concentration expected in sludge is 2 pCi/g (Appendix A.3).

Recent Health Protection monitoring results show that weapons test fallout Cs-137 in soils 100 miles away from SRP currently range up to about 1 pCi/g (Appendix A.4), and that sludge at the holding ponds presently contain about 2.5 pCi/g of K-40. It can be seen that the maximum Cs-137 sludge concentrations following L-Reactor restart will be only slightly greater than current background levels.

3.2 Cobalt-60 Transport From Steel Creek

A total of 66 Ci of cobalt-60 (Co-60) have been discharged to SRP streams. About 26.6 Ci of Co-60 was released to Steel Creek from L Area (14.9 Ci) and P Area (11.7 Ci). As a result of radioactive decay, about 2.1 Ci of the initial 26.6 Ci released to Steel Creek still remains. Assuming that all of the Co-60 released stayed in the Steel Creek system, the current 2.1 Ci inventory is considerably less than the Cs-137 inventory of 67 Ci. Expected maximum concentrations in the Savannah River resulting from the possible remobilization of Co-60 following L-Reactor restart will be 0.027 pCi/L. The maximum dose commitment to an individual consuming river water and fish containing Co-60 will be 0.0013 mrem to a teen and 0.0006 to an adult.

3.2.1 History

Small amounts of Co-60 were released to Steel Creek from fuel element storage basins in L- and P-Reactor Areas. The Co-60 was formed by neutron activation of stainless steel in the fuel and target assemblies.

Co-60 has a strong affinity for sediments; with distribution coefficients (3,000 to 15,000) in the same range as those for Cs-137. Therefore, after discharge to Steel Creek, the Co-60 probably followed a pattern similar to Cs-137 and became associated with the sediments of the Steel Creek system. Co-60 has been measured in the Steel Creek system by aerial survey (Figure 3.2-1) and analyses of the sediments (Table 3.2-1). The distribution of Co-60 measured by aerial survey is less than the Cs-137 distribution (Figure 3.2-2). Co-60 exposure rate isopleths range to 14.6 μR/hr in the Steel Creek system while those for Cs-137 range to 76.2 μR/hr. The Co-60 activity is about one-tenth the Cs-137 activity in the sediments of the Steel Creek system (Table 3.2-2).

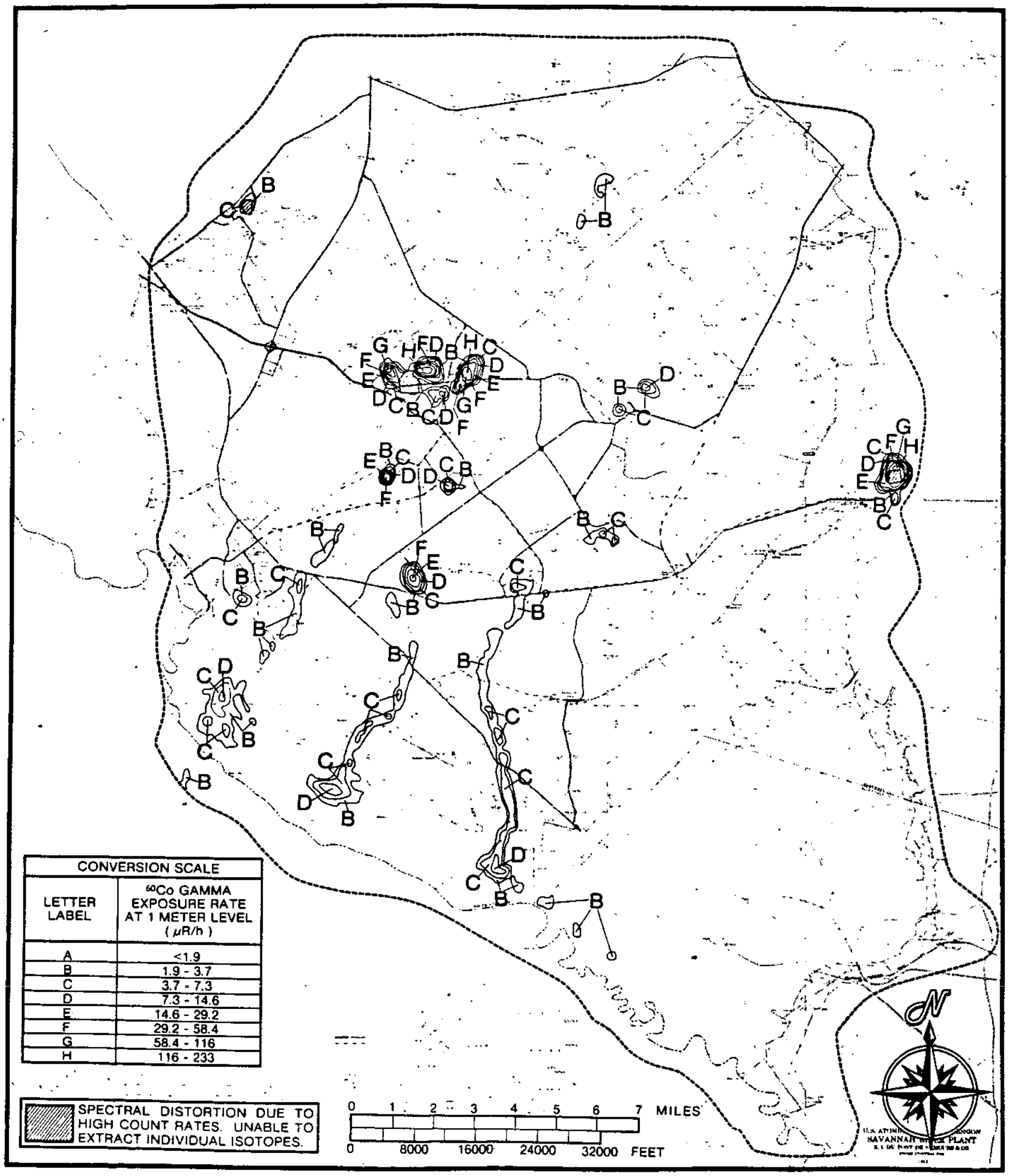

Figure 3.2-1. Co-60 gamma ray exposure rate isopleth — 1979

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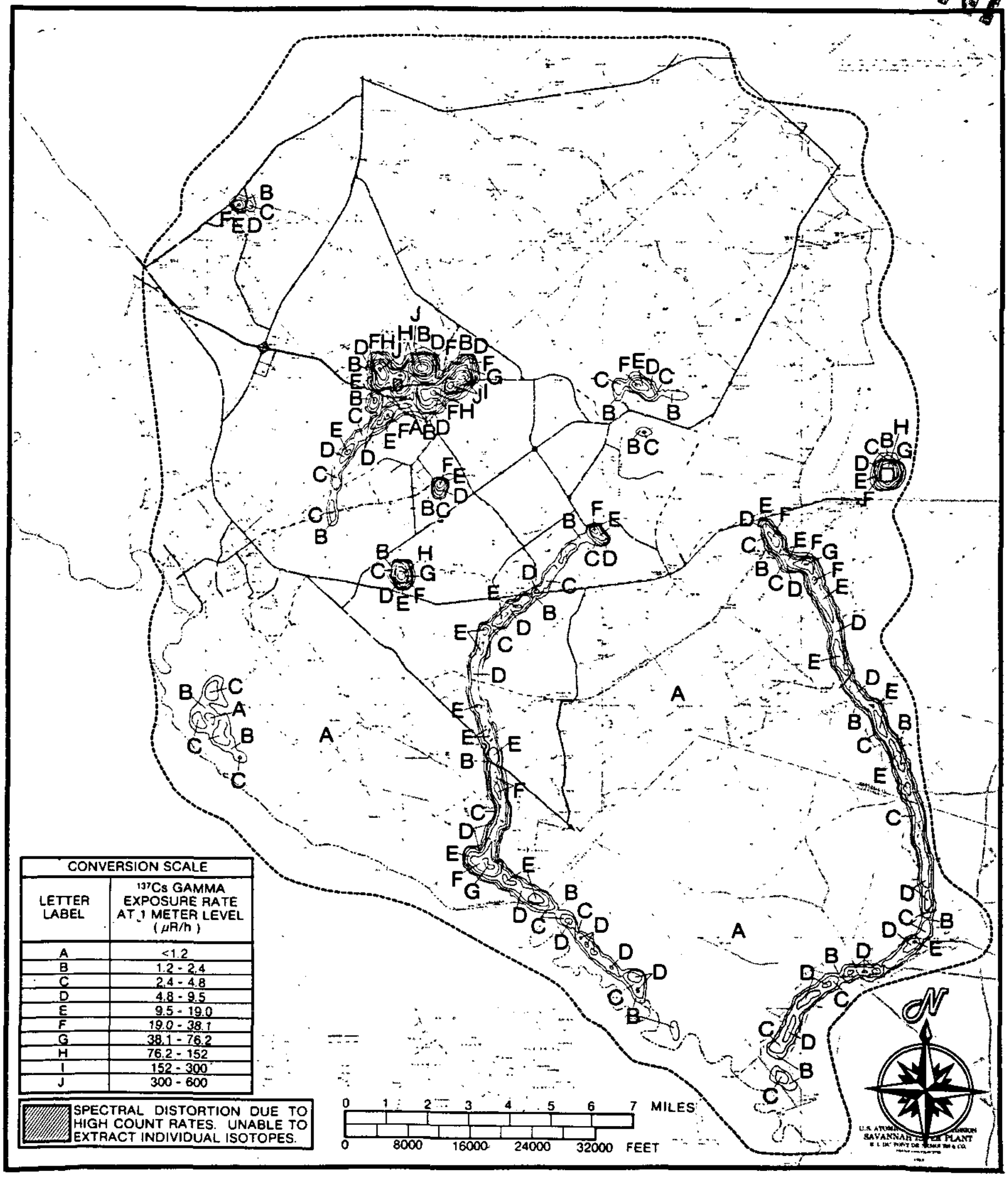

LETTER LABEL	^{137}Cs GAMMA EXPOSURE RATE AT 1 METER LEVEL (μR/h)
A	<1.2
B	1.2 - 2.4
C	2.4 - 4.8
D	4.8 - 9.5
E	9.5 - 19.0
F	19.0 - 38.1
G	38.1 - 76.2
H	76.2 - 152
I	152 - 300
J	300 - 600

Figure 3.2-2. Cs-137 gamma ray exposure rate isopleth — 1979

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TABLE 3.2-1

Co-60 and Cs-137 Activity in Steel Creek Sediments

	SRP Road B			Steel Creek at Swamp		
	Co-60 pCi/g	Cs-137 pCi/g	Co-60/Cs-137	Co-60 pCi/g	Cs-137 pCi/g	Co-60/Cs-137
1978	1.7	45	0.038	7.5	67	0.119
1979	1.7	50	0.034	1.5	61	0.025
1980	0.6	3.5	0.171	-	10	-
1981	0.9	42	0.021	1.2	2	(0.6)

Note: The average ratio of Co-60 to Cs-137 from the above table (excluding the 1981 Steel Creek swamp value) = 0.068 ±0.062

TABLE 3.2-2

Co-60 and Cs-137 Desorption from Sediments

	Activity Desorbed (pCi/L)		
Water Temp, °C	Co-60	Cs-137	Co-60/Cs-137
72	20.4	458	0.045
52	25.4	288	0.088
42	14.2	384	0.037
22	16.5	314	0.053

Average = 0.056 ±0.023

3.2.2 Transport of Co-60 from the Steel Creek System

Because of the small amount of Co-60 in the Steel Creek system, and the low offsite doses that would result if it were to be transported to the river, no field study of expected Co-60 transport from Steel Creek following L-Reactor startup was made. The estimated Co-60 transport was made using information developed during Cs-137 transport studies. It was assumed that the Co-60 would be transported from the Steel Creek system by sediments, hot water desorption and the destruction of biota.

Sediment transport should be the most important transport mode for Co-60. Special studies were made to monitor Cs-137 transport during the L-Reactor cold water flow tests in the spring of 1982 (Section 3.1.1). Water samples were filtered to determine the amount of Cs-137 in the suspended sediments and in solution. The Cs-137 activity was measured in each fraction using gamma ray analysis. This analysis was also capable of detecting the presence of Co-60. Of the approximately 250 samples analyzed, Cs-137 was detected in nearly all of the samples. Cobalt-60 was detected in only four of the suspended solids samples and was below the limit of detection in all of the soluble fractions. The sensitivity of the analysis for Co-60 is about 0.2 pCi/L.

Because of the limited number of positive Co-60 samples from the flow test, expected Co-60 transport from Steel Creek was conservatively estimated by assuming that the Co-60 in the sediments would be transported in a manner similar to the Cs-137. The ratio of Co-60 to the Cs-137 in the sediments of the Steel Creek system is about 0.068 (Table 3.2-2). Based on data from the March 1982 L-Area flow tests, a maximum of 0.0159 mCi/day-cfs of Cs-137 was remobilized from Steel Creek during the cold water flow tests. Therefore, the expected Co-60 transport from sediment sources is about 0.43 mCi/day at full cold water flow (0.0159 mCi/day-cfs x 0.068 x 400 cfs).

Hot water desorption experiments conducted in the laboratory to determine the desorption of Cs-137 from sediments also showed the desorption of small amounts of Co-60. Steel Creek sediment samples were contacted with hot water and the amount of Co-60 and Cs-137 desorbed was measured. The Co-60 to Cs-137 ratio of desorbed activity averaged 0.056 (Table 3.2-3). An estimate of the amount of Co-60 that would be desorbed during the first year of L-Reactor operation was made by multiplying the 1.7 Ci of Cs-137 that is expected to be desorbed by the laboratory determined Co-60/Cs-137 ratio of 0.056. This calculation indicates that about 95.2 mCi/yr (0.26 mCi/day) of Co-60 is expected to be desorbed from the sediments in the first year. No additional desorption is expected the second year.

TABLE 3.2-3

Estimated Co-60 Transport from Steel Creek

Year	Co-60 Ci/yr
1	0.252
2	0.138
3	0.095
4	0.068
5	0.047
6	0.033
7	0.023
8	0.016
9	0.012
10	0.008
Total	0.60

The Health Protection Department of SRP routinely monitors vegetation along Steel Creek for radionuclides. Even though Cs-137 is routinely detected in the vegetation, Co-60 is not. The limit of detection for Co-60 is about 5 pCi/g.

Up to 0.69 mCi/day of Co-60 will be transported from Steel Creek during the first year following restart of L-Reactor (0.43 mCi/day-sediment and 0.26 mCi/day-desorption). This 0.69 mCi/day will result in a maximum Co-60 concentration in the Savannah River of 0.027 pCi/L (.69E9 pCi/day/2.54E10 l/day) at Highway 301. The Co-60 concentration is about 6% of the expected Cs-137 concentration of 0.47 pCi/L. In the second year of L-Reactor operation, up to 0.38 mCi/day of Co-60 will be transported in association with sediments (0.43 mCi/day x 0.876, decay factor). After ten years of L-Reactor operations, up to 0.6 Ci of Co-60 and 14.4 Ci of Cs-137 will have been transported to the Savannah River (Table 3.2-4).

The calculated 0.027 pCi/L Co-60 concentration in the Savannah River is about 1/2700 of the EPA interim primary drinking water concentration guide of 100 pCi/L.

TABLE 3.2-4

50-Year Dose Commitment (mrem) to an Adult from Consumption of Water and Fish from the Savannah River at Highway 301 During the First Year of L-Reactor Operation

	Dose Commitment, mrem		
Radionuclide	Water Consumption 730 Liters/yr	Fish Consumption 34 Kilograms/yr	Shore Line Exposure
Co-60	0.000093	0.00022	0.0003
Cs-137	0.025	3.44	0.0025

3.2.3 Co-60 Radiation Dose Commitment

The maximum dose commitments from Co-60 were calculated for a hypothetical individual consuming river water (730 L/yr) and fish (34 kg/yr) from the Savannah River at Highway 301. Based on a first year release of 0.25 Ci Co-60, the 50-year dose commitment to an adult is 0.0006 mrem, primarily from fish consumption and shore line exposure. The dose commitments calculated for Co-60 are very small compared to those for Cs-137 (Table 3.2-4). This is because the expected Co-60 concentrations in water are 17 times less than those for Cs-137, the dose per unit of radioactivity is a factor of 17 less, and the concentration factor in fish is 60 times smaller (50 vs. 3,000).

3.3 Savannah River Sport Fishery Consumption

Fish consumption will contribute a major portion of the estimated individual and population doses from L-Reactor liquid releases and Cs-137 remobilization in Steel Creek. Since publication of the L-Reactor Environmental Information Document (EID),[1] data have become available on sport fishing in the Savannah River.[3] These data provide SRP with site-specific sport fish harvest and estimated consumption values for use in dose calculations.

3.3.1 Population Fish Consumption

Calculation of the population dose from fish consumption is based on the assumption that the 50-mile population consumes the entire edible sport fish harvest. The source of edible sport fish for the SRP 50-mile population is assumed to be the Savannah River. Table 5.1-13 of the EID presents an estimated sport fish harvest for the Savannah River of 90,700 kg total weight/year. The Georgia study reports a freshwater sport fish harvest in the Savannah River of 103,682 kg (±16%)* for the period December 1979 to December 1980. The EID sport fish harvest of 90,700 kg/year falls within the range of the estimated sport fish harvest for the Savannah River.

3.3.2 Individual Consumption

3.3.2.1 Average Individual

Table 3.3-1 presents average adult fish consumption values based on diet studies.[4-6] The range of average fish consumption varies from 4.7 to 7.8 kg/year, with an average consumption of approximately 6 kg/year. Adult fish consumption in the southeast is higher than the U.S. average. The EID average individual consumption of 6.9 kg/year is consistent with these data.

A summary of the Georgia fishery survey is presented in Table 3.3-2.[3] The data in Table 3.3-2 were used to estimate fish consumption. The calculation of fish consumption assumes that 50% of the fish weight harvested is edible flesh, and that the anglers consume the fish within one year. Both average and maximum anglers are assumed to have normal metabolic and physiological parameters.[6]

The calculated average angler fish catch is 23 (±8.4) kg/year, or 11.3 (±4.2) kg eaten/year (Appendix B). The average angler fish consumption is higher than the U.S. consumption values presented in Table 3.3-1. Dose to the average individual was recalculated using an average adult fish consumption value of 11.3 kg/year.

3.3.2.2 Maximum Individual

Data from the Georgia Department of Natural Resources indicates approximately 4,600 anglers fish the Savannah River.[8] One method of making a conservative estimate of maximum fish consumption is to calculate the fish consumption for an angler who catches and eats a maximum amount of fish from the Savannah River. Assumptions necessary to make a conservative estimate of the amount of fish eaten by such a potential maximum angler are as follows:

- catches the most fish,
- spends the most time fishing,
- catches the largest fish,
- takes the most trips per year.

* One standard deviation.

TABLE 3.3-1

Adult Average Fish Consumption

Year	Kg/Year
US average 1960	4.7
US average 1965	4.9
US average 1970	5.4
US average 1972	5.7
US average 1973	5.8
US average 1974	5.5
US average 1975	5.5
US average 1976	5.8
US average 1977 (prel.)	5.8
US average 1973	7.8
Southeast 1955	8.9
Southeast 1965	9.7

TABLE 3.3-2

Sport Fishing on the Savannah River*

Number of trips	70,054 — 85,848
Number of hours	305,398 — 399,222
Number of fish caught	456,235 — 644,329
Kilogram of fish	86,585 — 120,779
Total number of anglers	3,005 — 6,164
Trips per angler[8]	12 — 22

* Range is one standard deviation about the mean.

Calculations based on these estimates result in a maximum angler fish consumption of 34 kg/year (Appendix C). The EID value for maximum consumption is approximately 60% lower.

Since adult average and maximum fish consumption values have been increased in this assessment of the Georgia fisheries data, both teen and child fish consumption estimates have been increased in proportion to the increase in adult consumption. The new consumption values are given in Table 3.3-3.

TABLE 3.3-3

Average and Maximum Individual Fish Consumption Estimates

	Fish Consumption, kg/yr					
	Child		Teen		Adult	
	New	EID*	New	EID*	New	EID*
Average Individual	3.6	2.2	8.5	5.2	11.3	6.9
Maximum Individual	11.2	6.9	25.9	16	34	21

* Reference 1

3.4 Savannah River Water Users Dose Commitment

3.4.1 Routine Liquid Releases

During routine operations, radioactive materials will be discharged in liquid effluents from L Area to Steel Creek. In addition, some radioactive materials may be discharged to a low-level seepage basin in L Area. Those radioactive materials discharged to the seepage basin will move downward to the groundwater and then be transported laterally to outcrop areas along Steel Creek. These materials would diminish by radioactive decay which occurs during the transit time from the basin to the creek. The release of radioactive materials to liquid effluents and to seepage basins will increase in other SRP operational areas associated with restart of L Reactor.

Estimated annual releases from L Reactor and other associated plant operations to surface streams are tritium — 4.2×10^3 to 5.9×10^3 curies, fission products — 2.4×10^{-1} to 1.1×10^0 curies, uranium — 5.0×10^{-2} curies, and other alpha emitters — 2.9×10^{-3} to 3.0×10^{-3} curies. Estimated total annual releases to all seepage basins are tritium — 1.7×10^4 curies, fission products — 1.9×10^1 curies, uranium — 1.1×10^{-1} curies, and transuranics — 5.6×10^{-2} curies.

3.4.2 Downstream River Water Users

Radioactive materials discharged to surface streams on the SRP flow across the site and discharge into the Savannah River. The liquid effluents from L Area will be discharged to Steel Creek. Steel Creek is entirely on the SRP site, and there is no consumptive use of creek water; fishing is not allowed.

Four Mile Creek and Beaver Dam Creek together receive discharges from the F and H Separations Areas and the D Heavy Water Area. Four Mile Creek and Beaver Dam Creek are entirely on the plantside, and there is no consumptive use of creek water; fishing is not allowed.

The Savannah River borders the south boundary of the SRP site for a distance of about 17 miles. The river flows in a southeasterly direction about 120 miles before entering the area of tidal influence, about 20 miles from the Savannah Harbor entrance. The average annual flow rate of the river near the SRP site is about 10,400 cfs, and flow does not increase more than 10% before entering the Savannah Harbor. The flow time to Savannah, Georgia is approximately three days.

There is no known consumptive use of Savannah River water for a distance of 100 miles downstream from the SRP site. At about this distance, Jasper and Beaufort Counties, South Carolina, withdraw about 5.2 Mgal/day for public use. Further downstream the Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia, uses about 45 Mgal/day to supply a business-industrial complex near Savannah, Georgia.[1]

There is no known use of river water for crop irrigation downstream from SRP. The river supports limited commercial and recreational fishing downstream, as well as a commercial mollusc and shrimp industry in estuarine waters. River use for commercial traffic has declined, and use for recreational boating, water skiing, and swimming is small.[1]

3.4.3 Exposure Pathways and Models

Radioactive materials released in liquid effluents expose man through a variety of pathways. The importance of these pathways depends on the radionuclides released. In this supplement, the following pathways are considered:

- Consumption of water
- Consumption of aquatic foods
- Shoreline exposure
- Swimming
- Boating

Irrigation of food crops with river water was not considered as a pathway of exposure because there is no known use of river water for irrigation purposes.[1]

The method of calculating doses to man from liquid effluent pathways are those recommended by the U.S. Nuclear Regulatory Commission (NRC) in Regulatory Guide 1.109.[9] The NRC LADTAP II computer code was used to implement the dose models specified in the regulatory guide.[10] Fifty-year, age-specific, dose commitment factors specified in NUREG-0172 were incorporated in the computer code.[11] Human and site parameters used in the code are listed in Tables 3.4-1 and 3.4-2.

3.4.4 Individuals and Population Groups Exposed

The individual who will receive the maximum potential dose from liquid releases is a person who lives near the Savannah River, just downstream of where liquid releases enter the river. It is assumed that this individual uses river water regularly for consumption, consumes river fish, and receives external exposure from the shoreline, swimming, and boating.

The 50-mile radius population receives no river water downstream of SRP for domestic purposes. However, this population is assumed to use the river for recreational purposes and to consume fish and invertebrates from the river and estuary.

There is no known use of Savannah River water for human consumption for a distance of about 100 miles downstream from SRP. At this distance, Beaufort and Jasper Counties, South Carolina, pump water from the river for treatment and service to an estimated 1979 consumer population of about 35,000 people. Several miles farther downstream, the Cherokee Hill Water Treatment Plant withdraws water from the river to supply a business-industrial complex near Savannah, Georgia. This water does not enter normal domestic service, but an estimated 20,000 "effective" consumers used this water.[2]

Although the Beaufort-Jasper and Port Wentworth population groups are beyond the 50-mile radius, drinking water doses are nevertheless computed for these groups and are included.

TABLE 3.4-1

Human Parameters Used in Dose Calculations

Average Individual	Child	Teen	Adult
Water consumption, L/yr	260	260	370
Fish consumption, kg/yr	3.6	8.5	11.3
Other seafood consumption, kg/yr	0.33	0.75	1.0
Shoreline recreation, hr/yr	9.5	47	83
Boating, man-hours*	-	-	700,000
Swimming, man-hours*	-	-	100,000
Shoreline recreation, man-hours*	-	-	200,000
Maximum Individual			
Water consumption, L/yr**	510	510	730
Fish consumption, kg/yr	11.2	25.9	34
Other seafood consumption, kg/yr	1.7	3.8	5
Shoreline recreation, hr/yr	14	67	20
Swimming, hr/yr	10	10	10
Boating, hr/yr	60	60	60

* For population dose calculations

** Drinking water consumption for an infant = 330 L/yr

TABLE 3.4-2

Site Parameters Used in Dose Calculations

River flow rate, average cfs	10,400
River dilution in estuary	3
Transit time, L Area to river, hr	24
Transit time, SRP to water treatment plants, hr	72
Water treatment time, hr	24
Aquatic food harvest, kg/yr	
Fish — support	90,700
Fish — commercial	31,800
Invertebrates — salt water	299,000
Irrigation	None
Shore width factor	0.2
Population average (1990-2020)	
Beaufort-Jasper water consumers	40,300
Port Wentworth water consumers	29,200
50-mile radius population	781,000

Age distribution of population, %	Child	Teen	Adult
Beaufort-Jasper	21	10	69
Port Wentworth	-	-	100
50-mile radius population	21	11	68

3.4.5 Dose to the Maximally Exposed Individual From Surface Stream Releases

The total body and organ doses from all identified pathways of exposure from release of radioactivity to surface streams were calculated for four age groups (adults, teenager, child, and infant). Most of the dose is from the drinking water and fish consumption pathways. Of the four age groups, an adult receives the maximum dose, 0.119 mrem for total body and 0.288 mrem for bone. The radionuclides contributing most of these doses are H-3 (tritium) and Sr-90.

3.4.6 Population Dose From Surface Stream Releases

For an average year, the dose releases from L Reactor and other associated plant operations will be 2.06 man-rem (body) and 2.87 man-rem (bone) (Table 3.4-3).

3.4.7 Dose Estimates From Cesium-137 and Cobalt-60 Remobilization

Cesium-137 and cobalt-60 remobilization estimates from Steel Creek following L-Reactor operations are given in Sections 3.1.1 and 3.3.2, respectively. The calculated maximum adult individual whole body dose from the release of cesium-137 and cobalt-60 during the first year is 3.48 mrem under average flow conditions for the Savannah River and 5.92 mrem under conservative low-flow conditions, primarily from the fish pathway (Table 3.4-4). Other SRP liquid releases would add about 0.6 mrem to this maximum individual dose estimate. The previous EID estimate for cesium-137 maximal individual dose estimate was 8.29 mrem under low-flow conditions. Dose commitments would decrease with decreased remobilization in following years by about 20% each year. The calculated population dose estimate to downstream river water users is estimated to be 9.13 man-rem under average flow conditions and 15.5 man-rem under conservative low-flow conditions. Again these dose commitments would decrease by about 20% each year following L-Reactor restart (Table 3.4-4). Appendix D contains detailed estimates of organ doses for the individual and populations.

TABLE 3.4-3

Population Dose Associated with L-Reactor Operation

Population Group	Pathway	Population Dose, man-rem per year of intake							
		Skin	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLI*
Average Year									
Beaufort-Jasper	Drinking water	-	1.49×10^{0}	7.75×10^{-1}	1.15×10^{0}	7.70×10^{-1}	7.90×10^{-1}	7.71×10^{-1}	8.38×10^{-1}
Port Wentworth	Drinking water	-	8.85×10^{-1}	5.35×10^{-1}	7.61×10^{-1}	5.32×10^{-2}	5.44×10^{-1}	5.33×10^{-1}	5.86×10^{-1}
50-mile radius	Fish and invertebrates	-	4.93×10^{-1}	8.25×10^{-2}	1.52×10^{-1}	4.50×10^{-3}	3.10×10^{-2}	1.35×10^{-2}	1.94×10^{-2}
50-mile radius	Recreation and river traffic	7.98×10^{-4}	-	-	6.89×10^{-4}	-	-	-	-
	Total	7.98×10^{-4}	2.87×10^{0}	1.39×10^{0}	2.06×10^{0}	0.83×10^{0}	1.37×10^{0}	1.32×10^{0}	1.44×10^{0}
Maximum Year									
Beaufort-Jasper	Drinking water	-	5.88×10^{-1}	1.09×10^{0}	1.22×10^{0}	1.08×10^{0}	1.10×10^{0}	1.08×10^{0}	1.13×10^{0}
Port Wentworth	Drinking water	-	3.44×10^{-1}	7.52×10^{-1}	8.33×10^{-1}	7.48×10^{-1}	7.59×10^{-1}	7.48×10^{-1}	7.88×10^{-1}
50-mile radius	Fish and invertebrates	-	8.65×10^{-1}	1.23×10^{-1}	1.11×10^{-1}	6.33×10^{-3}	3.28×10^{-2}	1.53×10^{-2}	7.77×10^{-2}
50-mile radius	Recreation and river traffic	6.11×10^{-1}	-	-	5.29×10^{-3}	-	-	-	-
	Total	6.11×10^{-3}	1.80×10^{0}	1.96×10^{0}	2.17×10^{0}	1.84×10^{0}	1.89×10^{0}	1.84×10^{0}	2.00×10^{0}

* Gastrointestinal — lower large intestine

TABLE 3.4-4

Estimated Maximum Individual from SRP Liquid Releases and L-Reactor Restart, First Year

Source	Dose, mrem
SRP	0.526
L Reactor and Associated Operations	0.071
Cs-137 and Co-60 Transport	3.48
Total	4.08

3.5 Radiological Impact from Routine Operating Releases to Atmosphere

This section presents a reassessment of the potential doses to people living in the vicinity of the SRP from routine atmospheric releases due to reactivation of L Reactor. The annual doses to the maximally exposed individual and the population within 50 miles are calculated from the estimated average and maximum annual releases, using more realistic and less overestimative meteorological data and assumptions than in the Environmental Information Document on L-Reactor Reactivation (L-EID).[1]

Table 3.5-1 restates the estimated average and maximum release rates of the radionuclides from Section 3.3 of the L-EID.[2] These releases are from 200-ft stacks except for the several small ground-level releases denoted by asterisks in the table. In the previous assessment, all of the releases were treated as being from ground level, which resulted in an overestimation of the doses.

3.5.1 Exposure Pathways

Radioactive materials released to the atmosphere reach man through a variety of pathways, involving both internal and external exposure. The importance of these pathways depends upon the particular radionuclides released and the environmental factors which determine the extent of man's exposure. In this supplement, the following pathways were considered:

TABLE 3.5-1

Estimated Routine Operating Releases of Radioactivity to Atmosphere from Restart of L Reactor After Tritium Reaches Equilibrium Levels in the Moderator in About Ten Years

	Annual Releases, Ci/yr†			
	L Reactor		Separations	
Radionuclide	Average	Maximum	Areas (F&H)	D and M Areas
Gaseous:				
H-3	48,500	62,800	6,900	
	6,400*	6,450*	1,700*	790* (D)
C-14	12	13	8	
Ar-41	19,500	31,700		
Kr-85m	600	1,690		
Kr-85			201,800	
Kr-87	540	1,700		
Kr-88	790	2,390		
Xe-131m			1.9	
Xe-133	1,700	3,880	0.1	
Xe-135	1,390	3,550		
Particulate:				
Sr-89, 90[a]			1.5×10^{-3}	
Zr-95			6.0×10^{-3}	
Nb-95			1.2×10^{-2}	
Ru-103			1.2×10^{-3}	
Ru-106			2.8×10^{-2}	
I-129			7.0×10^{-2}	
I-131	8.4×10^{-4}	2.24×10^{-3}	1.7×10^{-2}	
	3.3×10^{-3}*	6.01×10^{-3}*		
Cs-134			1.1×10^{-4}	
Cs-137			1.2×10^{-3}	
Ce-141			8.0×10^{-5}	
Ce-144			8.0×10^{-3}	
U-235, 238[b]			1.7×10^{-3}	
U-238				8.6×10^{-7}* (M)
Pu-238			1.9×10^{-3}	
Pu-239			2.7×10^{-4}	
Am-241, 243[c]			3.9×10^{-4}	
Cm-242, 244[d]			3.5×10^{-4}	
Beta-Gamma[e]	2.0×10^{-4}	9.5×10^{-4}	2.2×10^{-4}	
Alpha[f]	1.0×10^{-6}	2.63×10^{-6}		2.6×10^{-6}* (M)

† From Tables 3.3-1, 3.3-4, and 3.3-6 of Reference 1.
* Asterisks denote ground-level releases; other releases are from 200-ft stacks.
a Assumed to be Sr-90.
b Assumed to be U-235.
c Assumed to be Am-241.
d Assumed to be Cm-244.
e Assumed to be Sr-90.
f Assumed to be Pu-239.

- Inhalation of airborne radionuclides
- Ingestion of contaminated foodstuff
- External exposure to gamma radiation from noble gases
- External exposure to gamma radiation from radionuclides deposited on the ground.

With respect to offsite man's exposure due to reactivation of L Reactor, the most important radionuclide is tritium (H-3), which will account for more than 70% of the total body doses via the inhalation and ingestion pathways. External exposure to Ar-41 and internal exposure to C-14, will also be important pathways.

3.5.2 Assessment Methodology

The annual doses are calculated from the estimated release rates (Table 3.5-1) using the methodology of USNRC Regulatory Guides 1.111 (meteorological models) and 1.109 (dose models).[9,12] These methods, together with the associated computer codes, are described in more detail in Appendices E and F, respectively. Appendix E also presents the average-annual atmospheric relative dispersion (X/Q) and deposition (D/Q) factors used in the dose calculations. Appendix F also indicates the dose conversion factors; for internal exposure (inhalation and ingestion), age-specific 50-year dose commitment factors have been utilized.

Table 3.5-2 lists the human parameters used in calculating doses to maximally exposed individuals. Table 3.5-3 shows the average individual parameters and demographic data used for calculating doses to the 50-mile population. Footnotes in these tables indicate the associated agricultural production data.

3.5.3 Annual Doses to the Maximally-Exposed Individual

The individuals considered (infant, child, teen, and adult) are members of a hypothetical farm family residing on the SRP buffer-zone boundary, producing their own foodstuff and consuming more food than counterparts in the general population (Table 3.5-2 vs. Table 3.5-3). The dose rates to these individuals are evaluated along the SRP boundary to find the maximum total body dose rates; one of these individuals — typically the child for SRP releases — receives the highest total body dose rate and the annual doses to that individual are reported here.

TABLE 3.5-2

Human Parameters Used in Calculating Doses to Maximally Exposed Individual*

Parameter	Infant	Child	Teen	Adult
Inhalation, m^3/yr	1,400	3,700	8,000	8,000
Ingestion**				
Cow's milk, L/yr	330	330	400	310
Meat, kg/yr	0	41	65	110
Leafy vegetables, kg/yr†	0	26	42	64
Fruits, vegetables, and grains, kg/yr††	0	520	630	520
External Exposure				
Transmission factor for shielding from buildings	0.7	0.7	0.7	0.7

* Data are recommended values from USNRC Regulatory Guide 1.109.[9]

** Foodstuff produced at the reference family's location, except as noted, where exposure to the air-released radionuclides is at a maximum. Crop yield and animal feeding parameters are presented in Reference 13.

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

†† Seventy-six percent from reference family's crops (Reg. Guide 1.109 recommended value);[9] remainder imported (uncontaminated).

TABLE 3.5-3

Human Parameters and Demographic Data Used in Calculating Doses to the 50-Mile Population

Average Individual Parameters*	Children	Teen	Adults
Inhalation, m^3/yr	3,700	8,000	8,000
Ingestion**			
Milk, L/yr	170	200	110
Meat, kg/yr	37	59	95
Leafy vegetables, kg/yr	10	20	30
Fruits, vegetables, grain kg/hr	200	240	190
External Exposure			
Transmission factor accounting for shielding by residential structures	0.5	0.5	0.5
Demographic Data, CY-2000†			
50-mile residual population	(679,000)		
Age-group distribution, %††	20.8	11.8	67.4
Geographical distribution	Table 2.2-5 of Ref. 1		

* Data are recommended values from USNRC Regulatory Guide 1.109.[9]

** Foodstuff obtained at large from the 50-mile agricultural production of man's foods; any insufficiency is assumed to be imported (uncontaminated). Crop yield and animal feeding data for the 50-mile vicinity are presented in Reference 13.

† 1970-Census data projected to the assumed midpoint of operations (Section 2.2.1, Table 2.2-5 of Reference 1).

†† From Table 2.2-8 of Reference 1.

Tables 3.5-4 and 3.5-5 show the annual doses to the maximally-exposed individual (the child) by pathway and body organ for the cases of average and maximum annual releases, respectively. The percentage contributions by radionuclide to these organ doses are shown in Tables 3.5-6 and 3.5-7. As indicated by these tables, the average annual dose rate to the total body to the maximally exposed individual (child) is 0.41 millirem per year, 59% by ingestion and 25% from external exposure to noble gases; tritium (H-3) contributes 71% of the dose rate.

3.5.4 Annual Doses to the 50-Mile Population

The population doses are based on the average air and ground concentrations of the released radionuclides in the compass sector segments of the 50-mile vicinity (Table 3.5-1 and Appendices E and F), and the population and agricultural production therein (Table 3.5-3). The calculated annual dose commitment is to the estimated CY-2000 population, with residual effects from ground deposition considered for an additional 100 years (a 100-year environmental dose commitment per year of operation).

Tables 3.5-8 and 3.5-9 show these estimated annual dose commitments by pathway and body organ for the cases of average and maximum annual releases, respectively. Tables 3.5-10 and 3.5-11 show the percentage contribution to the organ doses by radionuclide. As indicated by these tables, the maximum annual total-body dose commitment is 16.5 man-rem per year of operation. Inhalation, ingestion, and external exposure to noble gases account for 44%, 40%, and 15% of this total-body dose rate; radionuclides contributing more than 10% are tritium (81%) and Argon-41 (10.1%).

TABLE 3.5-4

Average Annual Doses to the Maximally Exposed Individual (Child) by Pathway — Average Annual Routine Atmospheric Releases of Radioactivity*

Pathway	Organ Doses, mrem/yr†							
	Total Body	GI-LLI	Bone	Liver	Kidney	Thyroid	Lung	Skin
Inhalation	0.053 (17.0%)	0.052 (16.7%)	0.011 (6.9%)	0.055 (17.4%)	0.054 (17.2%)	0.053 (4.4%)	0.054 (17.5%)	0.052 (12.2%)
Ingestion	0.20 (64.4%)	0.20 (65.0%)	0.095 (57.9%)	0.20 (64.1%)	0.20 (64.4%)	1.08 (90.7%)	0.20 (63.6%)	0.20 (46.1%)
External (γ-rays):								
Noble gases	0.058 (18.5%)	0.058 (18.3%)	0.058 (35.1%)	0.058 (18.4%)	0.058 (18.4%)	0.058 (4.8%)	0.059 (18.9%)	0.18 (41.6%)
Ground	0.00023 (0.07%)	0.00023 (0.07%)	0.00023 (0.14%)	0.00023 (0.07%)	0.00023 (0.07%)	0.00023 (0.02%)	0.00023 (0.07%)	0.00035 (0.08%)
Total	0.31	0.31	0.16	0.31	0.31	1.19	0.31	0.43

* At the location of the maximum total body dose on the SRP buffer-zone boundary (7.1 miles ESE of L Reactor).

† Dose rates at the midpoint of an assumed 30-year operating period (NRC Regulatory Guide 1.109).[9]

TABLE 3.5-5

Average Annual Doses to the Maximally Exposed Individual (Child) by Pathway — Maximum Annual Routine Atmospheric Releases of Radioactivity*

	Organ Doses, mrem/yr†							
Pathway	Total Body	GI-LLI	Bone	Liver	Kidney	Thyroid	Lung	Skin
Inhalation	0.065 (15.8%)	0.065 (15.6%)	0.011 (4.9%)	0.067 (16.1%)	0.066 (16.0%)	0.065 (5.0%)	0.067 (16.2%)	0.065 (11.5%)
Ingestion	0.25 (59.4%)	0.25 (59.8%)	0.12 (50.9%)	0.25 (59.2%)	0.25 (59.4%)	1.13 (87.1%)	0.24 (59.0%)	0.24 (43.3%)
External (γ-rays):								
Noble gases	0.10 (24.7%)	0.10 (24.5%)	0.10 (44.1%)	0.10 (24.6%)	0.10 (24.6%)	0.10 (7.8%)	0.10 (24.7%)	0.25 (45.1%)
Ground	0.00023 (0.06%)	0.00023 (0.06%)	0.00023 (0.10%)	0.00023 (0.06%)	0.00023 (0.06%)	0.00023 (0.02%)	0.00023 (0.06%)	0.00035 (0.06%)
Total	0.41	0.42	0.23	0.41	0.41	1.30	0.41	0.56

* At the location of the maximum total body dose on the SRP buffer-zone boundary (7.1 miles ESE of L Reactor).

† Dose rates at the midpoint of an assumed 30-year operating period (NRC Regulatory Guide 1.109).[9]

TABLE 3.5-6

Percentage of Average Annual Doses to Maximally Exposed Individual (Child) by Radionuclide — Average Annual Routine Atmospheric Releases from L-Reactor Restart

	Organ Doses, %							
Radionuclide	Total Body	GI-LLI	Bone	Liver	Kidney	Thyroid	Lung	Skin
Ar-41	16.1	16.0	30.6	16.0	16.0	4.2	16.1	18.7
Kr-85	0.2	0.2	0.4	0.2	0.2	<0.1	0.6	19.8
Kr-88	1.4	1.3	2.6	1.3	1.3	0.4	1.4	1.4
H-3	76.4	75.6	—*	76.0	75.8	19.9	76.2	55.2
C-14	4.3	4.2	40.6	4.3	4.2	1.1	4.3	3.1
Sr-90	0.1	<0.1	13.5	—	—	—	<0.1	—
Ru-106	<0.1	1.5	0.2	<0.1	0.1	<0.1	<0.1	<0.1
I-129	0.4	<0.1	1.4	0.5	0.8	73.0	<0.1	<0.1
I-131	<0.1	<0.1	<0.1	<0.1	<0.1	1.2	<0.1	<0.1
U-235	<0.1	<0.1	1.4	<0.1	0.1	<0.1	<0.1	<0.1
Pu-238	<0.1	<0.1	5.8	0.4	0.3	<0.1	0.4	<0.1
Others**	0.8	1.0	3.4	1.3	1.0	0.2	0.9	1.7

* Dashes signify no dose conversion factor.

** Each contributing less than 1%.

TABLE 3.5-7

Percentage of Average Annual Doses to Maximally Exposed Individual (Child) by Radionuclide — Maximum Annual Routine Atmospheric Releases from L-Reactor Restart

	Organ Doses, %							
Radionuclide	Total Body	GI-LLI	Bone	Liver	Kidney	Thyroid	Lung	Skin
Ar-41	19.8	19.6	35.3	19.7	19.7	6.3	19.7	23.3
Kr-85	0.2	0.2	0.3	0.2	0.2	<0.1	0.5	15.2
Kr-87	0.5	0.5	1.0	0.5	0.5	0.2	0.6	1.4
Kr-88	3.1	3.1	5.5	3.1	3.1	1.0	3.1	3.1
Xe-135	0.7	0.7	1.3	0.7	0.7	0.2	0.8	1.4
H-3	71.2	70.7	—*	71.0	70.8	22.6	71.1	52.3
C-14	3.4	3.4	30.8	3.4	3.4	1.1	3.4	2.5
Sr-90	0.2	0.1	17.5	—	—	—	<0.1	—
Ru-106	<0.1	1.2	0.1	<0.1	0.1	<0.1	<0.1	<0.1
I-129	0.3	<0.1	1.0	0.4	0.6	66.9	<0.1	<0.1
I-131	<0.1	<0.1	<0.1	<0.1	<0.1	1.5	<0.1	<0.1
Pu-238	<0.1	<0.1	4.1	0.3	0.2	<0.1	0.3	<0.1
Others**	0.4	0.5	3.0	0.7	0.6	0.1	0.5	0.7

* Dashes signify no dose conversion factor.

** Each contributing less than 1%.

TABLE 3.5-8

Annual Doses to the 50-Mile Population by Pathway — Average Annual Routine Atmospheric Releases of Radioactivity*

	Organ Doses, man/rem*							
Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Inhalation	6.0 (45.9%)	5.9 (43.0%)	3.0 (42.6%)	6.5 (48.0%)	6.3 (47.1%)	6.1 (6.9%)	6.2 (46.3%)	5.9 (17.5%)
Ingestion	5.5 (42.5%)	6.3 (45.9%)	2.5 (35.8%)	5.5 (40.7%)	5.6 (41.6%)	79.8 (91.3%)	5.4 (40.3%)	5.4 (16.1%)
External-Noble Gases	1.4 (10.5%)	1.4 (10.0%)	1.4 (19.5%)	1.4 (10.1%)	1.4 (10.2%)	1.4 (1.6%)	1.6 (12.2%)	22.1 (65.7%)
External-Ground	0.15 (1.1%)	0.15 (1.1%)	0.15 (2.1%)	0.15 (1.1%)	0.15 (1.1%)	0.15 (0.2%)	0.15 (1.1%)	0.23 (0.7%)
Total	13.0	13.7	7.0	13.5	13.4	87.4	13.4	33.6

Note: Number in parentheses = percentage by pathway.
* 100-Year Environmental Dose Commitment per year of operation.

TABLE 3.5-9

Annual Doses to the 50-Mile Population by Pathway — Maximum Annual Atmospheric Releases from L-Reactor Startup

	Organ Doses, man-rem*							
Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Inhalation	7.3 (44.0%)	7.2 (41.8%)	3.0 (35.5%)	7.8 (45.8%)	7.6 (45.1%)	7.4 (8.1%)	7.5 (44.4%)	7.2 (18.8%)
Ingestion	6.7 (40.5%)	7.4 (43.3%)	2.9 (34.1%)	6.6 (39.1%)	6.7 (39.7%)	81.2 (89.1%)	6.6 (38.8%)	6.6 (17.2%)
External-Noble Gases	2.4 (14.6%)	2.4 (14.1%)	2.4 (28.6%)	2.4 (14.2%)	2.4 (14.3%)	2.4 (2.6%)	2.7 (16.0%)	24.1 (63.4%)
External-Ground	0.15 (0.9%)	0.15 (0.9%)	0.15 (1.8%)	0.15 (0.9%)	0.15 (0.9%)	0.15 (0.2%)	0.15 (0.9%)	0.23 (0.6%)
Total	16.5	17.2	8.4	17.0	16.9	91.1	16.9	38.1

Note: Number in parentheses = percentage by pathway.
* 100-Year Environmental Dose Commitment per year of operation.

TABLE 3.5-10

Percentage of Annual Doses to the 50-Mile Population by Radionuclide — Average Annual Routine Atmospheric Releases from L-Reactor Restart

	Organ Doses, %							
Radionuclide	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Ar-41	7.9	7.5	14.6	7.6	7.7	1.2	7.6	5.4
Kr-85	0.9	0.9	1.7	0.9	0.9	0.1	2.9	58.7
Kr-88	0.9	0.9	1.8	0.9	0.9	0.1	0.9	0.5
H-3	84.3	80.3	—*	81.5	82.3	12.6	81.8	32.7
C-14	2.4	2.3	22.4	2.3	2.4	0.4	2.3	0.9
Sr-90	0.1	0.1	10.4	—	—	—	<0.1	—
Ru-106	<0.1	5.8	0.3	<0.1	0.2	<0.1	0.2	<0.1
I-129	1.6	0.9	2.6	1.2	1.5	84.3	0.9	0.6
I-131	<0.1	<0.1	<0.1	<0.1	<0.1	1.2	<0.1	<0.1
U-235	0.2	0.2	1.4	0.2	0.3	<0.1	0.5	0.1
Pu-238	0.5	<0.1	33.6	2.2	2.0	<0.1	1.5	<0.1
Pu-239	0.1	<0.1	5.5	0.3	0.3	<0.1	0.2	<0.1
Am-241	0.1	<0.1	2.6	1.3	0.7	<0.1	0.1	<0.1
Cm-244	<0.1	<0.1	1.5	0.7	0.2	<0.1	0.1	<0.1
Others**	0.8	1.2	1.6	0.8	0.8	0.1	0.9	1.0

* Dashes signify no-dose conversion factors.

** Each contributing less than 1%.

TABLE 3.5-11

Percentage of Annual Doses to the 50-Mile Population by Radionuclide — Maximum Annual Routine Atmospheric Releases from L-Reactor Restart

	Organ Doses, %							
Radionuclide	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Ar-41	10.1	9.7	19.8	9.8	9.9	1.8	9.9	7.8
Kr-85	0.7	0.7	1.4	0.7	0.7	0.1	2.3	51.8
Kr-88	2.2	2.2	4.4	2.2	2.2	0.4	2.2	1.4
Xe-135	0.9	0.9	1.8	0.9	0.9	0.2	0.9	1.3
H-3	81.1	78.0	—*	79.0	79.4	14.7	79.2	35.2
C-14	2.0	1.9	19.6	2.0	2.0	0.4	2.0	0.9
Sr-90	0.1	0.1	12.0	—	—	—	<0.1	—
Ru-106	<0.1	4.6	0.2	<0.1	0.2	<0.1	0.1	<0.1
I-129	1.3	0.7	2.2	1.0	1.2	80.9	0.7	0.5
I-131	<0.1	<0.1	<0.1	<0.1	<0.1	1.3	<0.1	<0.1
U-235	0.2	0.1	1.1	0.1	0.2	<0.1	0.4	0.1
Pu-238	0.4	<0.1	28.0	1.7	1.6	<0.1	1.2	<0.1
Pu-239	<0.1	<0.1	4.6	0.3	0.2	<0.1	0.2	<0.1
Am-241	0.1	<0.1	2.2	1.0	0.6	<0.1	0.1	<0.1
Cm-244	<0.1	<0.1	1.2	0.6	0.2	<0.1	0.1	<0.1
Others**	0.7	1.0	1.4	0.7	0.7	0.1	0.7	1.0

* Dashes signify no-dose conversion factors.

** Each contributing less than 1%.

3.6 References

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4. WETLANDS - FLORA AND FAUNA

This chapter describes recent information on wetlands of the Savannah River floodplain and the Steel Creek delta area. Information is provided on the more common waterfowl and vertebrates as well as the rare and/or endangered species of the Steel Creek area.

4.1 WETLANDS

4.1.1 Savannah River Floodplain

Radiant multispectral data from the Savannah River floodplain and from the Savannah River Plant was collected by a NASA Landsat satellite in February 1977. A computer-aided analysis of this Landsat data was conducted to characterize the Savannah River floodplain and the wetlands on the SRP. Analysis of the Landsat data provided an accurate quantitative land use inventory of the area.

There are approximately 130,000 acres of wetlands in the 179,400 acres of Savannah River floodplain between Augusta, GA (River Mile 195) and Ebenezer Landing, GA (River Mile 45). The width of this 150 mile long stretch of floodplain varies from one to six miles. The six categories used to classify land use within the floodplain area were bottomland hardwood swamp, upland mixed forest, agriculture, river, urban, and miscellaneous (Table 4.1-1).

4.1.1.1 Savannah River Plant

The land area of SRP is 192,323 acres. Standing water or seasonally moist areas total 39,870 acres. These wet areas include streams and their floodplains, Carolina Bays, Par Pond, former farm ponds, canals, and the Savannah River swamp and floodplain. The L-Reactor Environmental Assessment stated that SRP contains 39,000 acres of wetlands. This value is based on U.S. Forest Service estimates of creek floodplain bottomland hardwood forests (31,400 acres), plus an estimate of the SRP river swamp from Four Mile Creek to Steel Creek (7,800 acres). The EA estimate does not include Par Pond, Carolina Bays, and canals.[1,2] Although the EA and Landsat estimates of bottomland hardwood and swamp differ, the total acreage is similar. The EA estimated 39,000 acres and Landsat 34,976 acres. The acreage covered by the different kinds of SRP wetlands is shown in Table 4.1-2. L-Reactor startup will impact approximately 2.5% (1000 acres) of the total SRP wetland

TABLE 4.1-1

Land Use Classification of the Savannah River Floodplain*

Classification	Acres	Percentage	Acres of Wetlands
Bottomland Hardwood Swamp	124,600	70	124,600
Upland Mixed Forest	25,500	14	-
Agriculture	18,313	10	-
River	7,528	4	7,528
Urban	1,543	1	-
Miscellaneous	1,904	1	-
Total	179,388	100	132,128

* Analysis of February 22, 1977, NASA Landsat satellite multispectral data.

TABLE 4.1-2

Wetland Areas at SRP

Type wetland	Acres	Percentage	EA Acreage Estimates
Creeks/Floodplains	24,607*	62	31,400†
Savannah River Swamp	10,369*	26	7,800††
Par Pond	2,640**	7	-
Carolina Bays	1,250***	3	-
Other	1,004***	2	-
Total	39,870	100	39,200

* Analysis of February 22, 1977 NASA Landsat satellite multispectral data.
** T. M. Langley and W. L. Marter. The Savannah River Plant Site DP-1323 (1973).
*** J. D. Shields, et al. Locations and Areas of Ponds and Carolina Bays at the Savannah River Plant. DP-1525 (1980).
† U.S. Forest Service.
†† From Four Mile Creek to Steel Creek.

area. A description of each wetland category and the amount that will be affected by L-startup follows.

About 8% (10,369 acres) of the Savannah River swamp (i.e., from Upper Three Runs to Steel Creek) lies adjacent to the SRP. Studies by SREL indicated that vegetation in 45% of the SRP swamp has been affected to some degree by thermal discharges.[3] Estimates of impacted and nonimpacted swamp acreage are shown in Table 4.1-3. The nonimpacted and slightly impacted areas comprise 88% of the SRP swamp; both areas presently support a wide diversity of plant and animal life. Included in the impacted category are 300 acres of Steel Creek Delta that once experienced moderate to severe vegetative destruction from L-Reactor thermal discharges. Vegetation in the Steel Creek Delta (3% of the SRP total) will again be thermally affected when the stream receives L-Reactor cooling water effluents.

The SRP tributaries and their floodplains cover 27,968 acres. Bottomland hardwood characterizes the floodplains of the streams. Over 95% of these wetlands support diverse vegetative and wildlife communities. The other 5% (1270 acres) lies along Four Mile Creek and Pen Branch Creek and is currently affected by thermal discharges from C and K Reactors, respectively (Figure 4.1-1). Fish and aquatic vegetation in the wetland area along Steel Creek (from L-Reactor outfall to the delta) will be affected when L Reactor resumes operations. The EA estimated that the impacted area in the Steel Creek corridor would be 580 acres or 2% of the total creek floodplain area at SRP. The Landsat data estimated that 792 acres of bottomland hardwood exists along the Steel Creek corridor. The EID estimated the Steel Creek corridor as 725 acres. Since L-Reactor thermal discharges will probably not directly impact the entire bottomland hardwood area, the EID value remains as a reasonable conservative estimate of the impact area.

Although 2281 acres of the wetlands along Steel Creek above L Area and along Meyers Branch above its confluence with Steel Creek will not receive direct thermal discharges, access to these areas by fish from the Savannah River will be restricted. The entrance to Boggy Gut Creek, an offsite tributary immediately downriver of Steel Creek, could be blocked by the thermal plume at times and fish access therefore limited (Section 5.4). Wetland areas of Boggy Gut total about 231 acres.

4.1.1.2 Steel Creek Delta

During the summer of 1981, an intensive sampling of the vegetation of the Steel Creek Delta and surrounding swamp was conducted to provide wetlands habitat characterization and to serve as the basis for a vegetation map. Field sampling techniques and procedures for preliminary data analyses are detailed in Reference 4.

TABLE 4.1-3

Acres of SRP Swamp Impacted by Thermal Effluents

Vegetative Impact	Acres
Severe	560*
Moderate	650*
Slight	3,450*
None detected	5,709**
Total	10,369

* R. R. Sharitz, et al. "Impact of Production Reactor Effluents on Vegetation in a Southeastern Swamp Forest." Thermal Ecology. CONF-730505, pp. 356-362, (1974).

** Remainder of wetland area based on Landsat estimate.

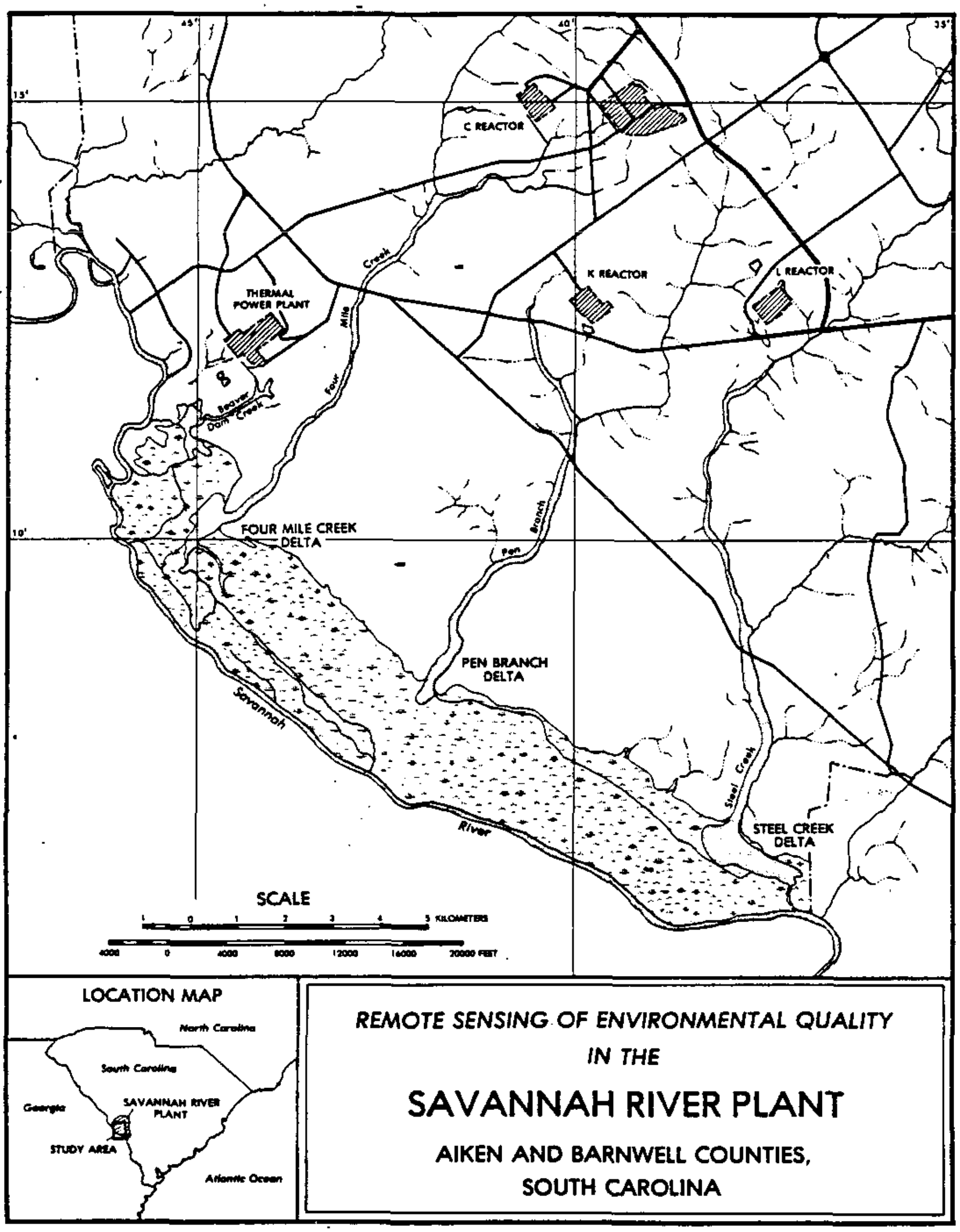


FIGURE 4.1-1. Map of the Savannah River Plant Showing Two Nuclear Reactors (C and K) Currently Discharging Thermal Effluent Into the Savannah River Swamp. L Reactor Will Also Discharge Hot Water Into the Swamp.

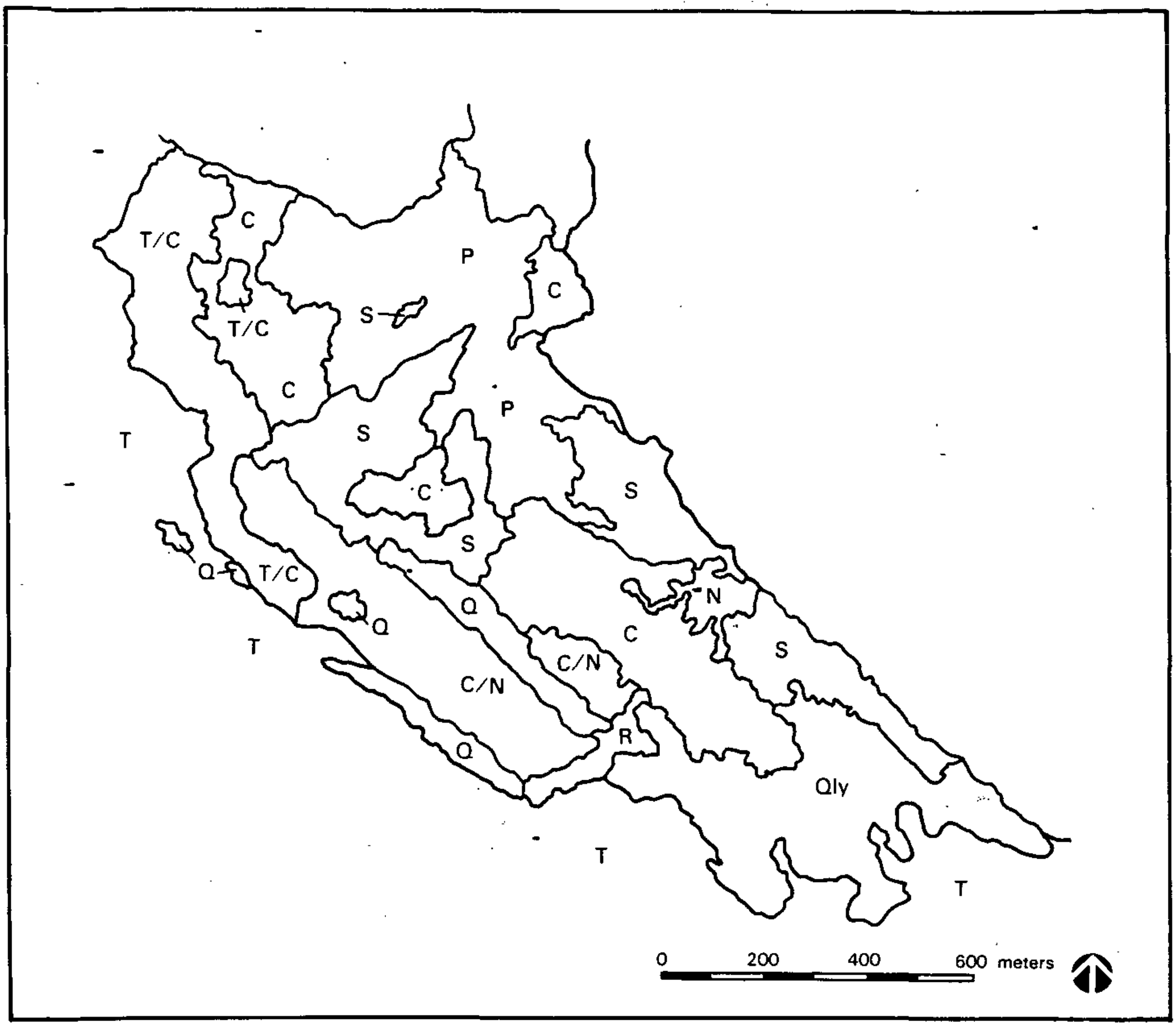
Preliminary vegetation maps of the Steel Creek corridor and delta were prepared from autumn 1978 color infrared aerial photographs (scale = 1:9600) and from the 1981 sampling data. These maps, along with descriptions of the plant community types, and a summarization of the sampling data including species density, basal area or standing crop, and community ordination have been presented previously.[4]

Subsequent to preparation of the 1981 report,[4] summer 1981 color infrared imagery of the Steel Creek Delta was obtained (EG&G Inc., Las Vegas, NV) at scales of 1:4000 and 1:6000. This imagery provided a more detailed and up-to-date resource for preparation of a final vegetation map than did the 1978 imagery. Therefore, further data analysis and map preparation were undertaken in 1982.[5] Plant community types were characterized according to the U.S. Fish and Wildlife Service system for classification of wetlands and deepwater habitats of the United States and used as vegetation mapping units.[6]

The following units, or combination of units, were identified for mapping purposes:

- Sv = Submerged vascular aquatic plants
- P = Persistent aquatic plants
- N = Nonpersistent aquatic plants
- C = Cephalanthus occidentalis (buttonbush-shrub community)
- S = Salix spp. (willow-shrub community)
- T = Taxodium distichum and Nyssa aquatica (cypress-tupelo forest)
- F = Fraxinus spp. (ash-dominated bottomland hardwood forest)
- Q = Quercus spp. (oak-dominated bottomland hardwood forest)
- T/F = Cypress-tupelo-ash forest
- T/C and T/C/N = cypress-tupelo forest with buttonbush shrubs (and with nonpersistent herbaceous vegetation = N)

Application of these mapping units to 1981 aerial photography resulted in the construction of a vegetation map of the Steel Creek Delta and swamp which differed in subtle ways from the preliminary one based upon 1978 imagery (Figures 4.1-2 and 4.1-3).[5] The resulting eleven mapping units are described in Table 4.1-4. Successional regrowth of the buttonbush and willow shrub communities has resulted in their expansion into areas previously characterized by persistent emergent grasses and other herbaceous species.[6]



Key:

Aquatic bed

R Rooted vascular (parrot-feather)

Emergent wetland

P Persistent (cut grass)
N Nonpersistent (hydrolea)

Scrub-shrub wetland

C Broad-leaved deciduous (buttonbush — willow)
C/N Mixed scrub-shrub/nonpersistent emergent (button bush — polygonum)

Forested wetland

S Broad-leaved deciduous (willow)
Q Broad-leaved deciduous (laurel oak)
Qly Broad-leaved deciduous (overcup oak — water hickory — tupelo gum)
T Mixed deciduous (bald cypress — tupelo gum)
T/C Mixed forested/scrub-shrub (bald cypress — buttonbush)

FIGURE 4.1-2. Vegetation Map of Steel Creek Delta Based on 1978 Aerial Photographs and 1981 Field Studies

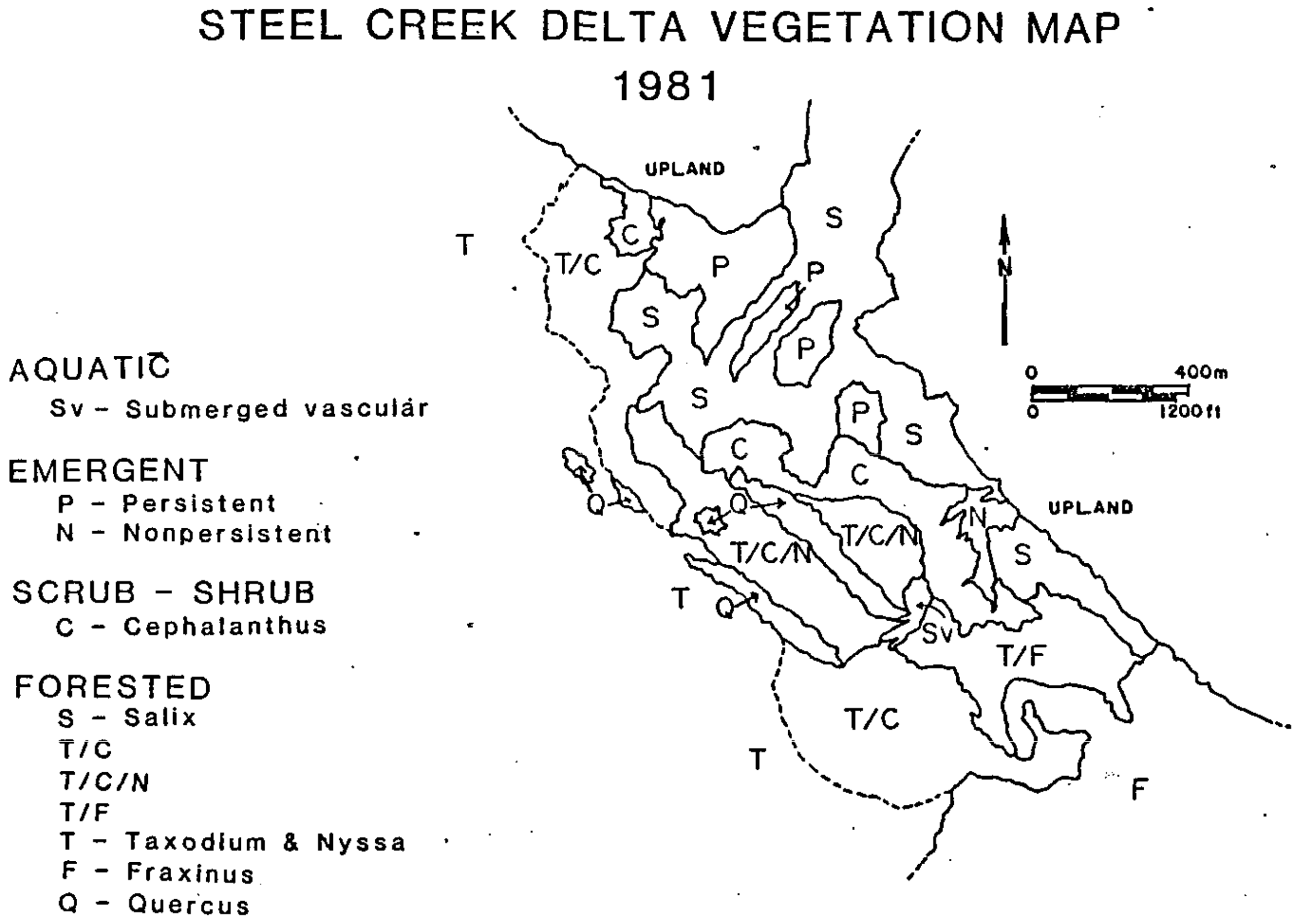


FIGURE 4.1-3. **Vegetation Map of Steel Creek Delta Based on 1981 Aerial Photographs and Field Studies**

TABLE 4.1-4

Steel Creek Delta Community Types

Wetland Type	Description	Common Dominant Plants
Palustrine System Aquatic Bed	Submerged Vascular (Sv)	Ceratophyllum demersum Lemna perpusilla Myriophyllum brasiliense Polygonum lapathifolium
Emergent Wetland	Persistent (P)	Leersia spp. Panicum agrostoides Scirpus cyperinus Typha latifolia
	Nonpersistent (N)	Hydrolea quadrivalvis Polygonum hydropiperoides Aneilema keisak Ludwigia palustris Sagittari latifolia
Scrub-Shrub Wetland	Broad-leaved Deciduous (C)	Cephalanthus occidentalis Mikania scandens Ampelopsis arborea
	Mixed Forest/Scrub-Shrub Wetland (T/C)	Taxodium distichum Nyssa aquatica Cephalanthus occidentalis
	Mixed Forested/Scrub-Shrub Nonpersistent Emergent Wetland (T/C/N)	Taxodium distichum Mussa aquatica Cephalanthus occidentalis Polygonum lapathifolium
Forested Wetland	Broad-leaved Deciduous (S)	Salix spp.
	Broad-leaved Deciduous (F)	Fraxinus spp.
	Broad-leaved Deciduous (Q)	Quercus spp.
	Mixed Deciduous (T)	Taxodium distichum Nyssa aquatica
	Mixed Deciduous (T/F)	Taxodium distichum Nyssa aquatica Fraxinus spp.

Examination of the revised vegetation map for the Steel Creek Delta (Figure 4.1-2) and comparison with the preliminary map (Figure 4.1-3) indicate the continued successional revegetation of the upper part of the delta. In 1978, this region was dominated by persistent herbaceous emergent species (chiefly cut grass); however, by 1981 the willow shrub and low forest community had spread across much of the upper delta. Some additional growth of buttonbush is also apparent in the deeper water zone peripheral to the deltaic fan.[6]

A mixed hardwood community characterized by ash (chiefly Fraxinus caroliniana) and numerous other hardwoods was identified and mapped in the southern periphery of the delta area. This community occurs in an area where the original swamp canopy has become partially open as a result of flooding by reactor effluents. An understory dominated by ash and tupelo saplings, chiefly the result of stump and root sprouting, has developed in this area.

4.1.2 Growth of Steel Creek Delta

The history of the Steel Creek delta was traced by digitizing aerial photographs from 1943 to 1982. Delta boundary changes were recorded and acreages estimated. The aerial photographs show thermal discharges first affecting the canopy between 1955 and 1956 more than one year after 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 1 acre 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 307 acres (Table 4.1-5 and Figures 4.1-4, and 4.1-5). When L Reactor discontinued operations in 1968, the swamp canopy began to recover. From 1968 to 1982 about 27 acres of impact zone recovered (Figure 4.1-6), and new canopy cover was established. Partial canopy recovery occurred in an additional 51 acres of former tree kill (Figure 4.1-6).

TABLE 4.1-5

Steel Creek Delta Impact Areas

Year	Total Impacted Area,* Acres	Total Canopy Loss,** Acres
1951	0	0
1955	0	0
1956	180	0
1961	303	214
1966	307	235
1974	299	210
1982	280	184

* Includes partial to total tree canopy losses.

** Includes primarily the sedimentation delta and peripheral areas experiencing total canopy removal.

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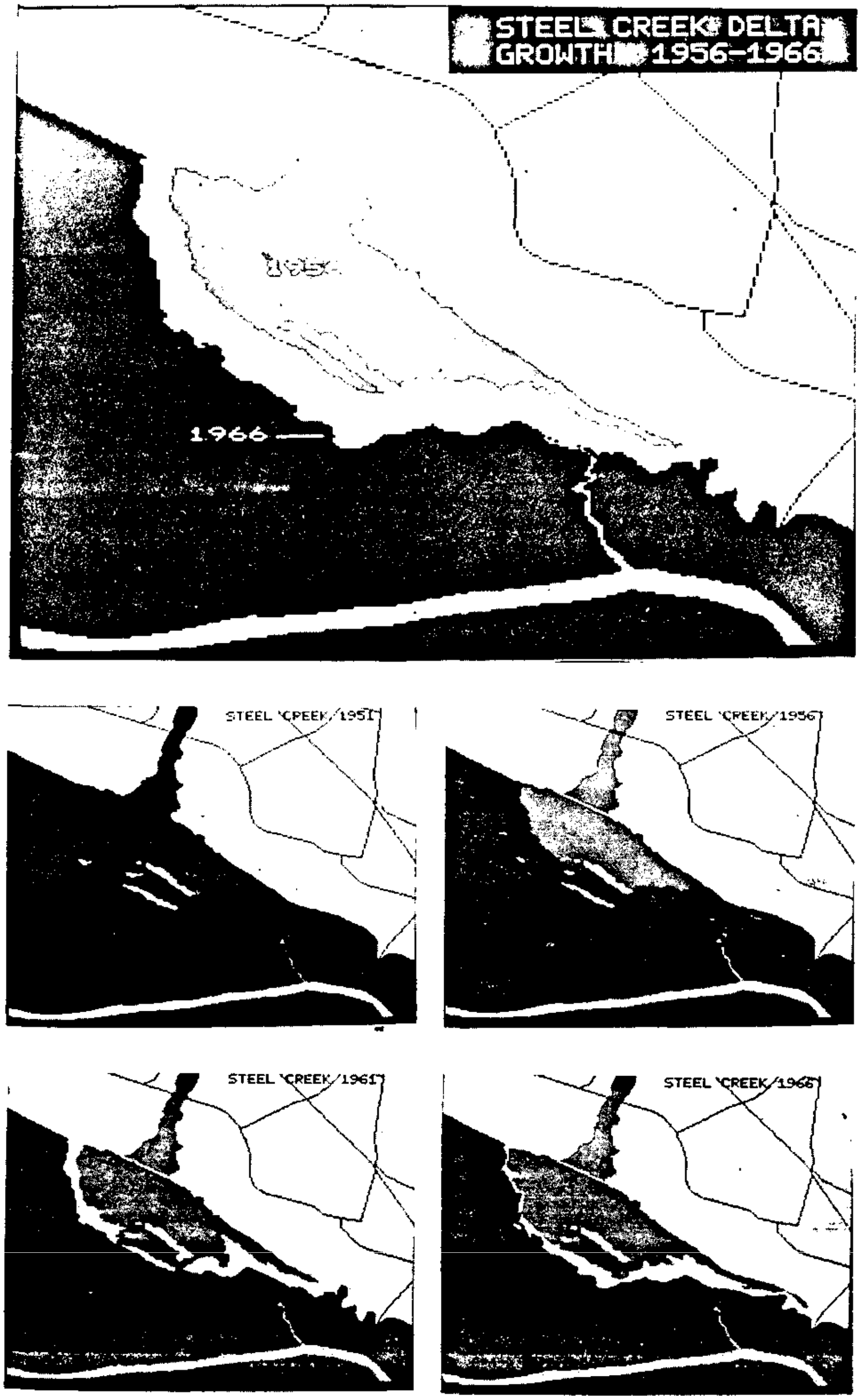

FIGURE 4.1-4. Steel Creek Delta Growth from 1956 to 1966

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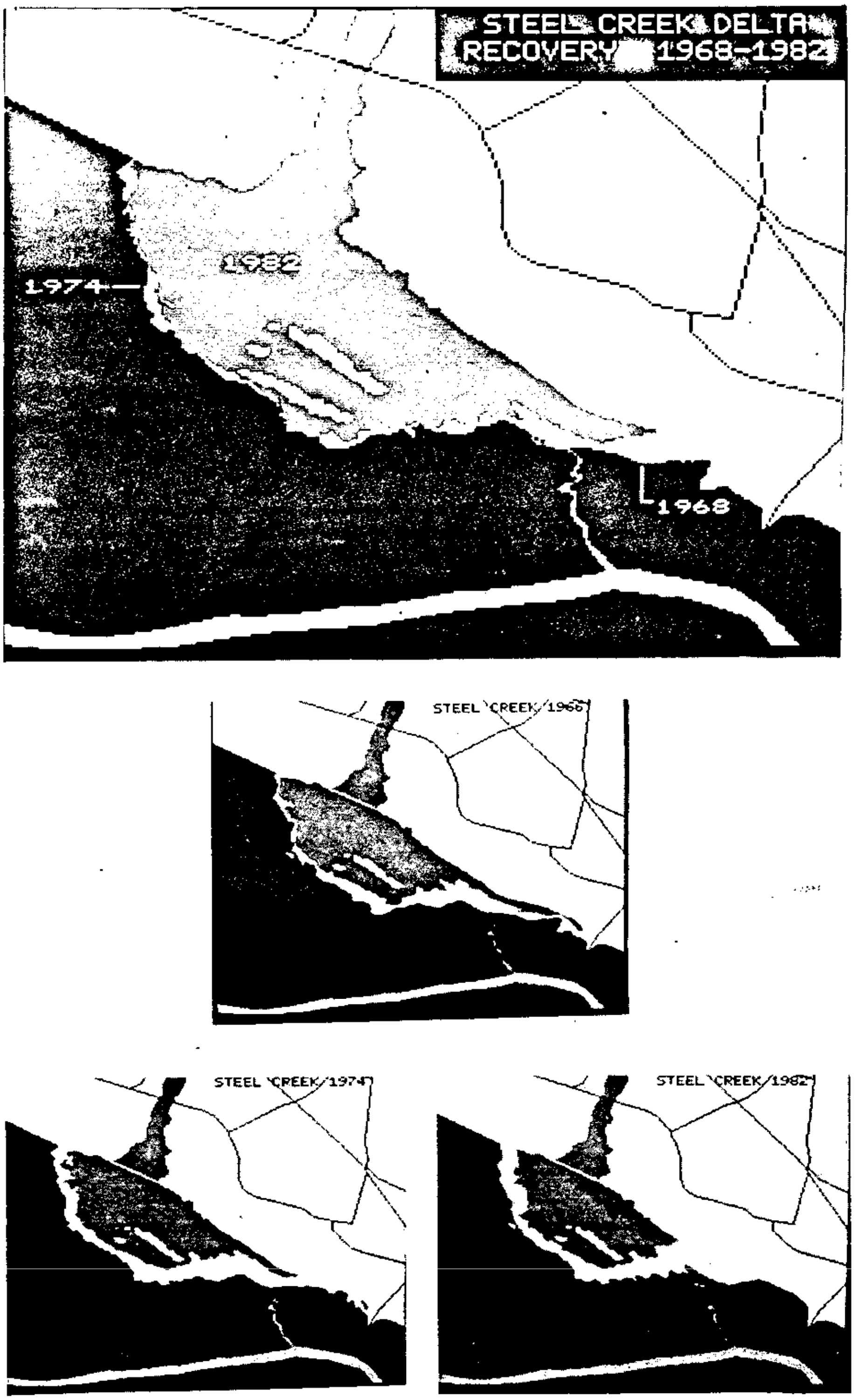

FIGURE 4.1-5. Steel Creek Delta Recovery from 1968 to 1982

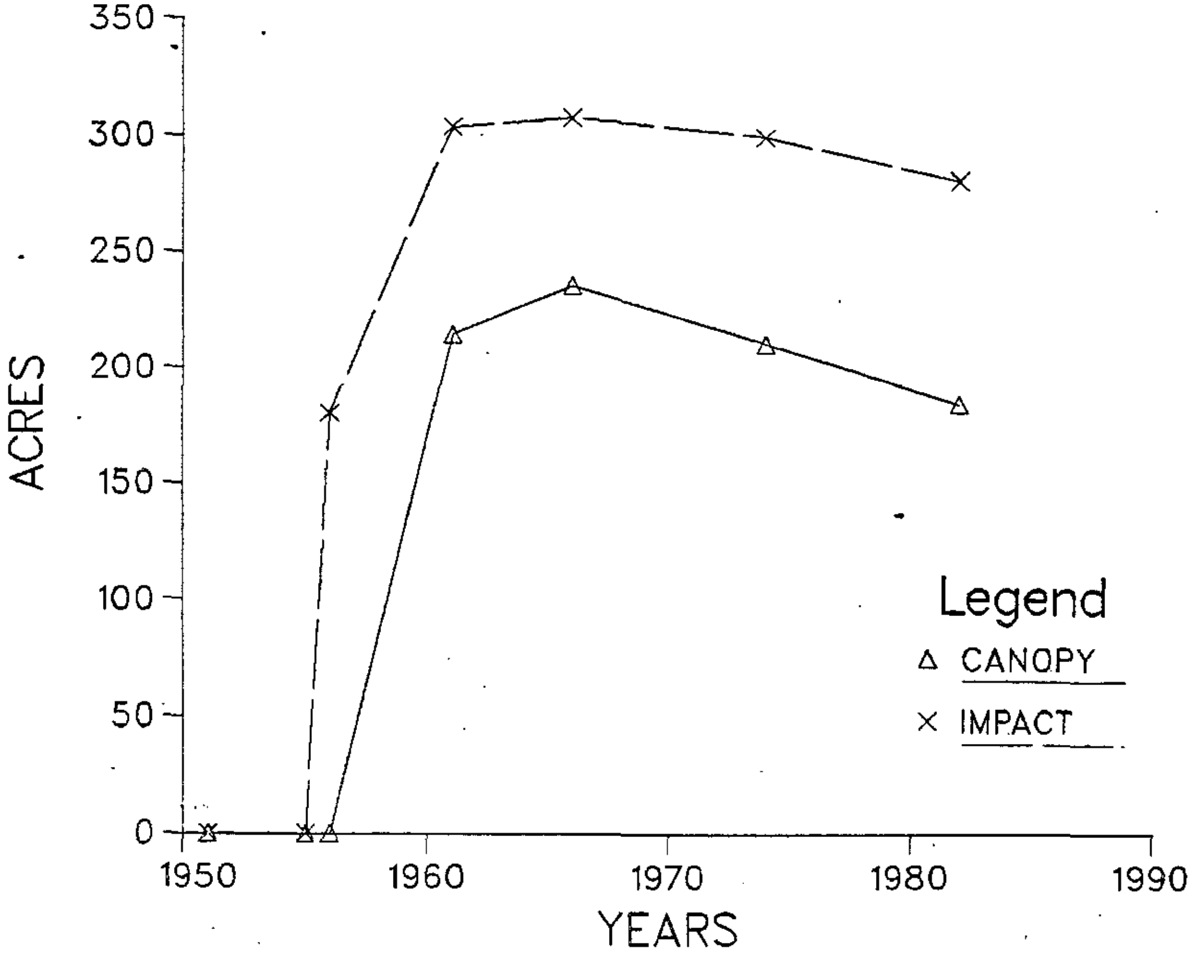

FIGURE 4.1-6. **Steel Creek Delta Growth and Recovery from Pre-SRP to 1982**

4.2 Important Av auna

Among the av auna of the Steel Creek Delta and floodplain areas are two gro s deserving special consideration regarding possible impacts om the restart of L Reactor. The first group includes those sp ies that are of a rare, endangered or threatened status, as well a those which are likely to be placed in such a status in the nea future. Included in this group are the red-cockaded woodpeck , Bachman's warbler, and the wood stork. The first two species re officially listed as endangered. The status of wood stork is rrently being reviewed. Previous reports have shown that neithe Bachman's warbler nor the red-cockaded woodpecker are li ly to be affected by L-Reactor operation (Appendix K.5). wever, the wood stork uses the Steel Creek area and therefore the pecies is of concern.

The second g up of the Steel Creek avifauna deserving special consideration are he waterfowl. Both in numbers and biomass, waterfowl are amo the most prominent members of the Steel Creek avifauna communit The potential value of these species to area sportsmen makes t m worthy of special consideration. The Steel Creek area may re esent a refuge-concentration area for waterfowl of the region as result of the freedom which birds in this area enjoy from public unting.

4.2.1 Waterfowl

The SRP Sava ah River Swamp contains a wide variety of habitat types and rovides excellent habitat for wintering waterfowl. Aquatic ha tats range from open channels to dense cypress-tupelo forest. T Steel Creek Delta area provides excellent waterfowl habitat ecause several vegetation types (marsh, shrub, bottomland hardwo s, cypress-tupelo) occur in close proximity to one another. Thi area receives utilization by mallards and wood ducks.[5,7-10] In uth Carolina, the mallard and wood duck comprise the larg t portion of the waterfowl hunter's bag, and thus represents a aluable renewable resource. Thermal effects from L Reactor wi probably destroy much of the shrub-marsh habitat in Steel eek Delta and may cause additional loss of the adjoining cypress upelo forest. Waterfowl use of Steel Creek Delta can also be ompared with Pen Branch Delta and Four Mile Creek Delta which re currently receiving reactor effluents and with Beaver Dam C ek which is receiving thermal effluents from a coal-fired power neration plant. Such comparisons among the different delta a as facilitate the prediction of changes in waterfowl utiliza on of Steel Creek Delta following the restart of L Reactor.

Two methods were used to document waterfowl distribution and abundance in Steel Creek and in the SRP Savannah River Swamp. The first method, ground counts and observations, was used exclusively in Steel Creek Delta and the surrounding cypress-tupelo forest. The second method, aerial survey, was used to census waterfowl around Pen Branch Delta and Four Mile Creek Delta, and Beaver Dam Creek, as well as around Steel Creek Delta.[5]

Nine species of waterfowl were observed in the Steel Creek Delta area between mid-September 1981 and March 1982 (Table 4.2-1). Wood ducks are present throughout the year, but a substantial turnover of individuals occurs seasonally. Wintering populations are larger than summer populations because of the influx of migratory wood ducks. Wood ducks banded in August, September, October, and November on the SRP have been recovered in Minnesota, Wisconsin, and Ontario, as well as in South Carolina. In general, the remaining species are present only during the fall and/or winter months, although hooded mergansers may occasionally breed on the SRP.[6] In previous years, shovelers (Athya clypeata) and lesser scaup (A. affinis) have also been observed in the Steel Creek area.[7,8]

Mallards and wood ducks dominate the Steel Creek Delta area waterfowl community (Figure 4.2-1). Even though the number of ducks counted during the annual Christmas Bird Counts varies 14-fold, the frequency distribution of the number of each species observed is rather stable. Mallards dominant in all three years and wood ducks are second in two of three years.[7-9]

An influx of wood ducks occurred in late October 1981, then their numbers declined through November. Another influx of wood ducks appeared in mid-December and their numbers declined again through January. By mid-February wood ducks had begun nesting on the SRP and many migrants had already flown north. The seasonal fluctuations in wood duck counts generally correspond with those reported by Fendley.[10]

Mallards did not arrive in the Steel Creek Delta area until late October 1981. The greatest number of mallards were present in the study area during mid-December through mid-January. Mallard numbers declined from mid-January to mid-February but sharply increased after mid-February. Mallards present in the study area during late February were probably transient migratory flocks that spent only one or two days on the Steel Creek Delta.[5]

Use of the Steel Creek Delta by the other species was generally low. Flocks of up to 50 American green-winged teal and 25 American widgeon were seen on a number of occasions during the fall and winter. Hooded mergansers were also present on the area but no more than 15 to 20 were seen at the same time. Only one pintail and one bufflehead were seen during the fall and winter.[5]

TABLE 4.2-1

Waterfowl Observed in or Around Steel Creek Delta During Fall 1981 and Winter 1982

Species	Months of Use
Wood Duck (Aix sposa)	Year round
Mallard (Anas platyrhynchos)	Late October-Late February
Blue-Winged Teal (Anas discors)	Mid-September-Early October
American Green-Winged Teal (Anas crecca)	Late October-Late February
Black Duck (Anas rubripes)	Late October-Late February
American Wigeon (Anas americana)	Late October-Late February
Pintail (Anas acuta)	
Hooded Merganser (Mergus cucullatus)	Late October-Late February
Bufflehead (Bucephala albeola)	

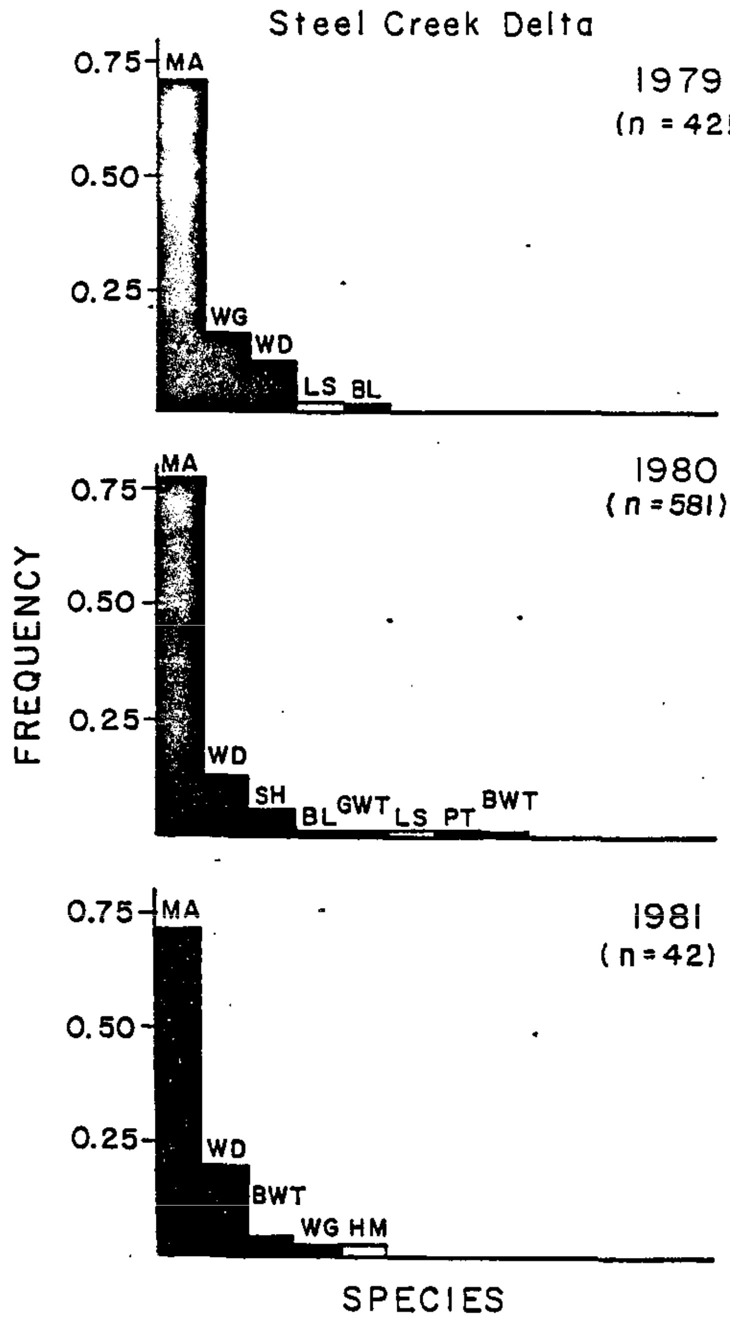

FIGURE 4.2-1. Frequency Distribution of the Number of Each Species of Waterfowl Counted in Steel Creek Delta During Annual Christmas Bird Counts (References 7-9); MA = Mallard, WD = Wood Duck, WG = Wigeon, LS = Lesser Scaup, BL = Black Duck, GWT = Green-Winged Teal, BWT = Blue-Winged Teal, PT = Pintail, HM = Hooded Merganser, SH = Shoveler.

Waterfowl used Steel Creek Delta for both feeding and roosting (Figure 4.2-2). Up to 300 mallards, 200 wood ducks, 50 green-winged teal, 25 American wigeon, and 20 hooded mergansers were seen flying into the Steel Creek Delta roost. This roost area was characterized by a dense growth of buttonbush (Cephalanthus occidentalis) that provided good overhead protection from predators. Both the roosting and feeding areas in Steel Creek Delta will be destroyed by thermal effluents from L Reactor. Waterfowl also fed extensively in the cypress-tupelo forest surrounding the Steel Creek Delta area. These feeding areas should not be as directly affected by L-Reactor startup. However, because L-Reactor effluents will destroy the shrub-marsh habitat in Steel Creek Delta that is used for both feeding and roosting, waterfowl use of the cypress-tupelo forest habitat may decline.[5]

A comparison of the number of mallards observed during aerial surveys of the Steel Creek Delta area, Pen Branch Delta, Four Mile Delta area, and Beaver Dam Creek revealed that both the Four Mile Delta area and Beaver Dam Creek were used by this species (Figure 4.2-3). However, waterfowl were not observed in Pen Branch Delta. Mallard use of the Four Mile Delta area was generally higher than that of Steel Creek. Mallards in the Four Mile Delta area were associated with open channels that branch off the main delta at a 90° angle. Mallards were observed in these channels whether C Reactor was up or down, except during the December 30 and January 5 surveys when C Reactor was operating and the swamp water level reached a peak. During this period, the Savannah River had breached its levee and normal water flow across Four Mile Delta was disrupted. Hot water normally flows in a southwesterly direction across the delta toward the river and does not flow directly into the open channels. However, during peak water levels, hot water was probably diverted directly into the open channels making them unsuitable for use by waterfowl. Thus, the open channels associated with Four Mile Delta provide waterfowl habitat, except when normal water flow is disrupted.[5]

The open channels exist at Four Mile Creek Delta because of the unique topography of the area. Hardwood islands prevent the flow of hot water directly into these channels during periods of normal water levels. Around Pen Branch, similar open channels have not developed because of the different orientation of the hardwood islands. Waterfowl were not observed in this area. Although two hardwood islands are present in Steel Creek Delta it is unlikely that suitable waterfowl habitat will develop between them after L-Reactor restart because flow from Steel Creek moves directly between the islands.[5]

STEEL CREEK DELTA:
ZONES OF REACTOR INFLUENCE AND HYDROLOGIC REGIME

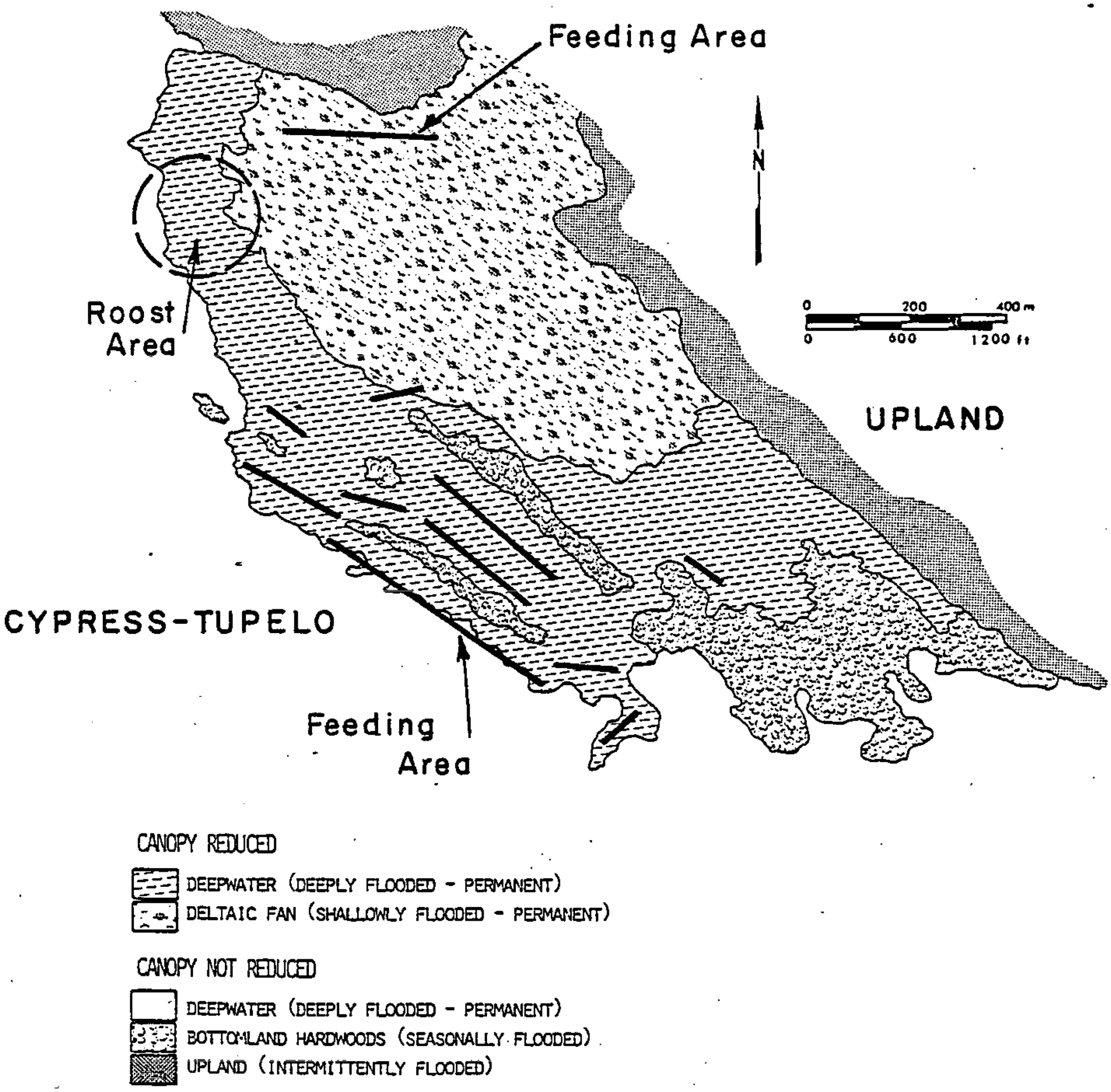

FIGURE 4.2-2. Feeding and Roosting Areas in Steel Creek Delta Used by Waterfowl During the Fall and Winter of 1981-1982.

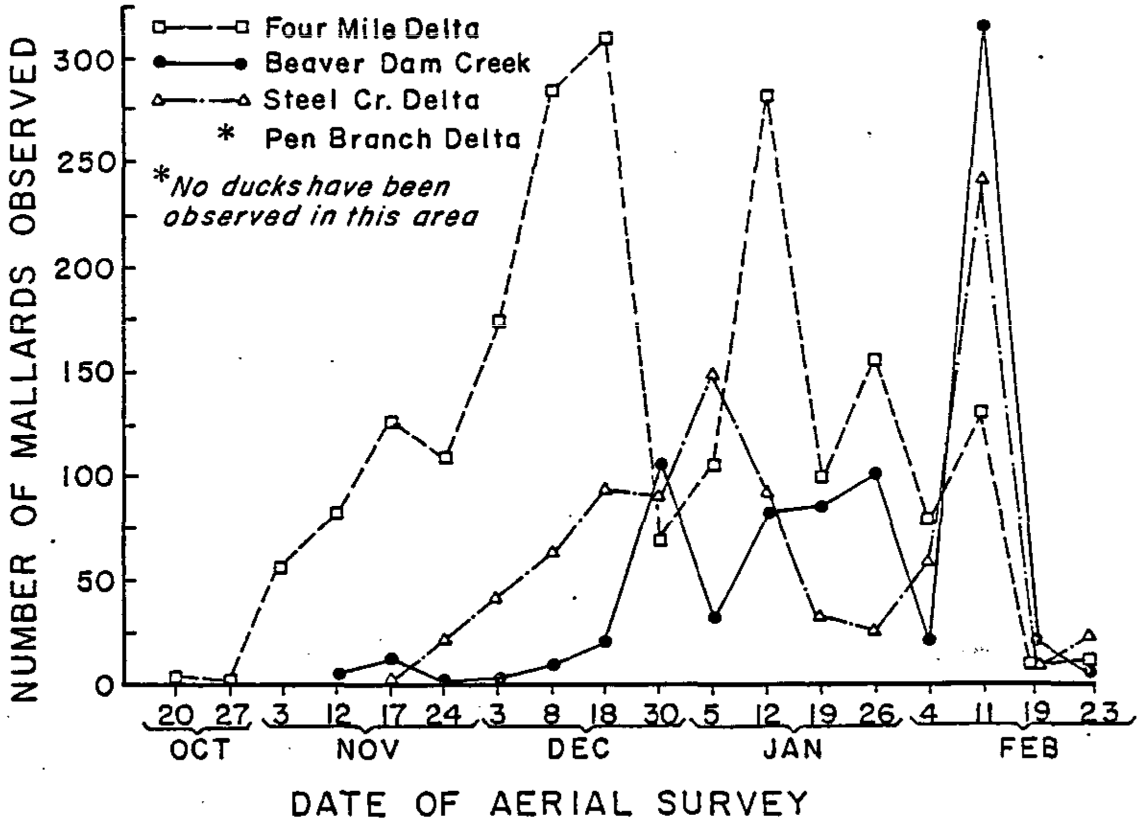

FIGURE 4.2-3. Number of Mallards Observed During Aerial Surveys of the Savannah River Swamp in the Fall and Winter of 1981-1982.

4.2.2 Wood Ducks

Studies during the spring and summer of 1982 emphasized the biology of the resident wood duck populations. Previous impacts of cooling water effluents in the Steel Creek Delta area, have produced habitats that are attractive to both migratory waterfowl in winter, and to spring and summer breeding populations of wood ducks (Aix sponsa).[5,10] The wood duck is the only species of waterfowl to breed commonly in the SRP region. Because of its requirement for nesting cavities near water, flooded marshy areas with large amounts of standing dead timber common in the lower reaches of Steel Creek, are ideal for this species.[5] Data presented by Fendley suggested that these areas have a higher carrying capacity for both migratory and breeding wood ducks than was the case either before or during the period of reactor effluent introduction.[10] The proposed restart of L Reactor represents a potential for reduction of the carrying capacity of this area.

Fifty nest boxes were erected in the Steel Creek drainage system in January 1973 (Figure 4.2-4). These boxes were placed on standing dead cypress trees approximately 1.75 to 6.00 m above high water. Bi-weekly checks of these boxes were made by Fendley from February through June during 1973, 1974, and 1975. After the completion of Fendley's study in 1975, the boxes were not checked again until 1979. Between 1976 and 1979, additional boxes were erected in the Steel Creek system and in other areas on the SRP. These boxes and those remaining from Fendley's study were checked at approximately bi-weekly intervals from February to April in 1979, monthly intervals from March to May in 1980 and from February to April 1981, and at least bi-weekly (or shorter) intervals from April to July 1981. In 1982, all boxes were checked at weekly intervals from February to mid-July. During each check, the presence and number of eggs in a box were recorded. Incubating females were also captured and banded with a U.S. Fish and Wildlife Service leg-band.[11] Newly-hatched ducklings were web-tagged with #1 monel fish-fingerling tags, to allow identification of birds from Steel Creek nests that might subsequently be collected in the area as adults.[5,10]

Wood ducks exhibited a rapid response to the initial erection of nest boxes in the Steel Creek system (Table 4.2-2). Use of nest boxes increased from 26% to 68% in the first three years of their availability. Nest box utilization was highest in 1979, declined in 1980 and 1981, and showed a slight increase in 1982. The number of clutches initiated exhibited a pattern similar to that of nest box utilization (Table 4.2-2) except in 1982 when the number of clutches initiated reached 1979 levels. Both 1980 and 1981 were extremely dry years and were therefore less favorable for wood duck nesting.[5]

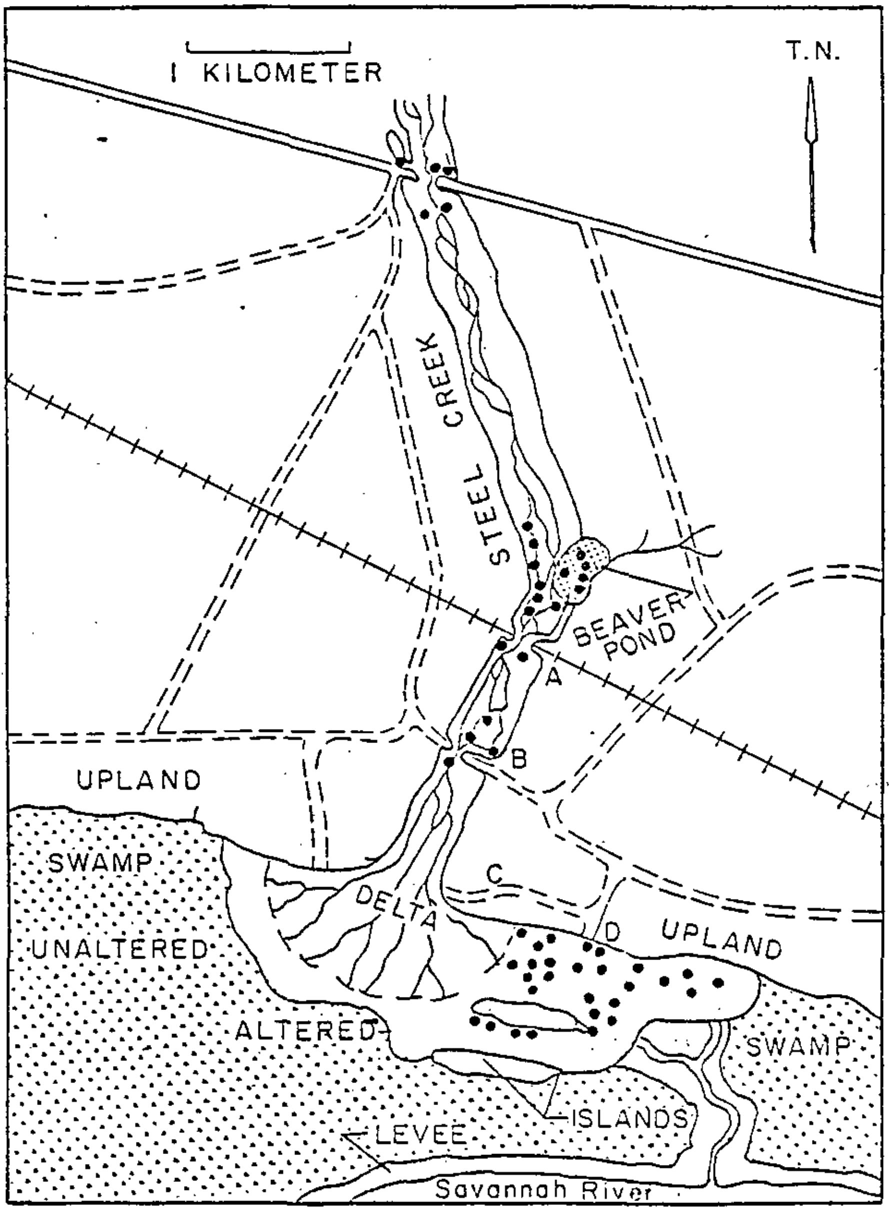

FIGURE 4.2-4. Location of Nest Boxes in the Steel Creek Drainage System.

TABLE 4.2-2

Use of Nest Boxes by Female Wood Ducks in the Steel Creek Drainage System

	1973*	1974*	1975*	1979	1980	1981	1982
Number of boxes used	13	29	34	39	30	25	28
Number of boxes available	50	50	50	50	44	45	46
Percent utilization	26.0	58.0	68.0	78.0	68.2	55.6	60.9
Number of clutches	13	29	34	45	38	31	44

* From Reference 10.

Specific locations of each line of boxes in the Steel Creek system during 1979 to 1982 are shown in Figure 4.2-5. Percent utilization was determined for the Steel Creek Delta line, the Steel Creek Beaver Pond line, and for the three other upstream Steel Creek lines combined. Nest box utilization in Steel Creek Beaver Pond remained high from 1979 to 1982 (Figure 4.2-6). However, percent utilization declined until 1981 in the Steel Creek Delta and leveled off in 1982. The other Steel Creek lines also declined until 1981 but increased in 1982. Normal water conditions enhanced reproduction in 1982.[5]

Also shown in Figure 4.2-6 is the percent utilization of boxes along Upper Three Runs Creek. Upper Three Runs Creek has never received reactor effluents and is a typical blackwater stream. Before the release of thermal effluents, the habitats of Upper Three Runs Creek and Steel Creek were floristically similar.[12] Percent utilization of boxes along Upper Three Runs was low and relatively constant from 1979 to 1982. The habitat created by post-thermal recovery of the Steel Creek drainage system is superior for wood ducks to that of the thermally unaltered habitat along Upper Three Runs Creek. However, the quality of habitat for nesting wood ducks in Steel Creek Delta and the other Steel Creek lines, with the exception of that in Steel Creek Bay and the Steel Creek Beaver Pond, is declining. This decline in habitat quality is probably associated with successional changes in the vegetation in the delta and along the main channel of Steel Creek. Dense stands of willow (<u>Salix</u> spp.) and other woody vegetation have grown around many of the nest boxes. These successional changes in the vegetation of the area have made it difficult for nesting ducks to find and enter nest boxes.[5]

The early successional marsh vegetation in the Steel Creek Beaver Pond, unimpacted by thermal effluents, has changed little since 1979 and percent utilization of nest boxes in this area remains high. The production of ducklings in the Steel Creek Beaver Pond line is also high. Of the 90 ducklings produced in all lines in the Steel Creek drainage system in 1981, 86.7% came from nests in this beaver pond. Four of the remaining 12 came from a box in Steel Creek Delta, and 8 came from boxes on the other Steel Creek lines. Of 213 ducklings produced in all lines in the Steel Creek drainage system in 1982, 74.6% came from nests in the Steel Creek Beaver Pond. Of the remaining 54 ducklings produced in the Steel Creek drainage, 14 came from a box in Steel Creek Delta, and 40 came from boxes on other Steel Creek lines.[5]

Of the 9 females captured and banded in 1979 to 1981 in Steel Creek Delta, one has been recaptured in a subsequent year. However, of 17 females captured and banded in Steel Creek Beaver Pond during 1979 to 1981, 10 have been recaptured there in one or more

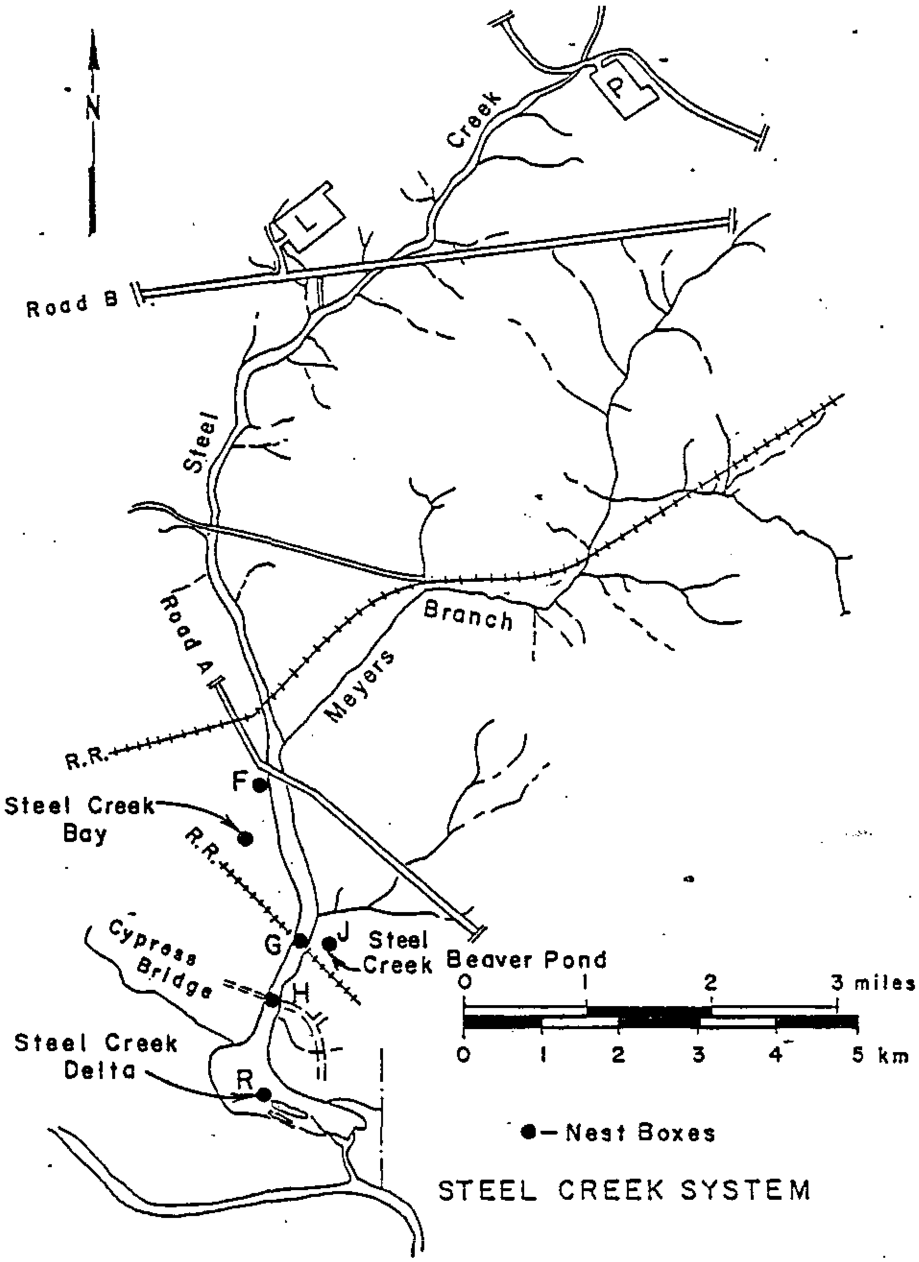

FIGURE 4.2-5. Location of Each Line of Boxes in the Steel Creek Drainage System During 1979-1982.

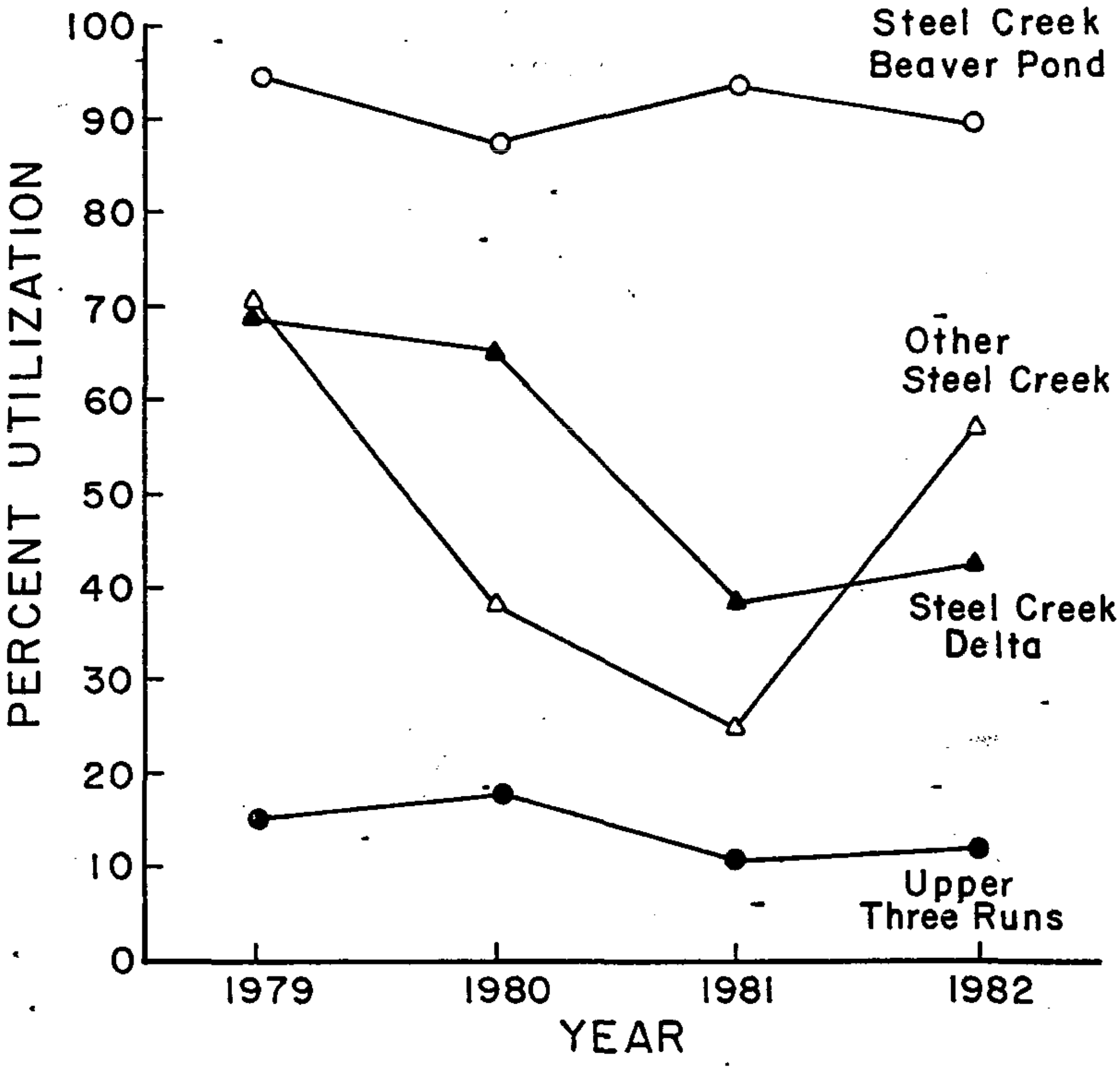

FIGURE 4.2-6. Use of Nest Boxes by Female Wood Ducks on Different Areas of the Steel Creek Drainage System and on Upper Three Runs Creek

years after the year of banding. Thus, banding data also supports the conclusion that the quality of habitat for nesting wood ducks in Steel Creek Delta is declining.[5]

Although the quality of habitat in Steel Creek Delta is declining with respect to wood duck nest box utilization, studies indicate that it still provides excellent brood habitat. From eight to ten different wood duck broods were observed in Steel Creek Delta in both 1981 and 1982, even though only one brood in each year was produced from boxes there. These observations in Steel Creek Delta represent minimal estimates of brood use because of the difficulty of observing broods in the dense vegetation.[6]

The broods observed in Steel Creek Delta in addition to those produced in boxes there could have been produced in natural cavities or the broods may have moved to the delta from the other Steel Creek lines. Hens and their broods often travel long distances (>2 km) from the nest site to suitable brood-rearing habitats.[5]

The results of the nest box surveys indicate that while portions of the Steel Creek habitat are still of high value to nesting wood ducks, other parts such as much of the Steel Creek Delta and the floodplains of the upper reaches of the stream watershed are becoming progressively less appropriate for duck nesting. This decline in usage occurs as normal succession replaces open areas, created by earlier thermal reactor effluent impacts, with dense stands of young woody vegetation which limits access to nest cavities. The importance of areas such as the Steel Creek Beaver Pond to nesting wood ducks of this area has been emphasized by the nest box surveys over the past eight years.[5]

4.2.3 Wood Stork

The wood stork has been proposed for listing as an endangered species by the US Fish and Wildlife Service.[13,14] Individuals and small groups of this species have been observed roosting and feeding in the Steel Creek Delta area during 1981 and 1982.[4,5] Although no nesting has been reported on the SRP, the nearest rookery is located 28 miles southwest of the SRP at Millen, Georgia, within feeding range of the species (Figure 4.2-7). The thermal effluents from L Reactor will eliminate potential feeding habitat for this wading bird in the Steel Creek Delta.

SRP Survey Results

Aerial census of the Savannah River Plant swamp have been conducted weekly from July 1981 to March 1982 and at irregular intervals from April to September 1982.[15] Aerial census of the

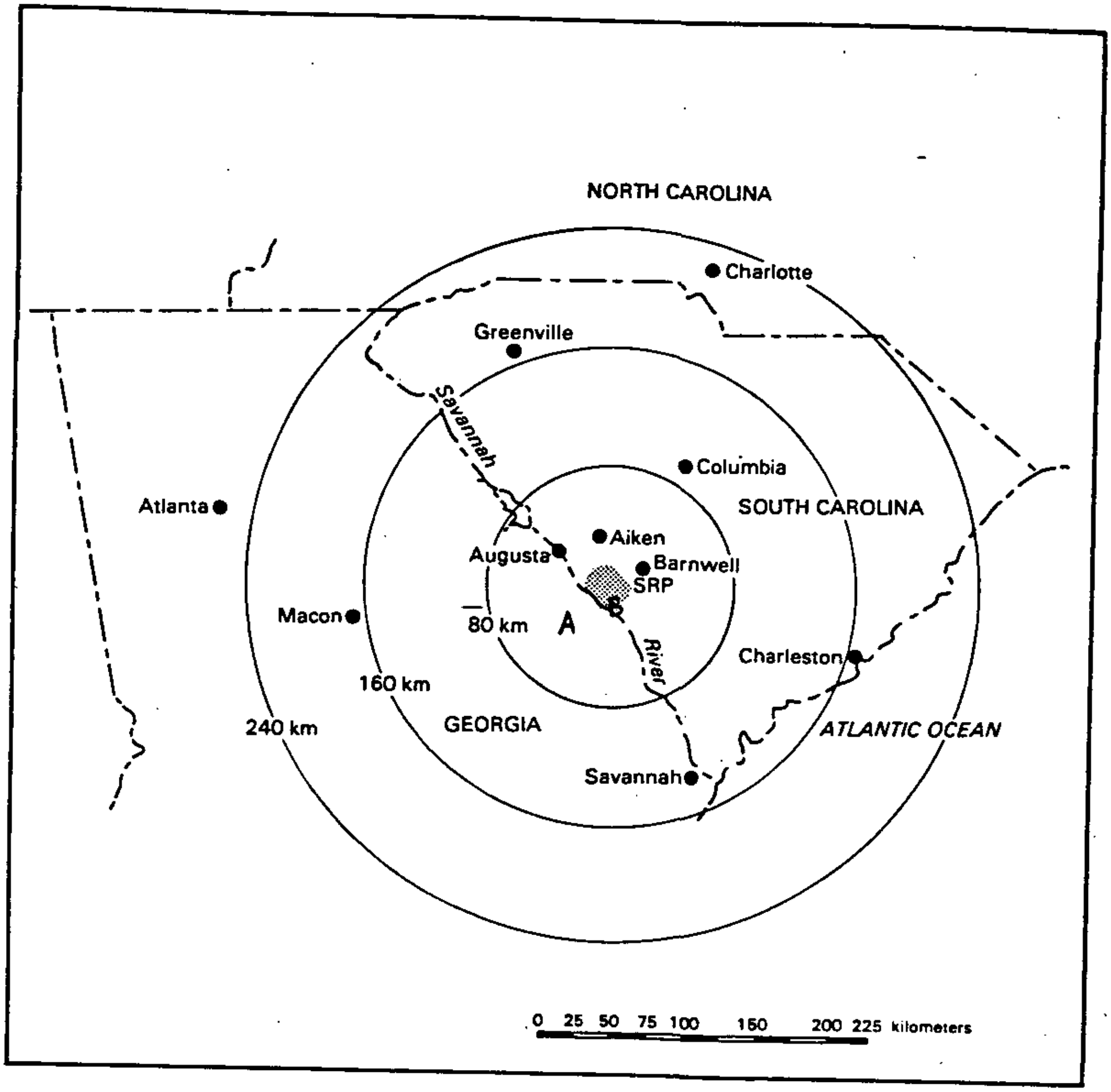

FIGURE 4.2-7. Location of Millen Wood Stork Rookery (A). Steel Creek Delta (B) is Approximately 28 Miles from the Rookery

rookery near Millen, Georgia, were conducted at irregular intervals from March to June 1982. Ground observations have also been recorded.[15]

During late summer of 1981, three wood storks were observed on two occasions in the SRP swamp. Two additional wood storks were observed in mid-June in the Steel Creek Delta area. Wood storks were sighted on 14 different days between May and September 1982 on the SRP (Table 4.2-3). These included perched and/or flying birds as well as wood storks feeding in shallow pools in the Steel Creek Delta. All of the feeding locations were within the zone of the pre-1968 thermal impact (Figure 4.2-8).

The sightings of wood storks in Steel Creek delta correspond with wood stork activity at the Millen Rookery. In early July of 1980, 400 wood storks were at this rookery and over 20 wood storks were seen at one time over Steel Creek Delta. In 1981, wood storks at the Millen rookery did not complete the nesting cycle and few birds were seen at SRP. In 1982, however, about 115 to 130 adult wood storks were present at Millen and nests were observed to contain feathered young. As indicated above, wood storks were sighted on numerous occasions at SRP during 1982 (Table 4.2-3). These preliminary survey results together with the observation of both juvenile and adult wood storks during August and September of 1982, may suggest that the Steel Creek Delta could represent feeding habitat for wood storks from the Millen rookery.[15]

Thermal effluents from L Reactor would preclude the use of Steel Creek Delta by feeding wood storks. Whether suitable alternative feeding locations exist nearby is unknown, but is under study.

4.3 SEMI-AQUATIC VERTEBRATES

The groups of semi-aquatic vertebrates which use the Steel Creek area range from amphibians which are almost exclusively aquatic to reptiles which use the creek as a source of water. Many reptiles such as the yellow-bellied slider turtle, brown water snake, and American alligator spend most of their lives in the water or basking near the water, although they are frequently encountered on land. Many amphibians depend on the aquatic environment for breeding. Most amphibians require water at the site of egg deposition. In the Steel Creek system such habitats include floodplain areas in which temporary flooding occurs, the delta region, and the marginal areas of the stream itself. Special attention was given to the American alligator because this species is protected by Federal and State law and a number of alligators were found in Steel Creek during initial surveys.[12]

TABLE 4.2-3

Date, Number, and Locations of Wood Storks Observed on the SRP During 1982

Date	Number Observed	Location
5/31/82	2	Bulldog Bay
6/11/82	1	Steel Creek Delta
6/15/82	1	Steel Creek Delta
6/18/82	1	P Reactor
6/23/82	1	Steel Creek Delta
6/25/82	1	Steel Creek Delta
6/29/82	5	Steel Creek Delta
7/1/82	1	Steel Creek Delta
7/20/82	1	Steel Creek Delta
7/22/82	1	Steel Creek Delta
8/6/82	1	Steel Creek Delta
8/27/82	14	Steel Creek Delta
9/2/82	11	Steel Creek Delta
9/3/82	11	Steel Creek Delta

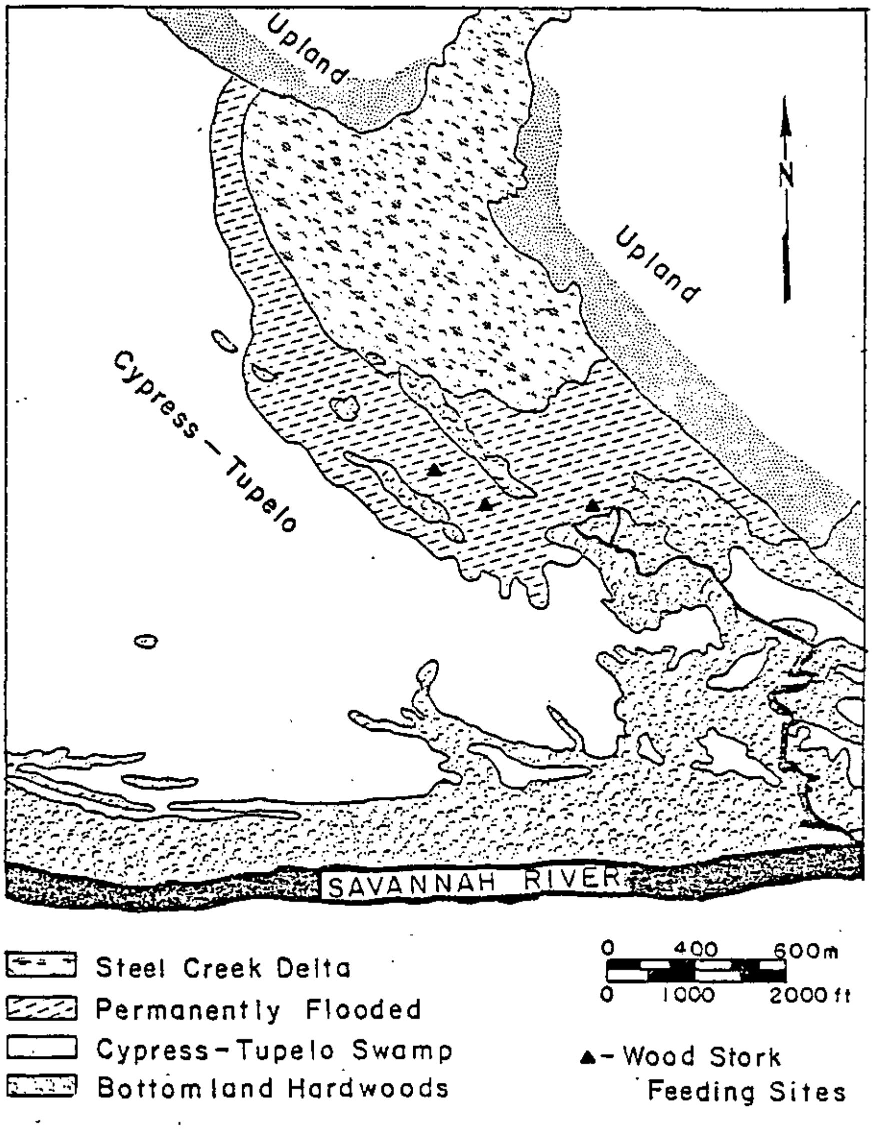

FIGURE 4.2-8. Map of the Steel Creek Delta Area with Locations of Sites Used for Feeding by Wood Storks

4.3.1 American Alligator

Previous assessment of the impacts of L-Reactor restart have estimated the population size and described the wintering behavior of the American alligator in the Steel Creek system.[4,5] This section provides additional information on alligators in the Steel Creek system.[15]

A series of alligator trap-board stations were established along Steel Creek and at various locations in Steel Creek Delta during the summers of 1981 and 1982. Intensive trapping efforts began in early September 1981 and continued through mid-October 1981. In 1982, trapping efforts began in April and continued through the summer. Three adult alligators were fitted with temperature sensitive radiocollars and stomach temperature transmitters. Collared animals were released at their capture location. Each alligator was located at intervals of 1 to 3 days when possible. Air and water temperatures (surface and at a depth of 1 meter) were measured near the animal's location and the interpulse period of the collar and stomach transmitters were recorded for determination of environmental and internal body temperatures.[15]

4.3.1.1 Movements

Three alligators, a male and 2 females, were outfitted with biotelemetry equipment. One female was captured in Lagoon A at the juncture of Steel Creek and S.C. Hwy. 125 (Figure 4.3-1). This alligator had occupied this lagoon throughout the summer along with a cohort of approximately 15 young (approximately 55 to 60 cm in length). After its release on September 4, 1981, the alligator moved into Steel Creek just north of the Lagoon A dike (Figure 4.3-1). On September 14, 1982, the alligator was recaptured, and outfitted with a new radiocollar and stomach transmitter.[15]

The male alligator was captured on the south side of an island in Steel Creek Delta (Figure 4.3-2). Soon after release, it moved into the extensive cypress-tupelo forest to the south of Steel Creek Delta where it remained throughout October and November 1981. During December 1981, the alligator could not be located, but it was found again in the Steel Creek Delta at location E on January 4, 1982. On April 23, the alligator changed its pattern and moved to pool D. In a five-day period between May 19-24, the alligator moved from Area F to C, then back to pool D. On May 27, the alligator returned to the impacted area of the swamp (area H), for the first time since its release. From June 29 through July 1, the alligator could not be located during ground searches. On July 2, 1982, using a Cessna 172 fixed-wing aircraft

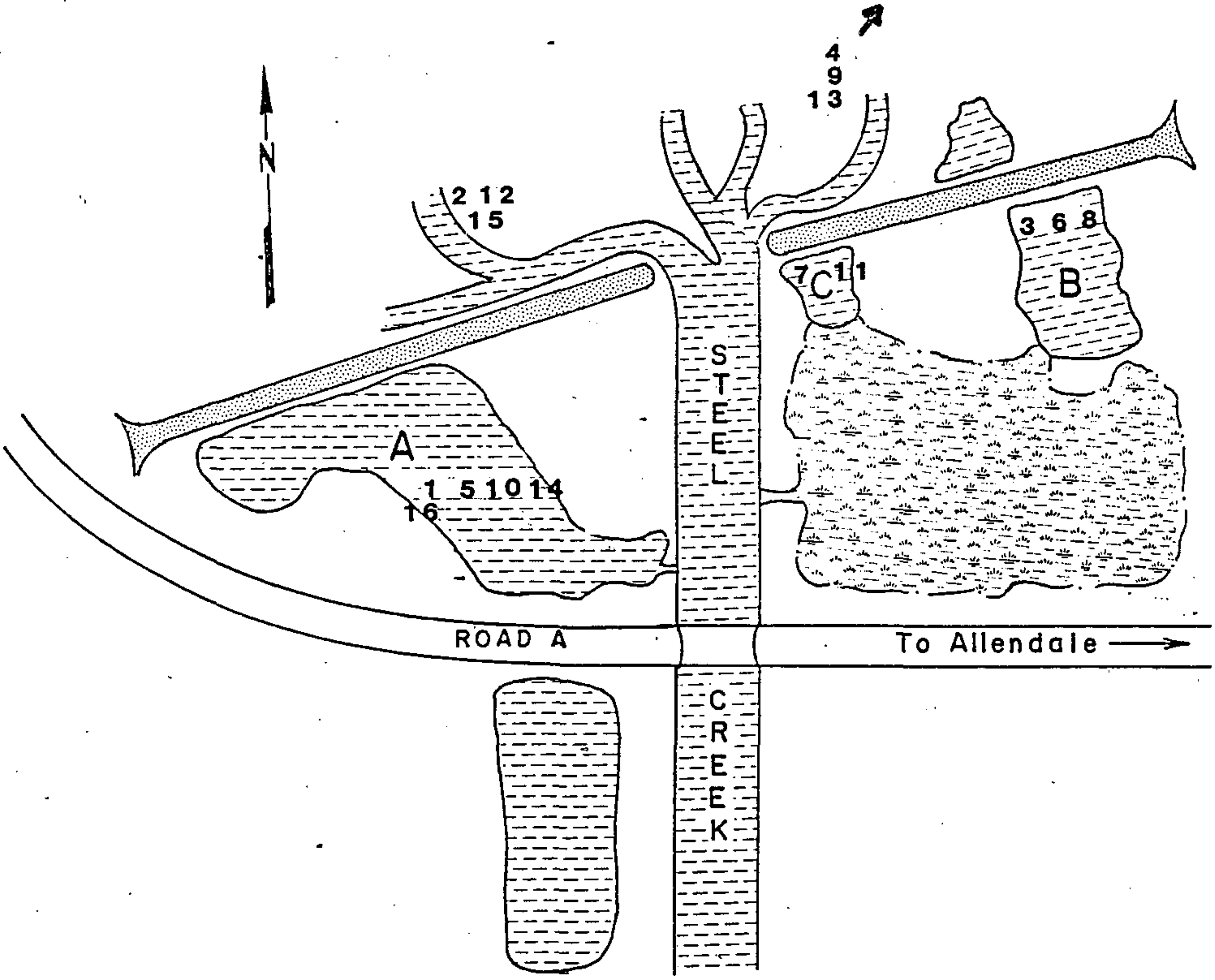

FIGURE 4.3-1. Locations of a Female Alligator in Two Backwater Lagoons From September 1981 Through August 1982. The Numbers and Letters Provided a General Chronological Record of the Alligator's Movement.

equipped for telemetry, the alligator was located in the swamp between Steel Creek and Pen Branch approximately 3 km from any previous known location. On July 17, the alligator was again located from the aircraft approximately 1 km west of pool A. On July 24, the alligator was found to the northwest of Stave Island between Steel Creek and Pen Branch. During August, the alligator could not be located, but on September 24, 1982 was found between Steel Creek and Pen Branch.[15]

A second female alligator was captured between the two large islands in Steel Creek Delta on May 11, 1982, and released there on May 13, 1982 (Figure 4.3-3). On May 14, the alligator moved north into location 2. It had moved from this location to location A by May 21, and remained there until May 25. On May 25, the alligator had moved to location B and remained there until May 28. On May 28, the alligator was found at location A. The alligator then moved between locations A and B at irregular intervals until June 25 when it was located in area F. It remained at this location until July 20. From July 21 until the end of August, the alligator again began moving at irregular intervals between locations A and B.

4.3.1.2 Environmental and Body Temperatures

The environmental and body temperatures experienced by two Steel Creek alligators during the fall and winter of 1981-1982 have been described in a previous report. Generally, it was found that alligators on the SRP do not utilize over-wintering dens, but remain active whenever winter temperatures are sufficiently high. Survival during freezing and sub-freezing temperatures is achieved by behavioral adaptations.[15,16]

4.3.1.3 Bellowing

On four separate occasions in 1982, alligators were heard bellowing in the Steel Creek Delta area. Bellowing is a form of vocalization used as an advertisement display during courtship by both male and female alligators. On June 5, 1982, an alligator was heard bellowing at location A (Figure 4.3-4). On June 11, two alligators were heard bellowing at each other. One was between the islands in the delta (B) and the other was on the north side of the islands (C) (Figure 4.3-4). On June 29, an alligator was heard bellowing at location D. On July 20, another alligator was heard near the point of the first island (E) (Figure 4.3-4).[15]

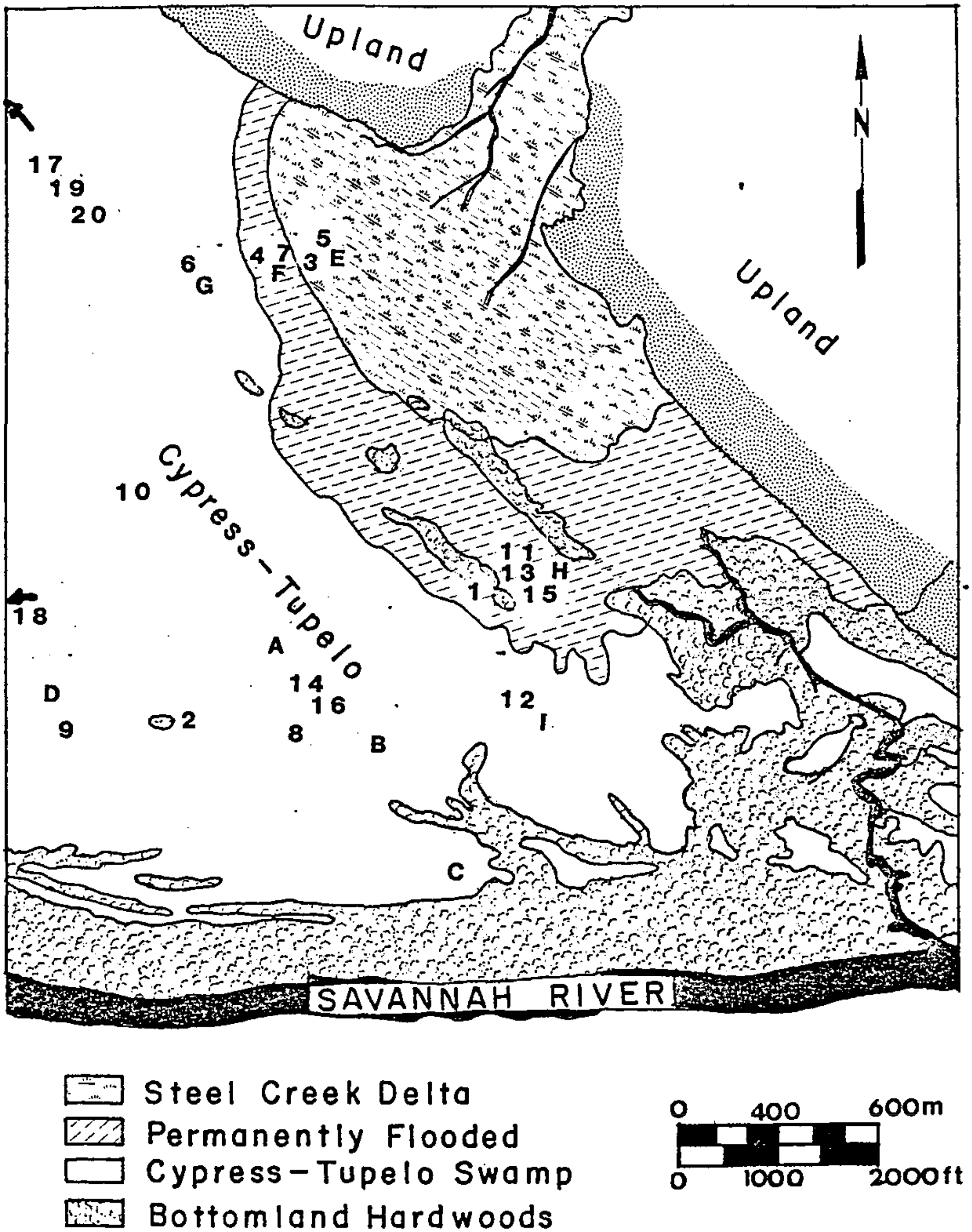

FIGURE 4.3-2. Locations of a Male Alligator in the Steel Creek Delta Area. The Numbers and Letters Provide a General Chronological Record of the Alligator's Movement.

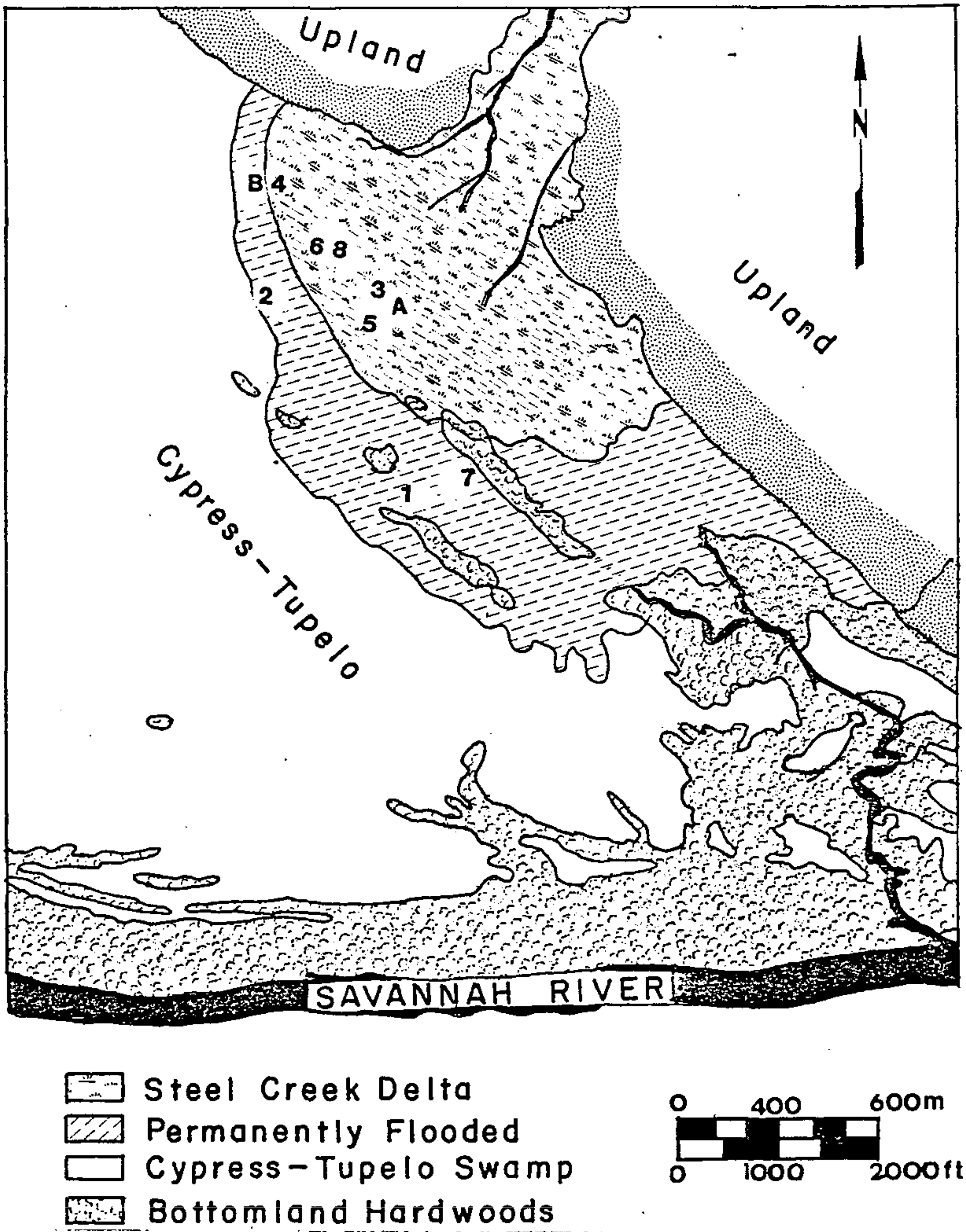

FIGURE 4.3-3. Locations of a Female Alligator in the Steel Creek Delta Area During the Summer of 1982. The Numbers and Letters Provide a General Chronological Record of the Alligator's Movement.

4.3.1.4 Population Status

New observations and locations of bellowing suggest that at least two additional adult alligators make use of Steel Creek Delta. It is still not known whether the juveniles observed in the backwater lagoons near SRP Road A represent one or two cohorts of young. Juveniles sighted in the lagoons are approximately the same size which suggests that they represent one cohort. Juveniles are observed most frequently in the lagoon occupied by the collared female suggesting that they may move between lagoons with the female. Depending on whether there are one or two cohorts of young in lagoons A and B, the number of alligators that use the Steel Creek system at some time during the year ranges from 25 to 35 individuals.[15]

4.3.1.5 Expected Effects on American Alligator

L-Reactor restart will effect the alligators in the Steel Creek system. The three alligators followed with telemetry collars use portions of the creek and delta where water temperatures should exceed maximum lethal body temperature for alligators when L Reactor is in operation.. The female alligators exhibit a limited home range which lies within the zone of L-Reactor effects, while the male alligator has a larger home range that includes a large area that will be unimpacted. Thus it is likely that L-Reactor restart will have a greater impact on female alligators that inhabit the Steel Creek system. Dispersal of the juvenile alligators located in lagoons A and B will almost certainly be disrupted by L-Reactor operations.[15]

4.3.2 Florida Striped Mud-Turtle

Duever reported the presence of a small population of Kinosternon bauri, the Florida striped mud turtle, at Steel Creek and SRP Road A.[17] Smith et al. presented analyses that indicated that Duever's earlier report of the Florida striped mud turtle in Steel Creek may well have been correct.[5] But rather than representing a disjunct population of the species, the Steel Creek individuals are the northernmost known group of the species that extends throughout the coastal plain region of Georgia.[5]

4.4 Other Species of Interest

Table 4.4-1 lists those species which have been observed in the Steel Creek area or in the Savannah River which are listed on the Federal list of endangered species or on various State of South

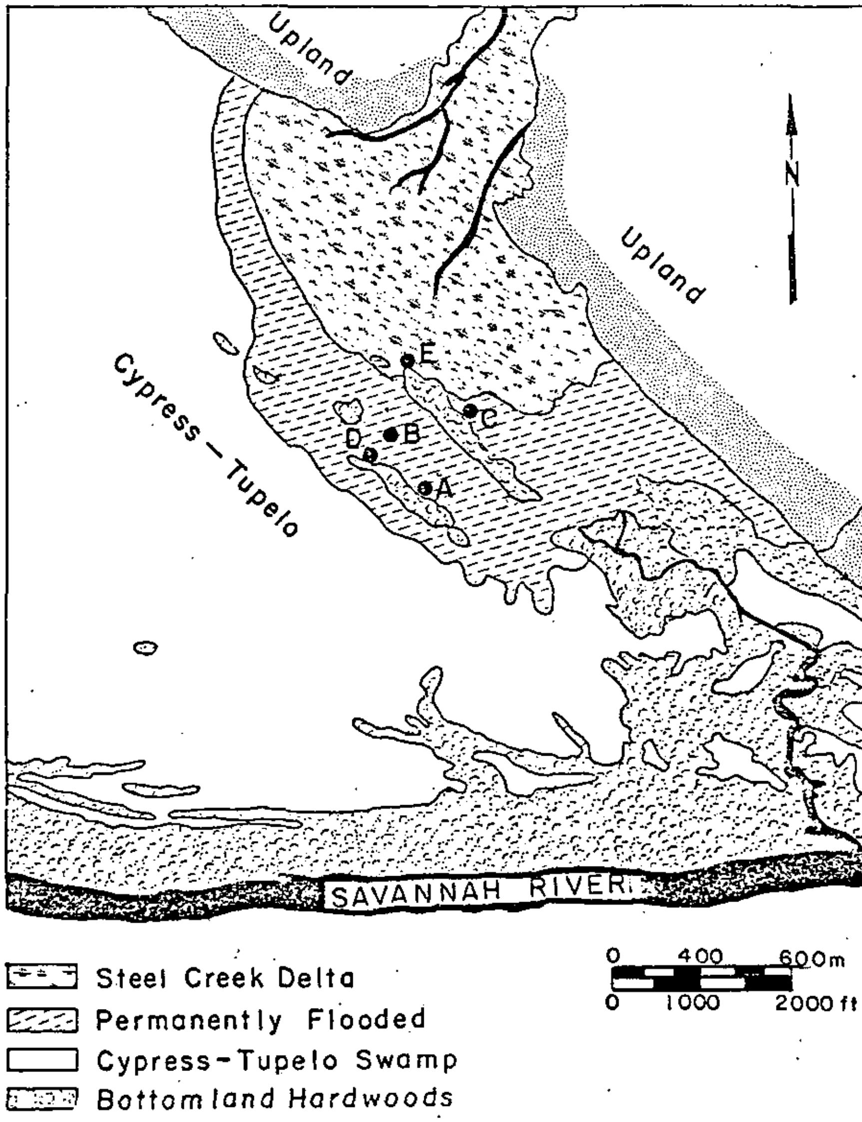

FIGURE 4.3-4. Locations of Alligators Heard Bellowing in Steel Creek Delta During 1982.

Carolina lists. Discussions of the red-cockaded woodpecker (Section 4.2) American alligator (Section 4.3.1), shortnose sturgeon (Section 5.1.1.3.4), and wood stork (Section 4.2.3), are given elsewhere with more detail. Most of the other species in Table 4.4-1 are listed by the State of South Carolina as species of "special concern" (i.e., the species is either of undetermined status or is vulnerable to loss if not now endangered or threatened). These species do not have legal protection, but they warrant consideration because their status is unknown.

Most of the species of concern are found in other wetlands and aquatic habitats of the SRP; for example, the red-headed and hairy woodpecker, the bobcat, the river otter, the bird-voiced treefrog, the tiger salamander, and the pig frog. A few others such as the American shad and blueback herring are common to the Savannah River (Chapter 5).

TABLE 4.4-1

Species that Have Been Observed in the Steel Creek Area or the Savannah River near SRP Which Are "Endangered," "Threatened," or "Of special Concern"*

Species	Federally Endangered**	Threatened, South Carolina	Of Special Concern, South Carolina
Red-cockaded woodpecker† (Picoides borealis)	X		
American alligator (Alligator mississippiensis)	X		
Shortnose sturgeon (Acipenser brevirostrum)	X		
Wood stork†† (Mycteria americana)		X	
Black bear (Ursus americanus)		X	
Atlantic sturgeon (Acipencer oxyrhynchus)		X	
Mayfly (Tortopus incertus)		X	
Bobcat (Lynx rufus)			X
River otter (Lutra canadensis)			X
Star-nosed mole (Condylura cristata parva)			X
Red-headed woodpecker (Melanerpes erythrocephalus)			X
Hairy woodpecker (Picoides villosus)			X
Great horned owl (Bubo virginianus)			X
Spotted turtle (Clemmys guttata)			X
Pig Frog (Rana grylio)			X

TABLE 4.4-1 (cont'd)

Species	Federally Endangered**	Threatened, South Carolina	Concern, South Carolina
American shad (Alosa sapidissima)			X
Blueback herring (Alosa aestivales)			X
Crayfish (Procambarus hirsutus)			X

* Sources:

Department of Interior, U.S. Fish and Wildlife Service. "List of Endangered and Threatened Wildlife and Plants." Federal Register, Vol. 44, No. 12, 3636-3654, (1979).

D. M. Forsythe and W.-B. Ezell, Jr. (eds). Proceedings of the First South Carolina Endangered Species Symposium. Sponsored by the South Carolina Wildlife and Marine Resources Department and the Citadel, November 11-12, 1976. Charleston, SC. (1979).

** Also state "endangered."

† An upland species of pine stands. Included for completeness of listing.

†† Has been proposed for the Federal List (Federal Register, Vol. 48, No. 40, February 28, 1983.

4.5 References

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5.0 FISHERIES

This chapter summarizes the fisheries data collected in the first six months of the Biological Measurements Program on the Savannah River, the fisheries surveys from the Steel Creek corridor, delta, and near the mouth of Steel Creek, and data from sports fishery surveys on the Savannah River below New Savannah Bluff Lock and Dam.

The Savannah River Biological Measurement Program began in March 1982 to evaluate the impact of SRP, particularly L-Reactor restart, on the Savannah River. Results from the first six months indicate that entrainment and impingement are somewhat similar to previous studies undertaken in 1977.

A total of 10,205 fish eggs and larvae were collected in 2138 samples from the Savannah River and SRP tributaries, between March 11 and August 29, 1982. The 5176 fish larvae were primarily blueback herring and shad. The 5029 fish eggs were primarily American shad. Striped bass and blueback herring eggs were abundant during a short period of time.

Peak spawning occurred in May. In May and June the abundance of fish eggs and larvae was higher in nighttime collections than in daytime collections. Striped bass spawning, which previously had not been recorded from the Central Savannah River Area, was noted twice in May and once in July. Fifteen sturgeon larvae also were collected with both the Atlantic and shortnose sturgeon present. Upper Three Runs and Steel Creeks were used for fish spawning, whereas, Four Mile Creek was not used for fish spawning.

Entrainment of ichthyoplankton was calculated to be approximately 17.9×10^6 fish larvae per year and 18.1×10^6 fish eggs per year. Larval fish entrainment in 1982 was very similar to entrainment in 1977 while egg entrainment was higher. Entrainment of fish eggs and larvae are dependent on several factors including: (1) the density of organisms in the river, and (2) the amount of spawning in the intake canals and, in the case of the 1G intake, on the density of organisms in Upper Three Runs Creek.

Impingement of fishes was low with a maximum of 44 fish impinged in a 24-hr period. A total of 228 fish in 22 species were collected in 13 samples or an average of 17.5 fish per sample.

Electrofishing was conducted in August 1982. A total of 407 fish in 32 species were collected. The results were consistent with electrofishing results by the Georgia Game and Fish Division. No fish were collected in Four Mile Creek, although the collection from the area below Four Mile Creek was not different from the other areas.

Studies of fish populations in the Steel Creek delta-swamp system by SREL showed a high species diversity. Fifty-five of the 79 fish species known from the SRP were found in this area. The highest abundance and diversity of fish occur in deep-water areas where the tree canopy was eliminated during previous reactor operations and the vegetation is currently dominated by submergent and emergent macrophytes. The use of the Steel Creek delta-swamp area by anadromous fish species (e.g., American shad and blueback herring) was minimal during 1982; however, ichthyoplankton were not sampled frequently in the Steel Creek delta swamp. The appearance of American shad in Steel Creek was late and the numbers were small. However, it appears that the shad spawning run in the Savannah River was smaller than in previous years.

The Fisheries Section of the Georgia Department of Natural Resources has published the results of a fisheries study conducted on the Savannah River. Approximately 4,600 anglers fish in the freshwater section of the Savannah River. Georgia residents comprise 68.2% of these anglers. The anglers fish in both the mainstream (58.2%) and oxbows, creeks, and lakes (41.8%) of the Savannah. Freshwater anglers spend the most time (43.8%) trying to catch bream - i.e., bluegill, redbreast sunfish, warmouth, redear sunfish, and spotted sunfish. Therefore, brem account for 73% of the fish caught. Largemouth bass is the next most popular species (38% of the time); however, success is low (2.5% of the fish caught). About 90,000 kilograms of freshwater fish are harvested from the lower Savannah River annually.

5.1 BIOLOGICAL MEASUREMENT PROGRAM

The Biological Measurement Program in the Savannah River was initiated in March 1982 and designed to provide additional data on the biological communities in the river that might be affected by the present and proposed activities at the Savannah River Plant.[1] The long-term study of the river will encompass many factors including fish populations, meroplankton communities, and fish impingement at the SRP pumphouse intake screens. This section summarizes the results of the meroplankton and impingement sampling conducted from March through August 1982 and an electrofishing collection in August 1982.[1] The objectives of the studies in the preliminary program were:

- To determine the density and distribution of ichthyoplankton and benthic macroinvertebrate meroplankton at designated locations in the river, tributary creeks and intake canals of the Savannah River Plant.

- To evaluate the possible impact of the present and proposed cooling water intake rates on aquatic organisms.
- To evaluate the possible impact of existing and proposed thermal discharges to the river.
- To determine the rate of impingement of fishes at the cooling-water intake screens.
- To determine the relative abundance and occurrence of fishes at the various sampling stations.

5.1.1 Ichthyoplankton

The ichthyoplankton community was sampled as part of the meroplankton sampling program. Meroplankton are organisms that spend a portion of their life cycles drifting as plankton and includes fish eggs and larvae and macroinvertebrates.

5.1.1.1 Materials and Methods

5.1.1.1.1 Sampling Station Locations

Meroplankton collections were made at nine transects and three creek stations during March through August 1982. Seven of the transects were located across the Savannah River, one was across the 1G pumphouse intake canal, and one across the 3G pumphouse intake canal. Additionally, single points were sampled within the mouths of Upper Three Runs Creek, Four Mile Creek, and Steel Creek. Each of the river transects were sampled near the South Carolina shore, mid-river, and near the Georgia shore. The intake canal stations were sampled near both shores and in the middle. Where water depth exceeded two meters, both surface and bottom samples were taken. All samples were taken in duplicate. The approximate locations of the sampling points are shown in Figures 5.1-1 and 5.1-2 and described in Appendix G.[1]

5.1.1.1.2 Sampling

To make a meroplankton collection at the river transects, two one-half meter diameter 505-micron mesh nets, mounted side by side in a common frame, were used. Each conical net was fitted with a one-liter plastic bottle to condense and contain the organisms and detritus filtered from the water. A digital flow meter was placed in the middle of the mouth of each net to provide data on the volume of water filtered for each sample. By adjusting the

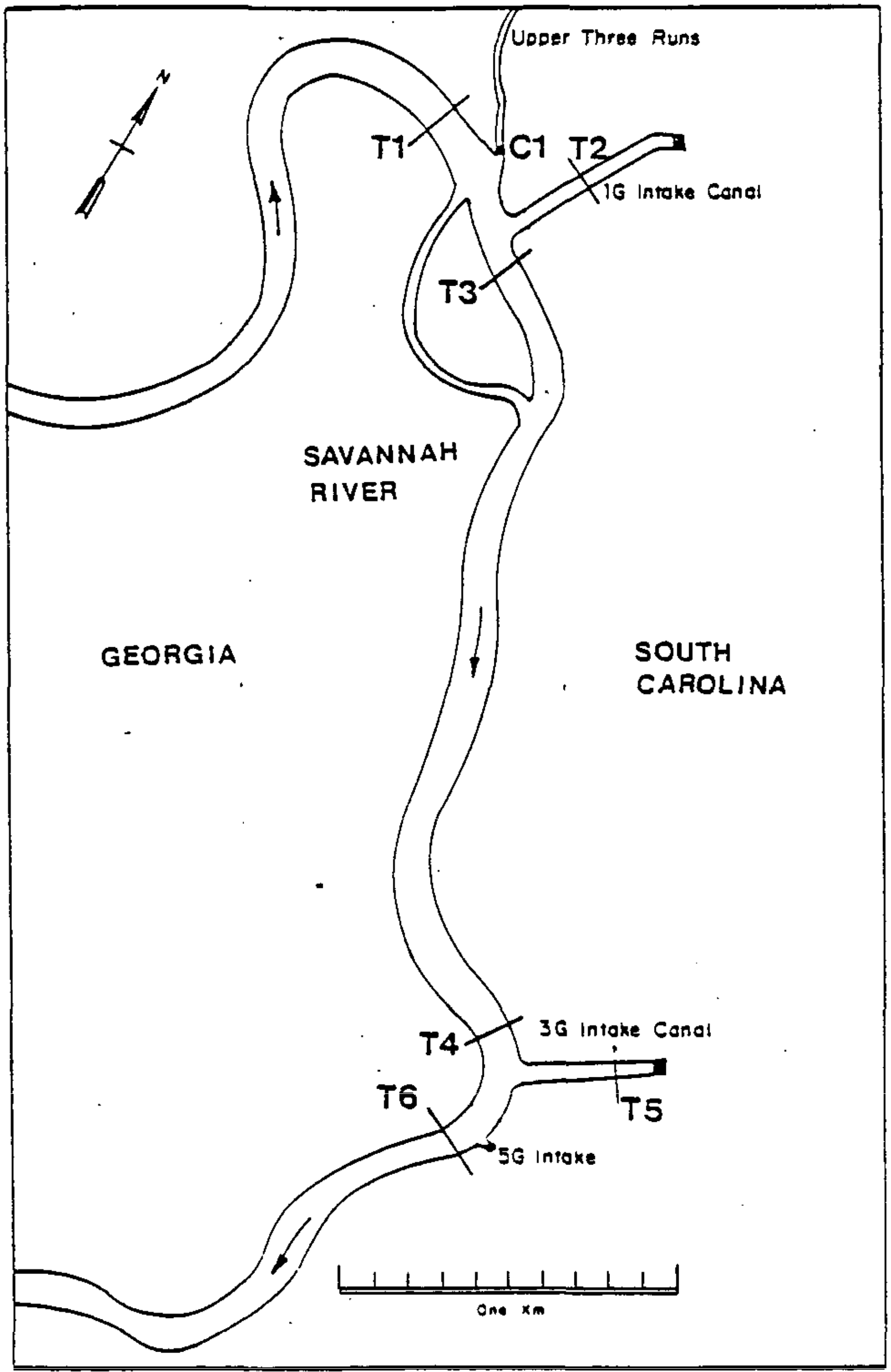

Figure 5.1-1. Locations of sampling Transects T1 through T6 and Station C1

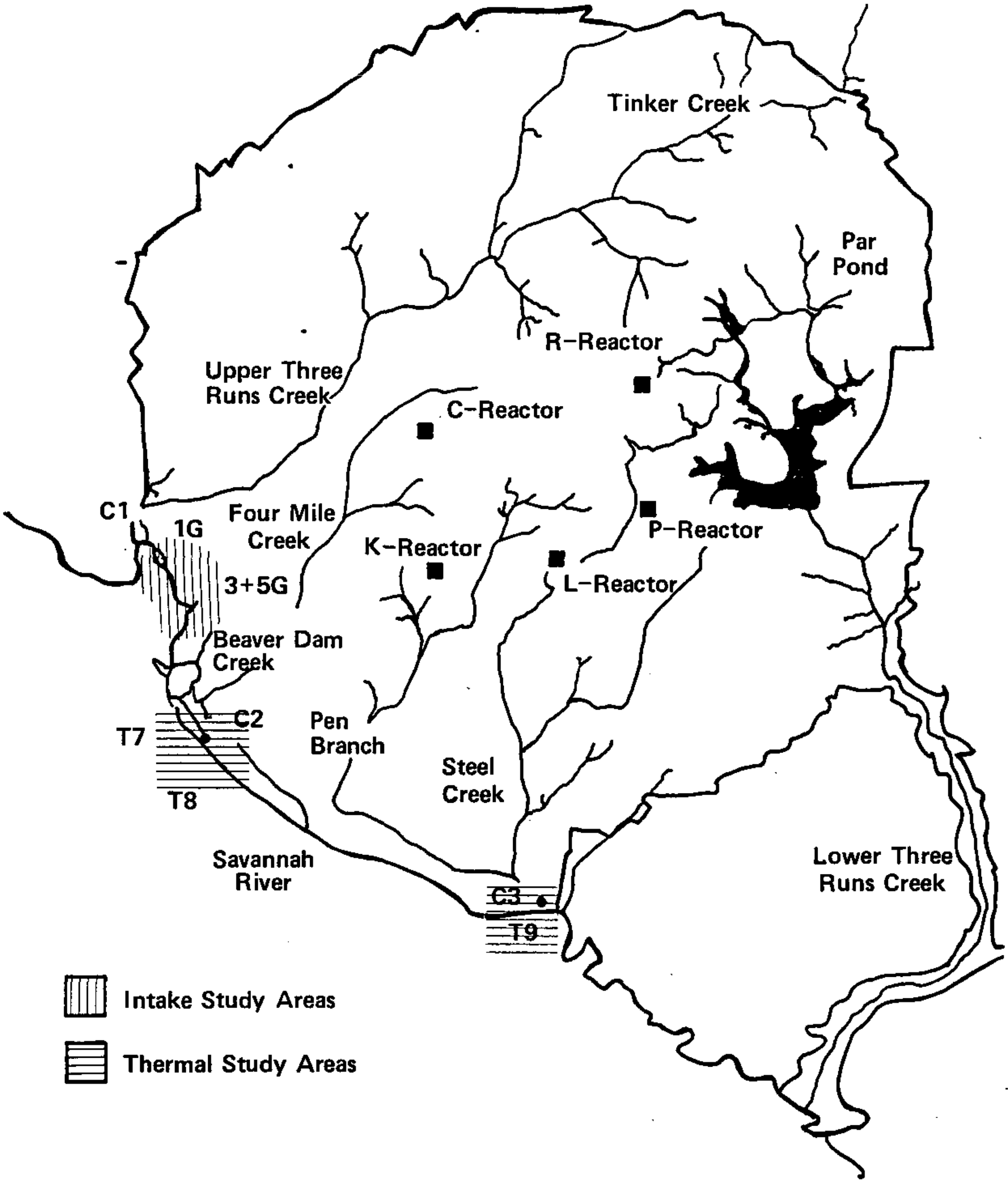

Figure 5.1-2. Locations of sampling Transects T7 through T9 and Stations C2 and C3

collection duration, approximately 50 cubic meters of water were filtered for each sample.[1]

In the intake canals, the current velocity was too low to allow the nets to be fished from an anchored boat. A sample was obtained by towing the nets for approximately three-fourths the length of the canal. The speed of the boat was adjusted so that approximately the same amount of water was filtered during a five-minute tow period as was obtained from a set net in the river.[1]

Sampling techniques in the creeks were determined by local conditions. Upper Three Runs Creek was initially sampled by towing the nets because of the low flow velocity. However, a large amount of detritus was stirred into the water column by the boat, which made the samples difficult to analyze. As a result, set net samples were taken instead of tows and only the mid-creek area was sampled. Four Mile Creek is extensively blocked by fallen trees, which prevents any towed samples from being obtained, so set net collections were made in the middle of this creek. A set net collection was also made in the middle of Steel Creek because of fallen trees. Steel Creek, and often Four Mile Creek, contained enough water so that both surface and bottom samples could be taken.[1]

The collecting protocol consisted of sampling Transects 7, 8, and 9, and all creek stations one day, and Transects 1 through 6 the following day. On March 26, April 20, May 20, and June 13, regular collections were supplemented by additional samplings at Transects 1 through 6 to obtain data on diurnal variation in meroplankton abundance. During this study, measurements of surface pH, conductivity, dissolved oxygen, temperature, flow velocity, and alkalinity were obtained concurrent with each sampling. At those locations where bottom meroplankton samples were taken, the bottom temperature was also measured.[1]

5.1.1.2 Identification of Ichthyoplankton

Fish eggs collected were assigned to one of the following categories: American shad, blueback herring, striped bass, perch, darters, and others.[1]

The category "unidentified clupeids" (Clupeidae) used in this report includes unidentified larvae that were probably blueback herring or Dorosoma sp. These species are easily distinguished while they have yolk sacs, but are difficult to differentiate after the yolk sac has been absorbed. The minnow family (Cyprinidae) contains numerous species of small fishes that occur in the Savannah River. These fishes are difficult to differentiate even as adults, and the larval forms of many species have not been described. For this study, the only taxonomic distinction made within this group was to place carp larvae (Cyprinus carpio) into a separate category.[1]

5.1.1.3 Results of Ichthyoplankton Collections

The densities of fish eggs and larvae were calculated by dividing the number of organisms collected by the volume of water filtered in each sample and multiplying by 1000. Densities were reported as the number of organisms per 1000 m^3. In each group of organisms, comparisons were made to determine differences in horizontal, vertical, and spatial and temporal distributions.[1]

On 13 sampling dates between March 11 and August 29, 1982, a total of 2138 samples were collected. When these samples were sorted and analyzed, 10,205 ichthyoplankters were removed, identified and counted. Of this total, 50.7 percent were fish larvae and 49.3 percent were fish eggs. A sharp increase in density occurred when temperatures increased on May 5 (Figure 5.1-3). Egg density changes preceded larval densities as expected. Spawning temperatures were consistent with normal values for the Savannah River species.[1]

5.1.1.3.1 Larval Fish

Larval fish populations in the region of the Savannah River sampled for this study were clearly dominated by the herring and shad family (Clupeidae). The herring and shad larvae combined made up almost 50 percent of all fish larvae collected (Table 5.1-1).

The second most abundant group was the unidentified minnows (980 specimens), which constituted 18.9 percent of the total. The third most abundant group was spotted suckers (825 specimens), which constituted 15.9 percent of the total. All other groups represented 31.6 percent (1631 larvae), with none representing more than 9.3 percent of the total.[1]

5.1.1.3.2 Seasonal Changes in Larval Abundance

In 1982, spawning for most Savannah River fishes occurred between early March and late July. On March 11-12, only 12 larval fishes were collected, which demonstrates that this sampling was prior to the main spawning period for most species. On March 25-26 285 larval fish were collected. At that time, spotted suckers were the dominant larval form, constituting 42.8 percent of the total

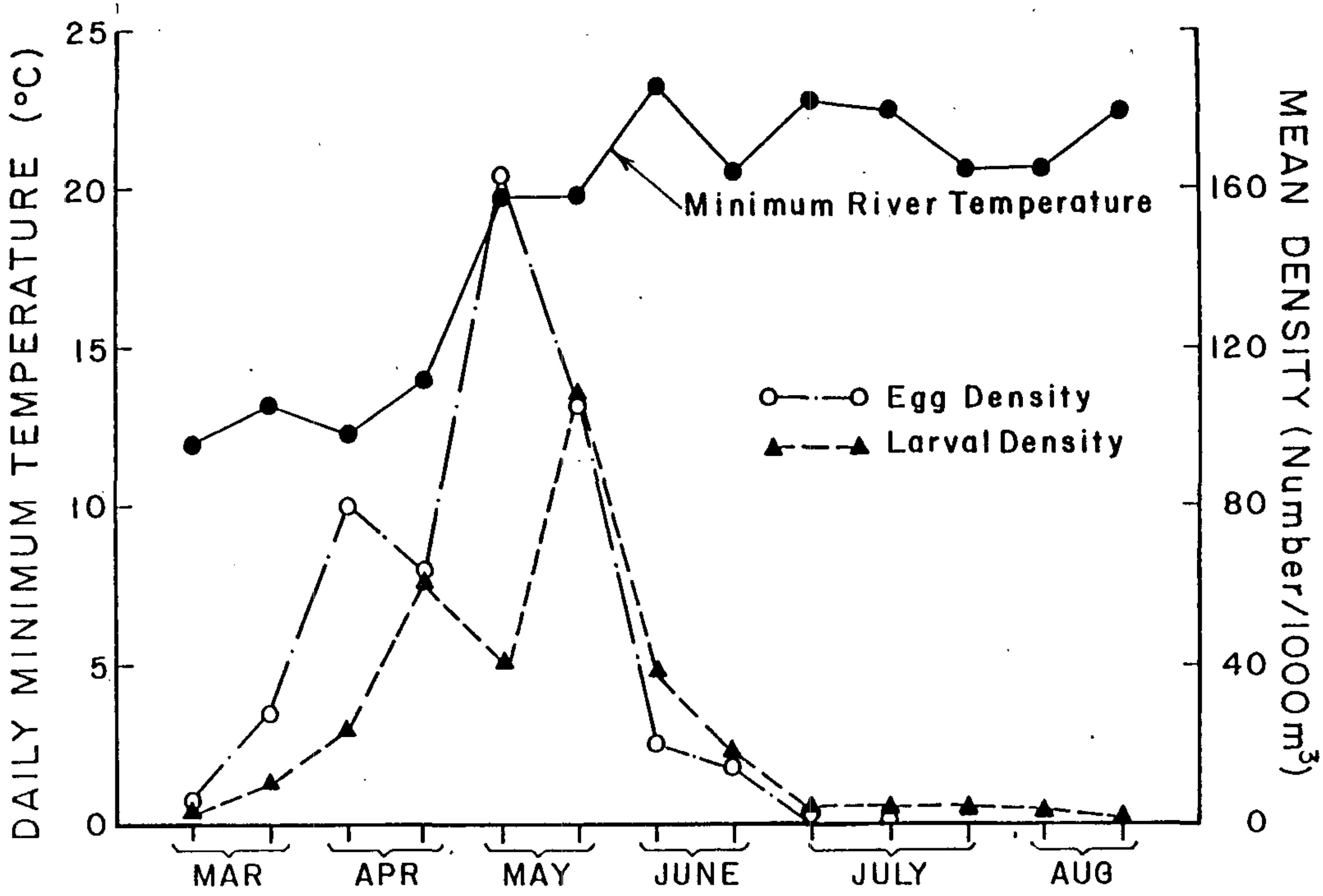

Figure 5.1-3. Density of fish eggs and larvae compared to river temperature, March - August 1982

TABLE 5.1-1

Number and Relative Abundance of Larval Fish Collected at All Stations, March — August 1982

Group	Total Number Collected	Percentage Composition
Unidentified clupeids	1740	33.6
Unidentified minnows	980	18.9
Spotted sucker	825	15.9
Dorosoma spp.	482	9.3
Sunfish and bass	294	5.7
Yellow perch	206	4.0
Blueback herring	127	2.5
American shad	110	2.1
Other	89	1.7
Unidentified suckers	88	1.7
Darter	88	1.7
Carp	52	1.0
Pirate perch	48	0.9
Unidentified catfish	21	0.4
Sturgeon	15	0.3
Gar	6	0.1
Atlantic needlefish	4	0.1
Swamp fish	1	<0.1
Total	5176	100.0

collection. On April 7-8, the minnows, which had not been taken in the prior collection, constituted almost 50 percent of the collection. Spotted suckers were again very abundant in April, making up 28.2 to 41.4 percent of the fishes collected. Minnows continued to dominate the collections from early April until May 20-21, when the number of unidentified clupeids increased to 43.0 percent of the total of 2268 larval fishes collected. Unidentified clupeids continued to dominate the larval collections through June, while minnows were almost absent from these collections. In July and August, the number of fish larvae collected was low.[1]

5.1.1.3.3 Larval Distribution

Horizontal and Vertical Distribution

The distribution of fish larvae across the river and intake canals was evaluated by sampling near the South Carolina shore, the Georgia shore, and in the middle of the river. Except for when small groups of larvae such as those of spotted suckers were collected near the river shore, or from patchy distributions in the intake canals, the horizontal distribution of fish larvae was uniform. This uniform distribution has been observed in other turbulent rivers. Likewise, the vertical distribution of fish larvae in the Savannah River and associated waters is quite uniform.[1]

Although both the horizontal and vertical distribution of fish larvae was shown to be relatively uniform throughout this collecting period, some species differences in distribution are known to occur. For example, 15 sturgeon larvae were collected throughout the study. Nearly all of them were taken from bottom samples.[1]

Spatial and Temporal Trends in Fish Larvae Abundance

Larval fish densities were usually similar at ecologically similar areas. River Transects 1, 3, 4, and 6 are within three miles of each other and are potentially influenced by Upper Three Runs Creek, and the intake canals. Considering the variability of biological data, the densities at these four transects are very close. The greatest variability at these stations was 2.7 to 17.5 larvae/1000 m^3 on March 25-26, while similar values of 50.0 to 61.7 larvae/1000 m^3 were observed on April 21-22.[1]

Larval densities at Transects 7, 8, and 9 were also similar. The most extreme range observed was between 60.2 to 139.6 larvae/1000 m^3 on May 20-21. On April 7-8, values were close, ranging from 23.8 to 27.7 larvae/1000 m^3.[1]

The heated discharge from Four Mile Creek could influence the density and distribution of fish larvae at Transect 8. Comparison of densities at Transects 7 and 8 showed that a significant difference between these transects occurred only on June 2-3. Since there were no horizontal or vertical differences at Transects 7 or 8 on this date, the difference in density was not attributed to Four Mile Creek.[1]

Larval densities in the intake canals differed substantially from river densities during several collections. In May and June, there was evidence that the canals were used as a spawning area for Dorosoma sp. and unidentified clupeids.[1]

Larval fish densities were compared for the Savannah River, Savannah River Plant intake canals, and selected creeks (Figure 5.1-4). The highest average density at the intake canals occurred on May 20-21, when values were 334.8 larvae/1000 m^3 at Transect 5 and 170.5 larvae/1000 m^3 at Transect 2. The highest average density at the river transects occurred on May 20-21, the same date as when larval densities peaked in the intake canals,[1] with densities ranging from 60.2 larvae/1000 m^3 at Transect 9 to 139.6 larvae/1000 m^3 at Transect 8.

Average density values for the creek stations do not include data from Four Mile Creek because the high temperatures there make it atypical. Two distinct density peaks were observed in the average values for the other two creeks (Figure 5.1-4). A peak on March 25-26, was caused by spawning blueback herring and unidentified clupeids in both Upper Three Runs and Steel Creeks, while a peak on May 4-5 was caused by a large number of spotted sucker larvae in Upper Three Runs Creek.[1]

5.1.1.3.4 Spatial and Temporal Trends of Selected Ichthyoplankton Groups

Unidentified Clupeids

Unidentified clupeids were the most numerous larvae collected and made up 33.6 percent of the total fish larvae collected. Unidentified clupeids were most abundant during late May through late June. The largest collection was made on May 20-21, when 56 percent of the unidentified clupeids were collected during a 24-hour diurnal sampling period. Average larval clupeid densities at this time were as high as 132.7/1000 m^3 in the intake canals and 37.0/1000 m^3 in the river. Creek stations had very few unidentified clupeids (Figure 5.1-5), except on March 25-26. These clupeids were probably part of spawning of blueback herring in Upper Three Runs and Steel Creeks on that date.[1]

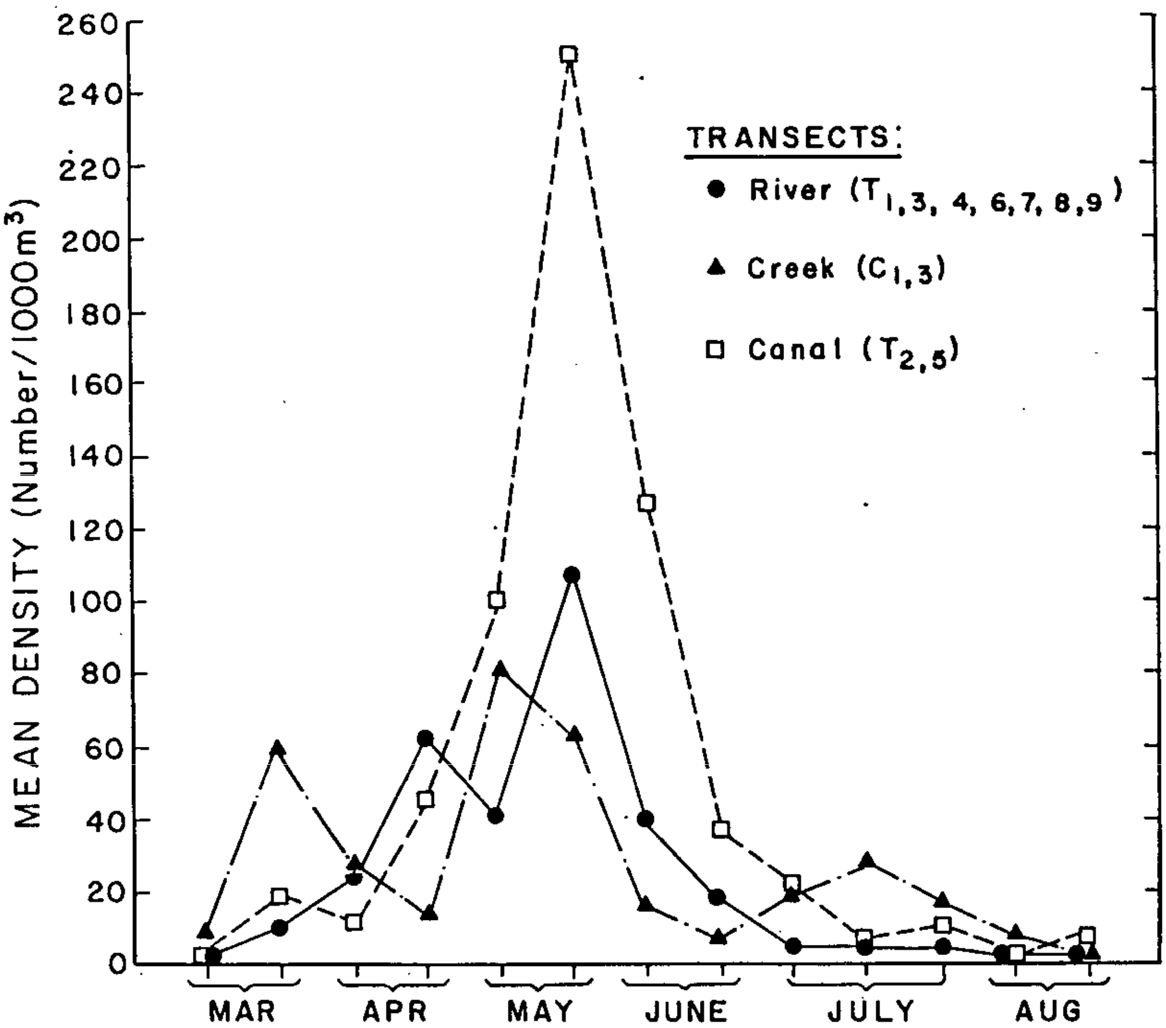

Figure 5.1-4. Seasonal changes in total fish larvae density, March - August 1982

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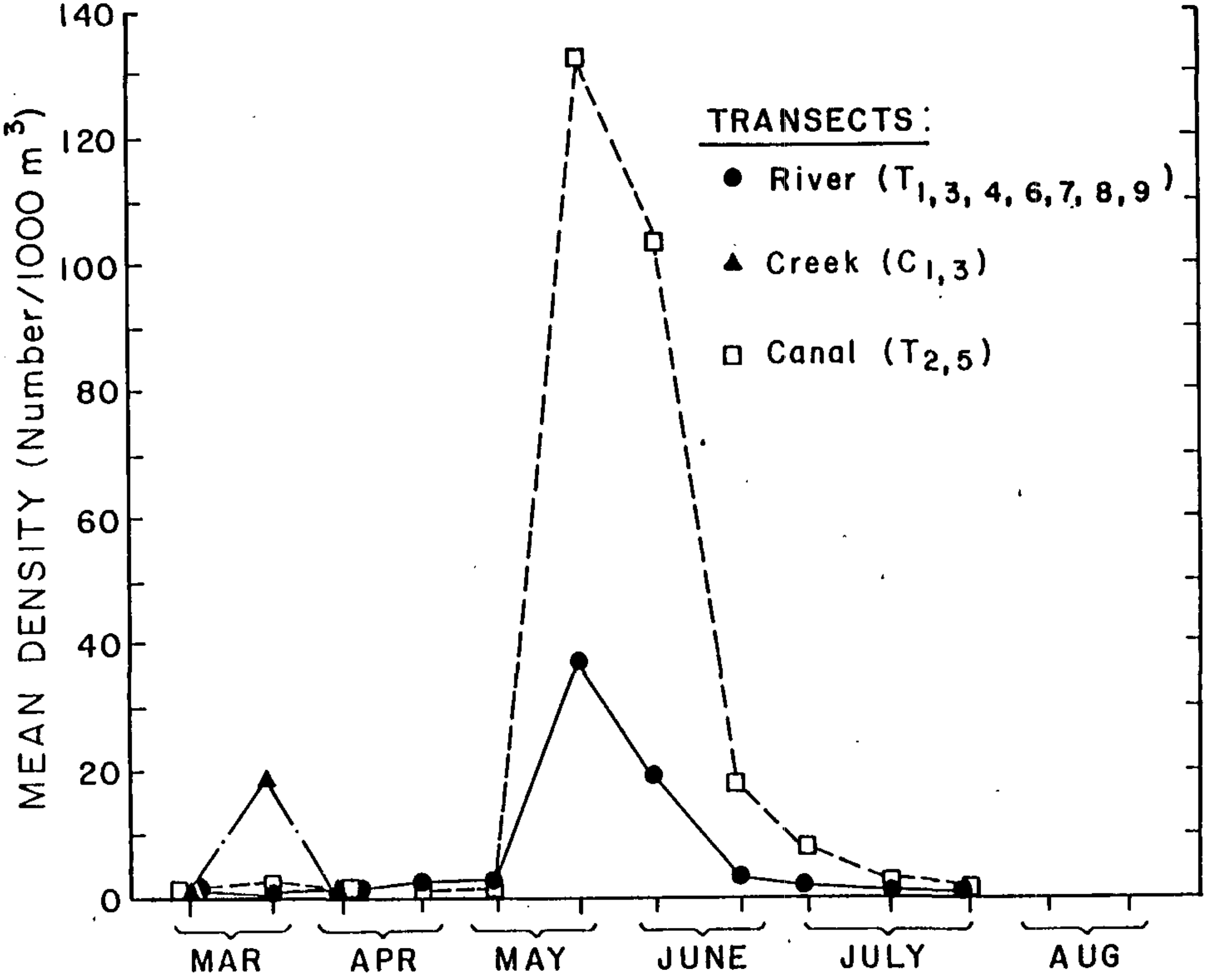

Figure 5.1-5. Seasonal changes in unidentified larval clupeid density, March - August 1982

On May 20, the highest density of larval clupeids was found in the 3G intake canal (Transect 5) where the density was 191 larvae/1000 m^3. Since this value was higher than the density at the transect upstream of the intake canal, it appears that clupeids were spawning in the intake canal. Because the number of larvae identified as Dorosoma sp. was high on this date, it is likely that many of the unidentified clupeids were Dorosoma sp. that had developed past the yolk-sac stage and were therefore more difficult to identify.[1]

Blueback Herring — The blueback herring is an important member of the Clupeidae family in the Savannah River and was considered as a separate group when specimens could be positively identified. It is clear that blueback herring was spawning in Upper Three Runs and Steel Creeks in late March and early April because average densities were 9.4 and 12.7 larvae/1000 m^3, respectively (Figure 5.1-6), and egg densities were high. On April 21-22, the density at Transect 2 was 17.5 larvae/1000 m^3, while no larvae were collected in any upstream waters. Rulifson et al. (1982) reported that blueback herring spawn in tributary creeks over shallows with vegetation.[2] This description approximates the intake canals. These factors suggest, although do not conclusively demonstrate, that the blueback herring were utilizing the intake canals as a spawning site.[1]

Sturgeon Larvae — During the 13 collecting periods, 15 sturgeon larvae were collected (Table 5.1-1). These larvae, which are large and distinctive, were mainly collected from the bottom of the river. Two species of sturgeon are known to occur in the Savannah River; the Atlantic sturgeon and the shortnose sturgeon. The Atlantic sturgeon is a large fish often exceeding ten feet in length. The shortnose sturgeon is a smaller fish which seldom attains four feet in length. The shortnose sturgeon is rare and is listed as an endangered species by the Federal government, and both South Carolina and Georgia. In the past few years, this species has been collected in the Savannah River about ten miles south of the Savannah River Plant boundary. Analyses indicate that at least two of the larvae collected are shortnose sturgeon (Appendix H).[1]

5.1.1.3.5 Fish Eggs

During the survey, eggs of several important species (American shad, striped bass, and blueback herring) were identified. Eggs of these three species constituted 90 percent of the total eggs collected.

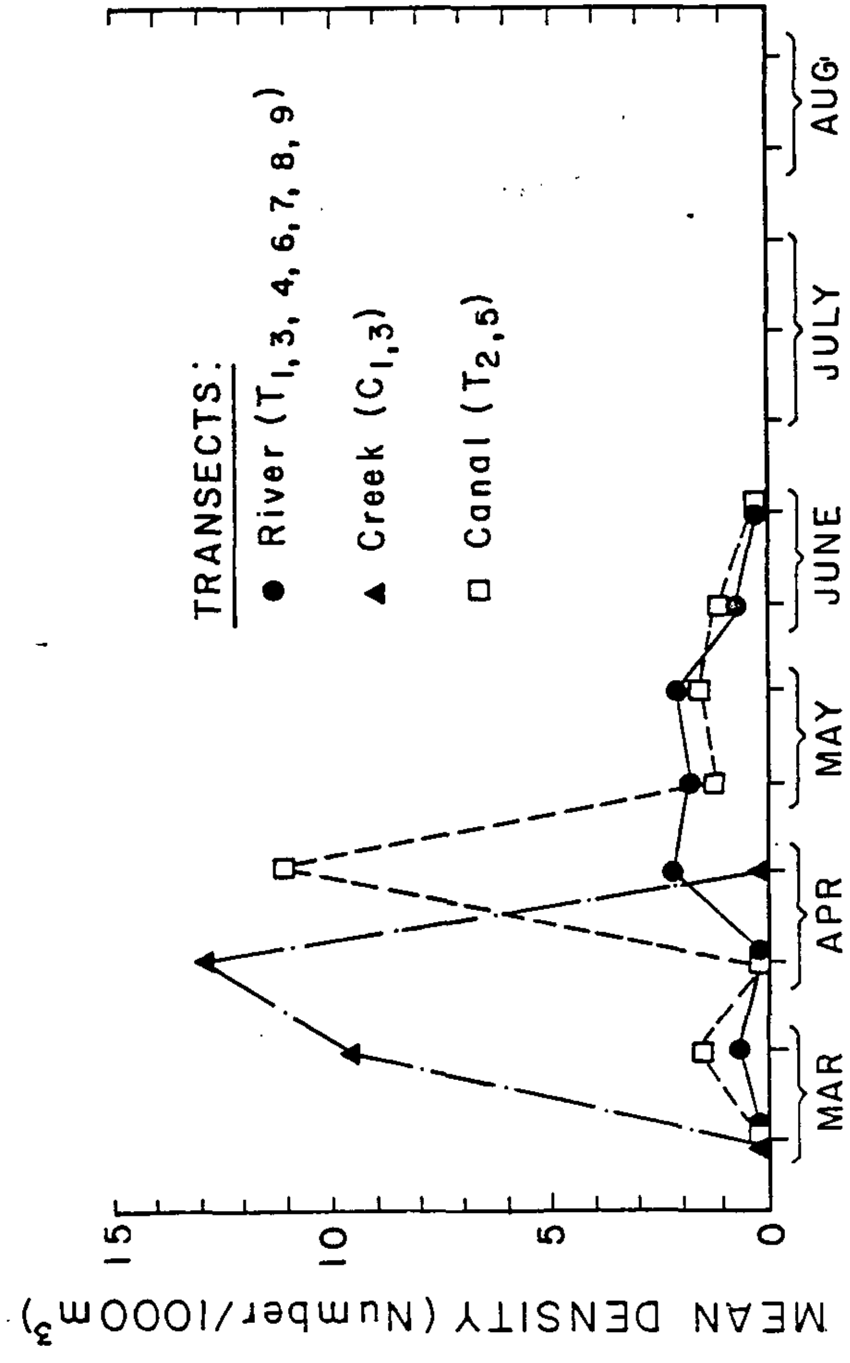

Figure 5.1-6. Seasonal changes in larval blueback herring density, March - August 1982

TABLE 5.1-2

Total Number of Eggs of Each Fish Group Collected, March — August 1982*

Group	Collection Date: March 11-12	March 25-26	April 7-8	April 21-22	May 4-5	May 20-21	June 2-3	June 12-13	July 1-2	July 15-16	July 28-29	August 11-12	August 28-29	Total
Clupeidae														
American Shad	7	110 (185)	319	239 (184)	595	318 (1098)	84	62 (339)	9	0	1	0	0	3550
Blueback Herring	0	253 (82)	45	0	0	0	0	0	0	0	0	0	0	380
Percidae														
Perch and Darters	0	6 (18)	6	7 (12)	2	6	2	0 (5)	0	1	0	2	0	87
Percichthyidae														
Striped Bass	0	0	0	0	125	217 (152)	0	0	0	0	0	0	0	494
Other	10	42 (47)	35	30 (87)	58	73 (74)	22	14 (6)	11	5	1	2	1	518
Total	17	411 (332)	405	276 (283)	780	614 (1344)	108	76 (350)	20	6	2	4	1	5029

* Total number of eggs taken during the three additional diurnal collections at six transects are shown in parentheses.

5.1.1.3.6 Seasonal Changes in Egg Dominance

Of the 5029 fish eggs collected during this study, 3550 were those of the American shad (Table 5.1-2). American shad commonly ascend rivers hundreds of miles to spawn. American shad spawning began at a low level in early March and increased steadily through April. In early May, American shad spawning was at its maximum with densities of over 220 eggs/1000 m^3 collected at Transects 1, 3, and 6 (Table 5.1-3). Except for the March 25-26 collection when blueback herring dominated, American shad was the dominant species in collections of greater than 20 eggs (Table 5.1-4).[1]

Seasonal trends of American shad egg density in the vicinity of the SRP were determined by averaging the densities for the seven river stations, two intake canals, and two creeks for every date. Because of the higher temperatures in Four Mile Creek, data from this location were excluded from the average. The mean density of American shad eggs for all river stations combined showed a peak during the May 4-5 collection. The density of eggs declined through the remainder of May and June (Figure 5.1-7). By July 1-2, small numbers of American shad eggs were found at only three locations in the river. The last collection of American shad eggs occurred on July 28-29, when only one egg was collected.[1]

American shad eggs were not collected in the intake canals during the study, except for one egg on May 4-5. The absence of American shad eggs in the intake canals indicates that this area is not used for spawning and that any eggs taken into the canals with the river water do not remain suspended in the water column. Similar results were observed by McFarlane in 1977 surveys.[3]

No American shad eggs were collected in Upper Three Runs or Four Mile Creeks. Steel Creek was the only creek where spawning of American shad was recorded. The density of eggs collected suggests that spawning in Steel Creek is low and sporadic. Over the entire season, American shad eggs represented about 71 percent of the 5029 fish eggs collected. McFarlane et al. reported that over 96 percent of the fish eggs collected in their study were American shad.[3]

Striped bass eggs were the second most abundant fish eggs collected. A total of 494 striped bass eggs were collected, which represents about 10 percent of all eggs collected during the study. Striped bass eggs were collected in the regular daytime collection on May 4-5, and in the diurnal collections on May 20-21 (Table 5.1-2). During May, striped bass eggs were collected at all river transects.[1]

Striped bass spawning near the Savannah River Plant has not been previously documented. Dudley studied the striped bass of the

TABLE 5.1-3

Density of American Shad Eggs (No./1000 m^3) Collected During Daytime Sampling
March — August 1982

Collection Date	Sampling Location: River T1	T3	T4	T6	T7	T8	T9	Intake Canals T2	T5	Creeks C1	C2	C3
Mar 11-12	0.0	2.1	0.0	2.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	7.3
Mar 25-26	11.0	2.7	4.4	28.3	26.0	50.4	66.5	0.0	0.0	0.0	0.0	19.0
Apr 7-8	103.4	144.6	130.3	72.6	10.6	9.5	90.1	0.0	0.0	0.0	0.0	0.0
Apr 21-22	23.6	28.1	18.7	32.1	93.7	37.5	128.3	0.0	0.0	0.0	0.0	0.0
May 4-5	224.5	243.5	193.1	268.3	63.3	68.8	66.5	4.5	0.0	0.0	0.0	50.0
May 20-21	82.8	54.2	64.7	83.1	76.3	105.8	187.0	0.0	0.0	0.0	0.0	0.0
Jun 2-3	29.5	11.9	36.1	13.1	11.6	10.8	33.2	0.0	0.0	0.0	0.0	10.2
Jun 13-14	21.5	19.6	11.1	5.0	12.7	7.1	31.3	0.0	0.0	0.0	0.0	0.0
Jul 1-2	4.7	0.0	0.0	5.7	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0
Jul 15-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul 28-29	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug 11-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug 28-29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.1-4

Percentage Composition of Total Eggs Collected, March — August 1982

Group	Collection Date March		April		May		June		July			August	
	11-12	25-26	7-8	21-22	4-5	20-21	2-3	12-13	1-2	15-16	28-29	11-12	28-29
Clupeidae American Shad	41.2	39.7	78.8	75.7	76.3	72.3	77.8	94.1	45.0	0.0	50.0	0.0	0.0
Blueback Herring	0.0	45.1	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percidae	0.0	3.2	1.5	3.4	0.3	1.3	1.9	1.1	0.0	16.7	0.0	50.0	0.0
Percichthyidae Striped Bass	0.0	0.0	0.0	0.0	16.0	18.8	0.0	0.0	0.0	16.7	0.0	0.0	0.0
Other	58.8	12.0	8.6	20.9	7.4	7.5	20.3	4.7	55.0	83.4	50.0	50.0	100.0
Total percentage	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total number	17	743	405	559	780	1960	108	426	20	6	2	4	1

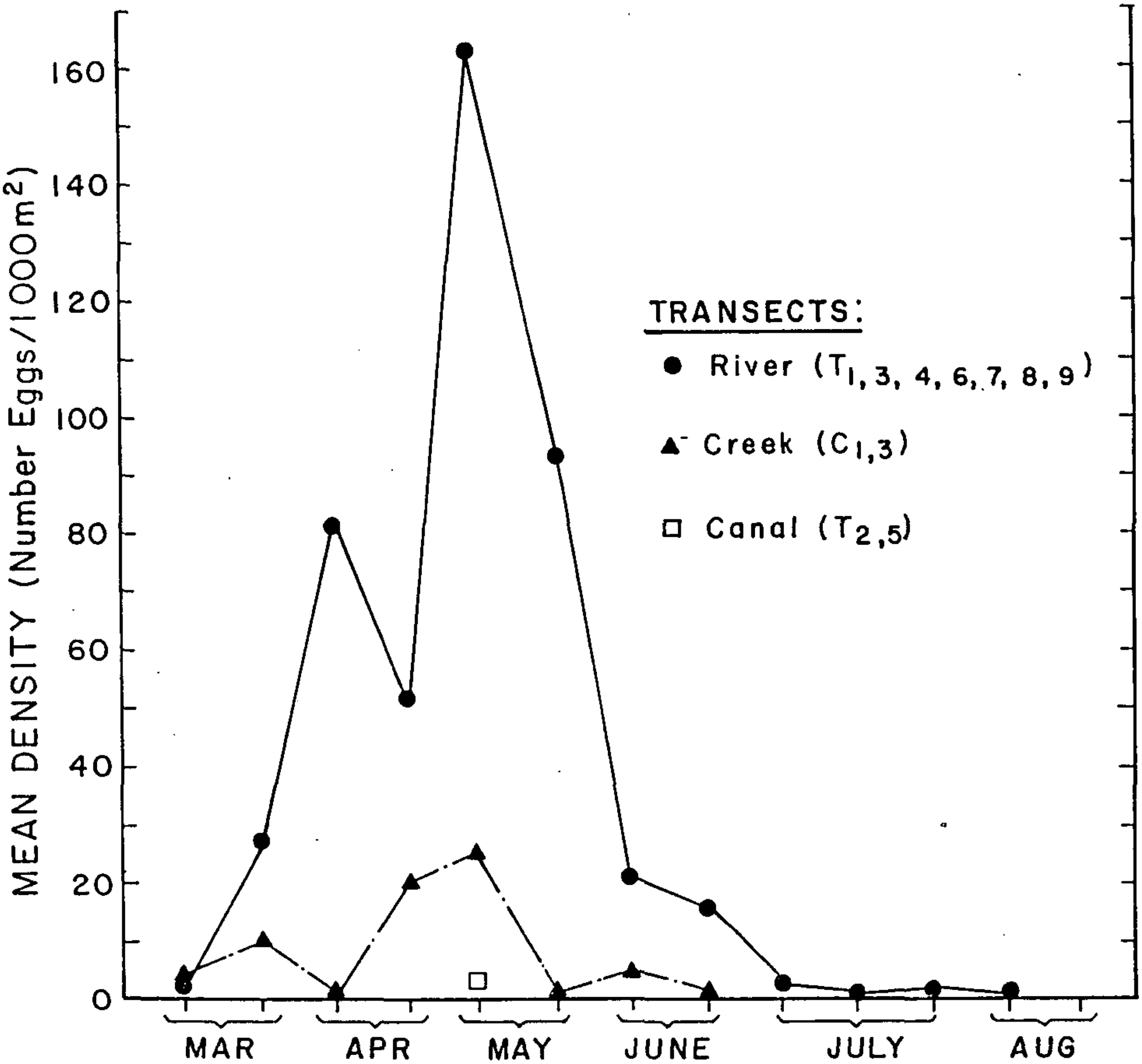

Figure 5.1-7. Seasonal changes in American shad egg mean density, March - August 1982

Savannah River and reported that spawning takes place only in the creeks near the mouth of the river.[4] They were unable to document spawning in any upstream waters. McFarlane, et al., and Georgia Power Company did not find striped bass eggs in collections in the Savannah River.[3]

Blueback herring eggs were the third most abundant group. Blueback herring eggs were collected on two dates: March 25-26 and April 7-8. On March 25-26, blueback herring eggs were the most numerous eggs collected (Table 5.1-2). Egg densities on this date were particularly high at Upper Three Runs and Steel Creeks, where they constituted the entire calculated densities of 472.7 and 863.5 eggs/1000 m^3, respectively (Table 5.1-5). This demonstrates that these creeks are used for spawning by this species. The flushing of herring eggs from Steel Creek resulted in high egg density at the South Carolina side of Transect 9. The discharge of blueback herring eggs from Upper Three Runs Creek did not appear to influence downstream populations, although a few blueback herring eggs were collected at Transect 3. It is likely that most of the eggs entered the 1G intake canal and settled out of the water column.[1]

Blueback herring eggs represented 8 percent of all eggs collected during this study. Blueback herring eggs are demersal and adhesive and are less susceptible to drift than either American shad or striped bass eggs. Because of the adhesive characteristic of herring eggs, the abundance of blueback herring eggs drifting in the water column and taken in the collections may reflect a high herring spawning rate in the area. Because herring eggs are adhesive, larval density may be a better indicator of the relative abundance or blueback herring in the ichthyoplankton.[1]

The remainder of the eggs collected were in the others group (518 eggs) and Percidae (87 eggs; Table 5.1-2). Eggs categorized as others were found on every collection date with a maximum of 147 eggs collected on May 20-21. Percidae eggs were by far the smallest group collected, constituting less than 1 percent of the total eggs collected.[1]

5.1.1.3.7 Fish Egg Distribution

The horizontal distribution of fish eggs in the Savannah River was evaluated by sampling at three locations: South Carolina shore Georgia shore and mid-river. When data from all collection dates were combined, the mid-channel density for all river transects was statistically greater than the Georgia or South Carolina positions.[1]

Fish eggs drift passively, so their horizontal distribution is determined by the hydrology of the river. However, the main concentration of eggs was in the center of the river even at transects

TABLE 5.1-5

Density of Fish Eggs (No./1000 m^3) Collected During Daytime Sampling
March — August 1982

Collection Date	Sampling Location: River T1	T3	T4	T6	T7	T8	T9	Intake Canals T2	T5	Creeks C1	C2	C3
Mar 11-12	0.0	2.2	0.0	4.3	3.2	3.7	3.6	0.0	0.0	0.0	0.0	7.3
Mar 25-26	34.3	21.8	18.4	42.4	61.4	88.1	130.8	0.0	0.0	472.7	19.5	863.5
Apr 7-8	112.1	155.9	138.5	83.0	12.4	23.7	107.8	0.0	0.0	49.7	0.0	191.8
Apr 21-22	29.4	40.6	31.7	38.2	103.1	45.6	129.8	0.0	0.0	20.0	0.0	0.0
May 4-5	305.2	261.7	208.9	289.4	78.1	82.7	265.3	8.7	1.9	0.0	0.0	50.0
May 20-21	120.9	92.6	104.8	91.5	410.5	286.6	193.3	0.0	0.0	13.1	0.0	0.0
Jun 2-3	34.7	14.5	42.1	16.0	17.9	16.1	42.8	0.0	0.0	0.0	5.6	14.7
Jun 13-14	25.5	19.6	22.2	6.7	19.4	8.6	31.3	0.0	0.0	0.0	23.3	0.0
July 1-2	1.3	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 15-16	3.2	1.8	0.0	0.0	0.0	1.7	0.0	0.0	0.0	10.4	0.0	1.4
July 28-29	1.3	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug 11-12	0.0	0.0	0.0	0.0	0.0	3.4	2.9	0.0	0.0	0.0	0.0	0.0
Aug 28-29	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

where the strongest current velocity was near the short. No explanation for the occurrences of higher egg densities in the middle of the river at some locations is evident at this time.[1]

Fish egg densities at near-surface and near-bottom locations were compared to determine if there were vertical differences in the distribution of fish eggs. Density values from surface and bottom samples were averaged for the river transects and the creeks for comparison. Near-surface and near-bottom densities were significantly different on seven occasions. In every instance, near-bottom densities were higher than surface densities. In general, the few creek samples that could be analyzed for vertical distribution of eggs showed no differences.[1]

When surface and bottom fish-egg densities were compared for each transect over all dates, the bottom samples at Transects 3 and 6 were significantly higher. The location of these transects just downstream from the intake canals should not cause this change in density. However, the possibility that egg distribution in the river is influenced by the intake canals cannot be overlooked and will be re-examined as more data are collected.[1]

5.1.1.3.8 Spatial and Temporal Trends in Fish Egg Abundance

Fish egg densities often were more variable than larval densities between ecologically similar areas. Some of this variation could be caused by high concentrations of eggs recently released by fishes spawning in the sampling area. For example, the density of 265.3 eggs/1000 m^3 at Transect 9 on May 4, was caused by a large number of striped bass eggs in the collection (Table 5.1-5). Since this was the only location where striped bass eggs were abundant on that date, the localized spawning influenced the total egg density. Large numbers of striped bass eggs were also observed at Transects 7 and 8 on May 20-21.[1]

No eggs were collected in either intake canal daytime samples except for a few during one sampling period (Table 5.1-5). This absence of eggs may be due to characteristics of the eggs and the location of the sampling. The eggs of most species of freshwater fishes are not normally suspended in the water column. Fish such as blueback herring broadcast eggs in areas of low flow, so that the eggs normally settle out and adhere to vegetation. Some eggs may drift with the current and become part of the ichthyoplankton. American shad eggs and striped bass eggs are pelagic and drift along with currents. When these eggs move into the intake canals or other areas where currents are reduced, they settle out and can be smothered in soft substrates.[1,3]

The potential influences and contributions of Upper Three Runs, Four Mile and Steel Creeks to the river ichthyoplankton were examined by comparing egg densities of the river transects above and below the confluence of the creeks and rivers as well as in the creek. Changes in egg density below incoming creeks could be affected by the contribution of organisms from the creek, or by environmental changes such as the addition of thermal effluent into the river.

Fish egg densities in Upper Three Runs ranged from 0 to 472.7 eggs/1000 m^3 during this study period (Table 5.1-5). The highest density occurred on March 25-26, and was caused primarily by blueback herring eggs. Low densities of blueback herring eggs at both Transects 1 and 3, indicate that many of the eggs from Upper Three Runs must have been transported into the intake canal.[1]

Fish eggs were collected from Steel Creek during 6 of the 13 collection periods. The densities ranged up to 863.5 eggs/ 1000 m^3 (Table 5.1-5), with the highest density collected on March 25-26. These eggs were primarily blueback herring.[1]

Comparisons of egg densities at Transect 7 and Transect 9 were performed to examine the potential influence of Steel Creek on the Savannah River. While Transect 7 is far from Steel Creek, it was used as a representative upstream station, fully recognizing that it may be different from the area immediately above Steel Creek (site of Transect 11). On three occasions, there were significant differences between the transects. On April 7-8 and May 4-5, the density at Transect 9 was greater than the density at Transect 7. In April, Steel Creek could have contributed to the differences because American shad eggs increased from Transect 7 to Transect 9 and were present in Steel Creek. However, in May, differences between Transects 7 and 9 were due to species not found in Steel Creek on that date. On May 20-21, egg density at Transect 7 was significantly higher than at Transect 9. This was the result of a large number of striped bass eggs at Transect 7, rather than to a contribution from Steel Creek. Since Steel Creek may only influence the South Carolina side of the river, the densities near the right shore were examined for possible differences. On 4 of 13 collecting dates, there were significant differences between transects. In three instances, densities at Transect 9 were greater than densities at Transect 7. However, on only one of these occasions, March 25-26, could the difference possible be attributed to the fish eggs coming out of Steel Creek.[1]

Fish eggs were collected from the heated Four Mile Creek on three occasions (Table 5.1-5). These collections consisted of few eggs and no attempt was made to evaluate their viability. To evaluate the possibility that the thermal discharge of Four Mile was affecting the ichthyoplankton in areas below the confluence of

Four Mile Creek and the Savannah River, comparisons were made between egg densities at Transects 7 and 8. No significant differences were found between these two transects or between comparisons of the South Carolina sides of the transects.[1]

5.1.1.3.9 Summary

In 1982, most fish spawning in the Savannah River occurred between March and June. The most abundant ichthyoplankton were larvae of blueback herring, American shad, and unidentified clupeids, suckers (Catastomidae) and minnows (Cyprinidae), and eggs of American shad and striped bass.

Fish larvae were generally distributed uniformly at the river stations. Fish eggs tended to be more concentrated in the middle portion of the river and often near the bottom.

The intake canals had high densities of larvae and low densities of eggs. The eggs entrained into the canals probably settled to the bottom because of low-flow rates in the canal.

Steel Creek and Upper Three Runs Creek contained numerous larvae and were sites for blueback herring spawning. High temperatures in Four Mile Creek precluded any extensive spawning in these waters.

During diurnal collections, egg and larval densities were higher during nighttime collections in May and June, but not in March or April.

5.1.1.4 ENTRAINMENT ESTIMATES

5.1.1.4.1 Fish Larvae

Ichthyoplankton entrained into the intake pumps along with the cooling water is lost to the Savannah River environment. For fish larvae in the river, entry into the intake canal takes them from a region of rapid currents to one with slow currents which may enable larger larvae to migrate to protected shoreline areas. This process would tend to reduce the mortality of larvae entrained from the river. However, there is evidence from the larval collections that the intake canal is used as a spawning site for several species. Accordingly, loss of entrained larvae may be greater than is indicated by the ichthyoplankton densities in the water entering the canal from the river.[1]

The average density of larvae in six surface and two bottom replicates collected in the intake canals was used to calculate entrainment. To calculate the total number of larvae entrained per day, the average larval density was multiplied by the volume of water pumped during the day of the sampling period.[1]

To estimate the entrainment of larvae between samples, the daily entrainment rate was multiplied by the number of days until the next sample was taken. Generally, this was 13 or 14 days. The estimates of larvae entrainment were then totaled for an estimated annual entrainment.[1]

5.1.1.4.2 Fish Eggs

Almost no fish eggs were collected in the intake canals. Apparently water velocity in the canals is too low to support drifting semi-bouyant eggs. Eggs entering the intake canals with the river water settle to the bottom of the canal and are probably suffocated in the bottom mud.[1,3]

Since the eggs entering the intake canal from the river probably do not survive, the removal of eggs from the river can be considered an entrainment loss. Total egg losses were calculated using the same method described for fish larvae except that the density of eggs in the river water was used instead of the density of eggs in the intake. Entrainment into the 3G and 5G intake canals was calculated using the density of eggs at Transect 4.[1]

The density of eggs entering the 1G canal could not be calculated directly from the density of eggs at the upstream river station since a large portion of the discharge of Upper Three Runs Creek enters the 1G intake canal. The percentage of the intake canal water that came from Upper Three Runs Creek ranged from 15 to 39 percent. This percent was multiplied by the density of eggs from each source to get an average density of fish eggs entering the 1G canal.[1]

5.1.1.4.3 Results

Larval fish entrainment ranged from 0 to a calculated maximum of 1.50×10^5 at 1G, 3.65×10^5 per day at the 3G intake, and 1.97×10^4 at the 5G intake on May 21. The annual entrainment of larvae was calculated to be 5.2×10^6 at 1G, 12.0×10^6 at 3G, and 0.7×10^6 at 5G for a total entrainment of $17.9\ 10^6$ larval fish for the combined intakes. This total value is consistant with the total estimated 19.6×10^6 larvae reported by McFarlane.[1,3]

Fish egg entrainment ranged from 0.0 to a calculated maximum of 2.24×10^5 at 1G, 1.92×10^5 per day at 3G, and 3.04×10^4 at 5G. For each canal, the total number of eggs entrained during the

1982 sampling was 8.7 x 10^6 at 1G intake, 8.2 x 10^6 at 3G intake, and 1.2 x 10^6 at 5G intake canals for a total entrainment of 18.1 x 10^6 eggs for the combined intakes. McFarlane estimated that a total of 6.8 x 10^6 eggs were entrained into the three intake canals or pumphouses in 1977. This estimate is lower than was found in the present study.[1,3]

Egg entrainment rates into the 1G canal were influenced by a high density of 472.7 eggs/100 m^3 entering the canal with water from Upper Three Runs Creek. These eggs were from blueback herring spawning in Upper Three Runs Creek.[1]

5.1.2 Impingement

Collections of fishes impinged on the traveling screens at the 1G, 3G, and 5G intake canals were made biweekly between April 17 and August 16, 1982.

Pumping rate data were obtained from the Savannah River Plant. These data included the pumping rates and the number of pumps operating during impingement and meroplankton sampling. The pumping rates and volumes were compared with the number of fishes impinged.

A total of 228 fishes representing 22 species were collected during the twelve impingement samplings (Table 5.1-6). The 22 species collected in the present study is less than the 35 collected by McFarlane, but additional species will undoubtedly be collected as sampling continues.[1,3]

The number of fishes in impingement collections varied from 0 to 44 fishes in a 24-hour period. Although there were generally fewer fishes impinged in the latter part of the study, there was no consistency in the occurrence of high or low numbers of fish impinged at any intake on any given day. A total of 136 fishes (59.6 percent) were impinged at the 3G intake; 49 fish (21.5 percent) at the 5G intake, and 43 fish (18.9 percent) at the 1G intake.[1]

The most commonly impinged fishes belonged to the family Centrarchidae. Nine species in this family were represented in the collections. The spottail shiner, a minnow, was the most commonly impinged species with a total of 64 specimens recorded from the 12 sampling periods (Table 5.1-6). All of the species impinged are common residents in the Savannah River and associated waters. The only unusual species collected was the blackbanded sunfish, Enneacanthus chaetodon. This species was not collected by McFarlane, nor by Georgia Power Company fish population surveys.[1,3]

TABLE 5.1-6

Total Number of Fishes Impinged at 1G, 3G, and 5G Intake Screens on Each Collecting Date, March — August 1982

Species	Collection Date March 18	March 30	April 15	April 30	May 11	May 28	June 9	June 24	July 7	July 22	August 3	August 16	Total	Percent Abundance
Gizzard shad	2	0	9	0	2	0	1	0	0	0	0	0	14	6.1
Threadfin shad	2	0	4	0	2	0	2	0	1	1	0	0	12	5.3
Unidentified shad	0	0	0	0	0	0	1	0	0	0	0	0	1	0.4
Redfin pickerel	0	0	1	0	2	0	0	0	0	0	0	0	3	1.3
Spottail shiner	35	17	8	0	3	0	0	0	0	0	0	0	64	28.0
Pugnose minnow	0	0	0	0	1	1	0	0	0	0	0	0	2	0.8
Unidentified shiner	0	0	3	0	0	0	0	0	0	0	0	0	3	1.3
Spotted sucker	0	0	1	0	0	0	0	0	0	0	0	0	1	0.4
Channel catfish	0	0	0	0	4	0	4	1	1	0	0	0	10	4.4
White catfish	0	0	0	0	1	1	0	0	0	0	1	0	3	1.3
Flat bullhead	0	0	1	0	0	2	2	0	0	0	0	0	4	2.2
Snail bullhead	0	0	0	0	0	0	0	1	0	0	0	0	1	0.4
Unidentified catfish	0	0	0	0	0	0	1	0	0	0	1	0	2	0.8
Bluegill	0	0	2	3	0	0	2	2	0	0	0	1	10	4.4
Flier	2	0	0	5	1	0	0	0	0	0	0	0	8	3.5
Warmouth	3	0	2	7	2	1	1	0	0	0	0	0	16	7.0
Redbreast sunfish	3	1	3	1	3	0	5	0	0	0	0	0	16	7.0
Redear sunfish	6	1	4	0	2	0	0	0	2	0	0	0	15	6.6
Blackbanded sunfish	1	0	0	0	0	0	0	0	0	0	0	0	1	0.4
Black crappie	4	1	8	0	2	0	3	0	0	1	0	0	19	8.3
Spotted sunfish	1	0	2	0	0	0	0	0	0	0	0	0	3	1.3
Largemouth bass	0	0	0	0	0	0	1	0	0	0	0	0	1	0.4
Unidentified *Lepomis*	0	0	2	0	1	1	0	0	0	0	1	1	6	2.6
Yellow perch	3	0	1	0	0	0	0	0	0	0	0	0	4	1.8
Unidentified darter	0	0	0	0	1	0	0	0	0	0	0	0	1	0.4
Hogchocker	4	1	1	0	1	0	0	0	0	0	0	0	7	3.0
Total	66	21	52	16	28	6	23	4	5	2	3	2	228	99.4

The volume of water pumped from each of the three intake canals differed. The average rate was 809,000 m^3/day at the 1G intake, 1,179,000 m^3/day at 3G, and 156,000 m^3/day at the 5G intake. During the study, there was a general decline in impingement rates, which was emphasized by the low impingement in July and August (Figure 5.1-8). The only high rate of impingement was recorded on March 17-18, when a rate of 245 fish/million cubic meters was calculated for the 5G intake. This high rate at the smallest intake was due to the impingement of 35 spottail shiners. This species is a common minnow found in the Savannah River and this collection probably represents the impingement of a portion of a school.[1]

The frequency of sampling used during the six-month period covered in this report is too low to allow a reasonable estimate to be made of the total yearly loss of fishes by impingement. However, based on biweekly collections during the six month period between March and August 1982, impingement rates at all intakes were low relative to what has been reported at other inland power plants.[5]

5.1.3 Electrofishing

Sample stations were the same as those described in Section 5.1.1.1.1. At the river stations, canal stations, and Upper Three Runs Creek, a 100 meter section of shoreline was measured and marked. On Four Mile and Steel Creeks, the lengths of the shocking transects were limited to less than 100 m by fallen trees that blocked the creeks.

Electrofishing collections were made in each sample area on four occasions within a 12-day period in August 1982. The repeated sampling was conducted to obtain a more complete species list and to collect sufficient numbers of fishes for an estimate of their relative abundance.

A total of 407 fishes in 32 species were collected by electrofishing during the four collecting periods in August 1982 (Table 5.1-7). Of this number, 99 were small fishes representing 11 species of fish, primarily minnows. No attempt was made to collect all of the minnows stunned by the electrofisher and, therefore, values for the collection of these small fish are not included in the general discussion.[1]

Four species dominated the collections. Redbreast sunfish was the most abundant species representing 18.8 percent of the total. Spotted suckers made up 15.3 percent of the collections, redear sunfish 15.0 percent, and striped mullet 11.7 percent. The remaining 16 species of fishes constituted 39.2 percent of the total

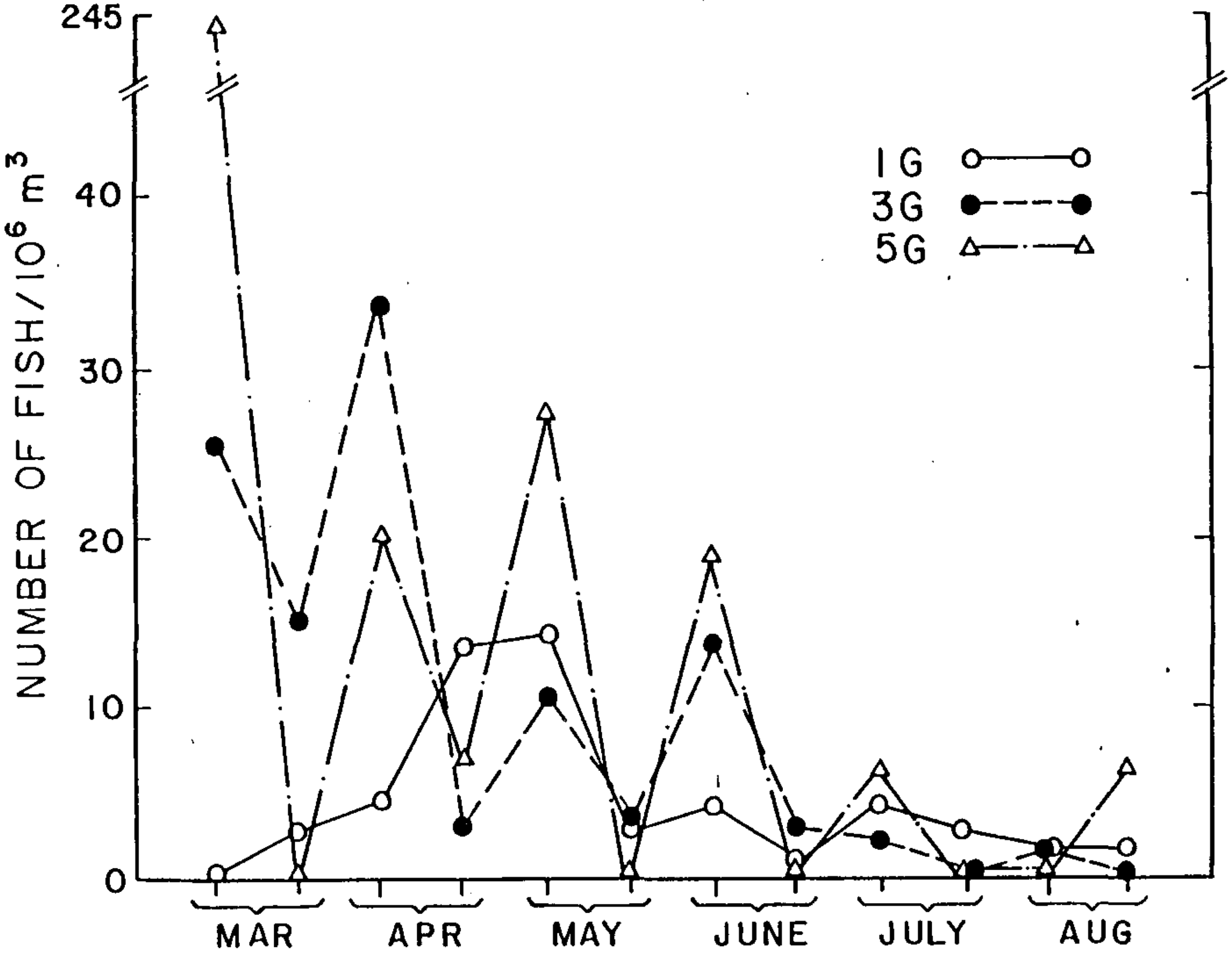

Figure 5.1-8. Seasonal change in fish impingement rates at the 1G, 3G and 5G intake pumphouses, March - August 1982

TABLE 5.1-7

Species Occurrence and Abundance at Each Electrofishing Sampling Location, August 1982

	Sampling Stations											
	River							Canal		Creek		
Species	T1	T3	T4	T6	T7	T8	T9	T2	T5	C1	C2	C3
Group 1												
Longnose gar	0	0	0	0	0	1	1	0	0	0	0	0
Bowfin	1	3	1	2	2	0	3	0	0	4	0	1
American eel	5	0	0	0	0	0	1	0	0	5	0	2
Gizzard shad	1	0	3	0	0	2	0	2	2	0	0	0
Chain pickerel	0	0	0	2	0	0	0	1	0	0	0	1
Carp	0	2	1	0	1	0	1	0	0	0	0	0
Spotted sucker	4	8	12	4	3	4	2	0	5	4	0	1
Silver redhorse	0	0	1	0	1	1	1	0	0	0	0	0
American shad	2	0	0	3	0	7	0	0	0	0	0	0
Flat bullhead	0	0	2	0	1	0	0	0	0	0	0	0
Redbreast sunfish	3	3	19	8	4	4	12	5	5	4	0	1
Warmouth	0	0	0	0	0	1	0	0	0	1	0	0
Bluegill	1	0	1	4	0	0	1	4	0	3	0	0
Redear sunfish	2	3	3	2	2	2	8	1	6	0	0	16
Spotted sunfish	0	0	0	0	0	0	1	0	0	1	0	2
Largemouth bass	1	2	1	0	1	3	3	3	0	0	0	8
Black crappie	0	0	0	0	0	1	0	0	0	0	0	1
Yellow perch	0	0	0	2	0	1	0	3	1	0	0	0
Striped mullet	4	1	10	0	0	5	2	1	11	0	0	2
Hogchoker	0	0	0	0	0	2	0	0	0	0	0	0
	24	22	44	27	15	34	36	20	29	22	0	35
Group 2*												
Pirate perch	0	0	0	0	0	0	0	0	0	0	0	1
Tessellated darter	1	0	0	0	0	2	1	0	0	0	0	1
Brook silverside	0	0	0	0	0	0	0	0	1	0	0	0
Minnows**	13	6	0	3	16	26	15	2	4	3	0	2
Mosquitofish	0	0	0	0	0	0	1	0	0	0	0	0
Speckled Madtom	0	0	0	0	0	0	1	0	0	0	0	0
	17	6	0	3	16	28	18	2	5	3	0	4

* Fishes were not collected quantitatively because of small size

** Undifferentiated at time of collection number collected (Table 5.1-8). These data were consistent with the results of electrofishing collections made by the Georgia Game and Fish Division in the Savannah River.[6] The Georgia study listed redbreast sunfish, striped mullet, spotted sucker, and bluegill as the most abundant fishes, exclusive of miscellaneous minnows. McFarlane listed redbreast sunfish, bluegill, and spotted sucker as the three most common species, exclusive of minnows.[1,3]

Catfish are known to be common inhabitants of the Savannah River, but were rarely collected in this study. Catfish species generally occupy deep channels that are beyond the range of the electrical field used in this study. Catfishes that may have been stunned were probably deeper in the water column and would not have appeared near the surface. Present studies incorporate a hoop-netting program to obtain information on the relative abundance of catfishes.

5.1.3.1 River Stations

The number of fishes and species was similar along both the South Carolina and Georgia shoreline at most stations. The largest collections in the river were made at Transects 4, 8, and 9. The relative abundance of fish species at Transect 4 was similar to that for all collections combined because the dominant fish were spotted suckers, redbreast sunfish, and striped mullet. The dominant species at Transect 9 were redbreast and redear sunfishes while no species dominated the community at Transect 8. The smallest collection of fishes was a Transect 7 where 15 fish were collected.[1]

Near the heated water discharges at Transects 8 and 9, both fish abundance and species occurrence were similar on both sides of the river. At Station 8, the temperature difference between the two sides of the river averaged 2.3°C during the four sample days. At Station 9, the difference averaged 0.6°C during the four sample days.[1]

5.1.3.2 Canal Stations

The number of fishes and species collected at the two canal transects was similar. More striped mullet, spotted suckers, and redear sunfish were collected at Transect 5, while more species were collected at Transect 2. As expected, no species were collected in the canals that were not taken in the river.[1]

TABLE 5.1-8

Species Occurrence at Each Sampling Habitat and Relative Abundance in the Total Collection, August 1982

Major Species	Number of Individuals Collected at Each Sampling Station				
	River	Canal	Creeks	Total	Percent Abundance
Group 1					
Longnose gar	2	0	0	2	0.6
Bowfin	12	0	5	17	5.5
American eel	6	0	7	13	4.2
Gizzard shad	6	3	0	9	2.9
Chain pickerel	2	1	1	4	1.3
Carp	5	0	0	5	1.6
Spotted sucker	37	5	5	47	15.3
Silver redhorse	4	0	0	4	1.3
American shad	12	0	0	12	3.9
Flat bullhead	3	0	0	3	1.0
Redbreast sunfish	43	10	5	58	18.8
Warmouth	1	0	1	2	0.6
Bluegill	7	4	3	14	4.5
Redear sunfish	22	7	16	45	15.0
Spotted sunfish	1	0	3	4	1.3
Largemouth bass	11	3	8	22	7.1
Black crappie	1	0	1	2	0.6
Yellow perch	3	4	0	7	2.3
Striped mullet	22	12	2	36	11.7
Hogchoker	2	0	0	2	0.6
	202	49	57	308	100.1
Group 2*					
Pirate perch	0	0	1	1	1.0
Tessellated darter	4	0	1	5	5.0
Brook silverside	0	1	0	1	1.0
Minnows**	79	6	5	90	90.9
Mosquitofish	1	0	0	1	1.0
Madtom**	1	7	7	1	1.0
	85	7	7	99	99.9

* Fishes were not collected quantitatively because of small size

** Undifferentiated at time of collection

5.1.3.3 Creek Stations

More fish representing more species were collected at Steel Creek than Upper Three Runs Creek, but the two creeks had many species in common. The major difference in abundance was caused by the collection of a large number of redear sunfish and largemouth bass in Steel Creek and none in Upper Three Runs Creek. However, comparisons of collections from Upper Three Runs Creek with collections from other creeks may be misleading because of water quality differences which affect electrofishing efficiency. The specific conductivity in Upper Three Runs Creek is much lower than that of the other creeks, which greatly limits the electrical input to the water.[1]

The average temperature of Four Mile Creek was 38.4°C during the August sampling period. Since no fishes were collected in Four Mile Creek on any of the collection dates, this temperature is obviously above the thermal preference level for Savannah River fishes.[1]

5.1.3.4 Habitat Comparisons

Of the 20 major species collected by electrofishing, all were found in the river, twelve species were collected in the creeks, and only nine species were found in the canals. These differences are not unusual considering the diversity of habitats sampled in the river compared to the relatively uniform habitat of the creeks and the extremely uniform canal habitat.[1]

Catch per unit effort (CPUE) is a standard fisheries parameter calculated by dividing the number of fish collected by a designated unit of space or effort. The abundance of fishes in the three habitats sampled was very similar when related to the number of sampling stations and the total distance electrofished (Table 5.1-9). Since each sampling effort is also dependent upon the amount of time the electrodes are activated, the CPUE was calculated as fish per hour of actual shocking time. The CPUE for river stations (73.0 fish/hr) was lower than that of canal stations (94.8) and creek stations (83.4), but was very similar to the 67.5 fish/hr calculated for the midsummer electrofishing sample made by the Georgia Game and Fish Division.[6]

5.2 STEEL CREEK FISHERIES SURVEYS

The purposes of the fish population studies were to determine the spatial and temporal use of the Steel Creek area of the SRP Savannah River Swamp fish and to characterize the fish community in terms of species use and abundance.[7] Although some species known

TABLE 5.1-9

Catch Per Unit Effort (CPUE) at River, Canal, and Creek Sampling Locations, August 1982

Parameter	Sampling Location River	Canal	Creek
Total No. fishes	202	49	57
No. stations	7	2	2*
Mean	27.9	24.5	28.5
CPUE (fish/100 m)	3.6	3.1	3.6
CPUE (fish/hr)	73.0	94.8	83.4
CPUE (fish/hr)**	67.5		129.0***

* Four Mile Creek was not included because of high temperatures

** Georgia Fish and Game Division Study, Reference 6.

*** Creeks and exbows combined

to occur within the Savannah River drainage are on the federal or state lists of rare and endangered species (Section 4.4), no such fish have been collected in Steel Creek. Species listed among South Carolina's commercially and recreationally important species have been collected. The commercially important species are primarily anadromous.

5.2.1 Materials and Methods

The Steel Creek region of the Savannah River swamp was divided into six sampling areas (Figure 5.2-1) in order to determine habitat utilization by resident and anadromous fish. The lower Steel Creek channel between the swamp and the Savannah River (Area E) was also sampled. Areas A_1 and A_2 are characterized by a cypress-tupelo canopy with occasional beds of submergent and emergent macrophytes. Areas B_1, B_2, C and D are characterized by an open canopy (due to previous thermal impact) with dense beds of aquatic macrophytes. Areas A_1 and B_1 have comparatively low current velocities while Areas A_2, B_2, C and E are characterized by high flow. Area D has no discernable current.[7]

Areas A_1, A_2, B_1, B_2 and C were subdivided into 50 meter (m) transects to standardize electrofishing effort among areas and to obtain replicate samples within areas. Low water levels in Area D and swift current in Area E prevented collection by electroshocking within these sites on most dates.[7]

Sampling for anadromous fish began on January 30, 1982 and continued through mid-May. Two fyke nets were set in Steel Creek, one approximately 200 m above the Steel Creek - Savannah River confluence (E_2) and the other approximately 100 m dowstream from the swamp outlet (E_1). Replicate ichthyoplankton samples were collected with 0.5 m diameter nets (500 μm mesh) on two dates following what appeared to be a small run of American shad to ascertain the presence or absence of eggs and larvae.[7]

5.2.2 Results of Collections

Fish of all sizes were collected in the swamp and a wide range of sizes was collected for most species. The collections should be representative of both relative abundance and species composition of the swamp fish community. A total of 5,313 fish representing 55 species were collected from the Steel Creek river-swamp from November 1981 through July 1982 (Table 5.2-1). These fish represent 55 of 79 species and 19 of 21 families known to occur on the SRP. The high diversity of fish species is a result of the wide array of habitat types and niches available within the creek-swamp environment.[7]

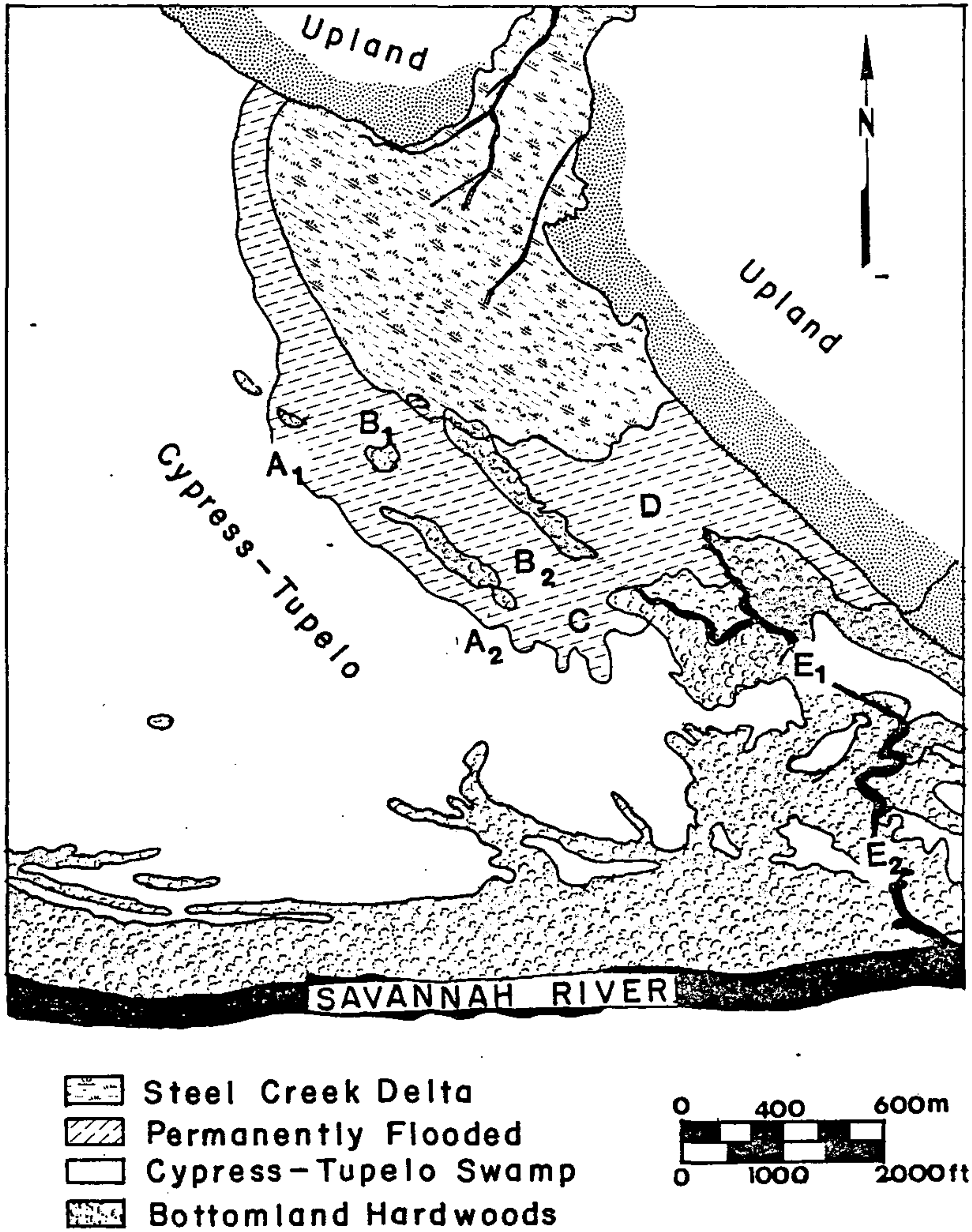

FIGURE 5.2-1. Fish sampling locations in the Steel Creek delta and swamp during 1981-82

TABLE 5.2-1

Scientific and common names of fish collected in the Steel Creek Area, October 1981 - July 1982

Amblyopsidae	
Chologaster cornuta	Swampfish
Amiidae	
Amia calva	Bowfin
Anguillidae	
Anguilla rostrata	American eel
Aphredoderidae	
Aphredoderus sayanus	Pirate perch
Atherinidae	
Labidesthes sicculus	Brook silverside
Belonidae	
Strongylura marina	Atlantic needlefish
Catostomidae	
Erimyzon oblongus	Creek chubsucker
Erimyzon sucetta	Lake chubsucker
Minytrema melanops	Spotted sucker
Centrarchidae	
Centrarchus macropterus	Flier
Elassoma zonatum	Banded pygmy sunfish
Enneacanthus chaetodon	Blackbanded sunfish
Enneacanthus gloriosus	Bluespotted sunfish
Lepomis auritus	Redbreast sunfish
Lepomis glulosus	Warmouth
Lepomis machrochirus	Bluegill
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Micropterus salmoides	Largemouth bass
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Clupeidae	
Alosa sapidissima	American shad
Alosa aestivalis	Blueback herring
Dorosoma cepedianum	Gizzard shad
Cyprinidae	
Cyprinus carpio	Carp
Hyboganthus nuchalis	Silvery minnow
Notemigonus crysoleucas	Golden shiner
Notropis chalybaeus	Ironcolor shiner
Notropis cummingsae	Dusky shiner
Notropis emiliae	Pugnose minnow
Notropis hudsonius	Spottail shiner
Notropis leedsi	Bannerfin shiner
Notropis lutipinnis	Yellowfin shiner
Notropis maculatus	Taillight shiner
Notropis niveus	Whitefin shiner
Notropis petersoni	Coastal shiner

TABLE 5.2-1 (cont'd)

Cyprinodontidae	
Fundulus lineolatus	Lined topminnow
Esocidae	
Esox americanus	Redfin pickerel
Esox niger	Chain pickerel
Ictaluridae	
Ictaluris natalis	Yellow bullhead
Ictaluris nebulosus	Brown bullhead
Ictaluris platycephalus	Flat bullhead
Ictaluris punctatus	Channel catfish
Noturus gyrinus	Tadpole madtom
Noturus leptacanthus	Speckled madtom
Lepisosteidae	
Lepisosteus osseus	Longnose gar
Lepisosteus platyrhincus	Florida gar
Mugilidae	
Mugil cephalus	Striped mullet
Percichthyidae	
Morone saxatilis	Striped bass
Percidae	
Etheostoma fusiforme	Swamp darter
Etheostoma olmstedi	Tesselated darter
Perca flavescens	Yellow perch
Percina nigrofasciata	Blackbanded darter
Poeciliidae	
Gambusia affinis	Mosquito fish
Umbridae	
Umbra pygmaea	Eastern mudminnow

The order of rankings of mean number of fish collected in each area were $B_1 > A_1 > B_2 > C > A_2$, with more fish collected in Area B_1 than in all other areas, and Area A_2 with the least number of fish (Figure 5.2-2). Brook silverside, spotted sunfish and largemouth bass were the most frequently collected fish in area A_1 and B_2, and were generally the most abundant. Area B_2 was dominated by dense beds of macrophytes, thus spotted sunfish and largemouth bass were more abundant than brook silverside, an open water species. The opposite was true for Area A_1 with its greater open water environment. Areas A_2 and C were also very similar in dominant species. Spotted sucker, spotted sunfish, and largemouth bass were the most frequently collected species in these areas. However, both spotted sunfish and largemouth bass were more abundant in Area C than A_2 and this was probably due to the greater abundance of macrophytes in Area C.[7]

Areas B_1 and B_2 also appear to be important as spawning and/or nursery areas for resident fishes in the swamp. Young-of-year (YOY) fishes were captured almost exclusively in these areas, although no spawning activity was ever observed. YOY fish dispersed into other areas as they increased in size through the summer, although they were usually associated with macrophytes.[7]

Areas D and E were sampled only once by electrofishing during November-February due to shallow water (D) and high water velocity (E). Insufficient numbers of fish were collected in either area to determine species composition during winter months. However, large numbers of mosquito fish were observed during the summer of 1981 throughout Area D. Data from the two fyke nets located in Area E provide some initial data on resident fish as well as on the use of the lower creek by migrating species. During high water in February, bowfin and longnose gar were regularly captured in the upper fyke net. Shiners were occasionally collected in the lower net.[7]

5.2.3 Migratory Fish

No major run of anadromous fish was detected in the Steel Creek area during 1982; a total of six American shad and four blueback herring were collected with fyke nets from February through April. To determine if the nets were an effective method for capturing clupeids, portions of lower Steel Creek were electrofished on selected dates and few fish were collected. Conversations with fishermen at the confluence of Steel Creek and the Savannah River also suggested that a major run did not occur in 1982 and that this year was atypical.[7]

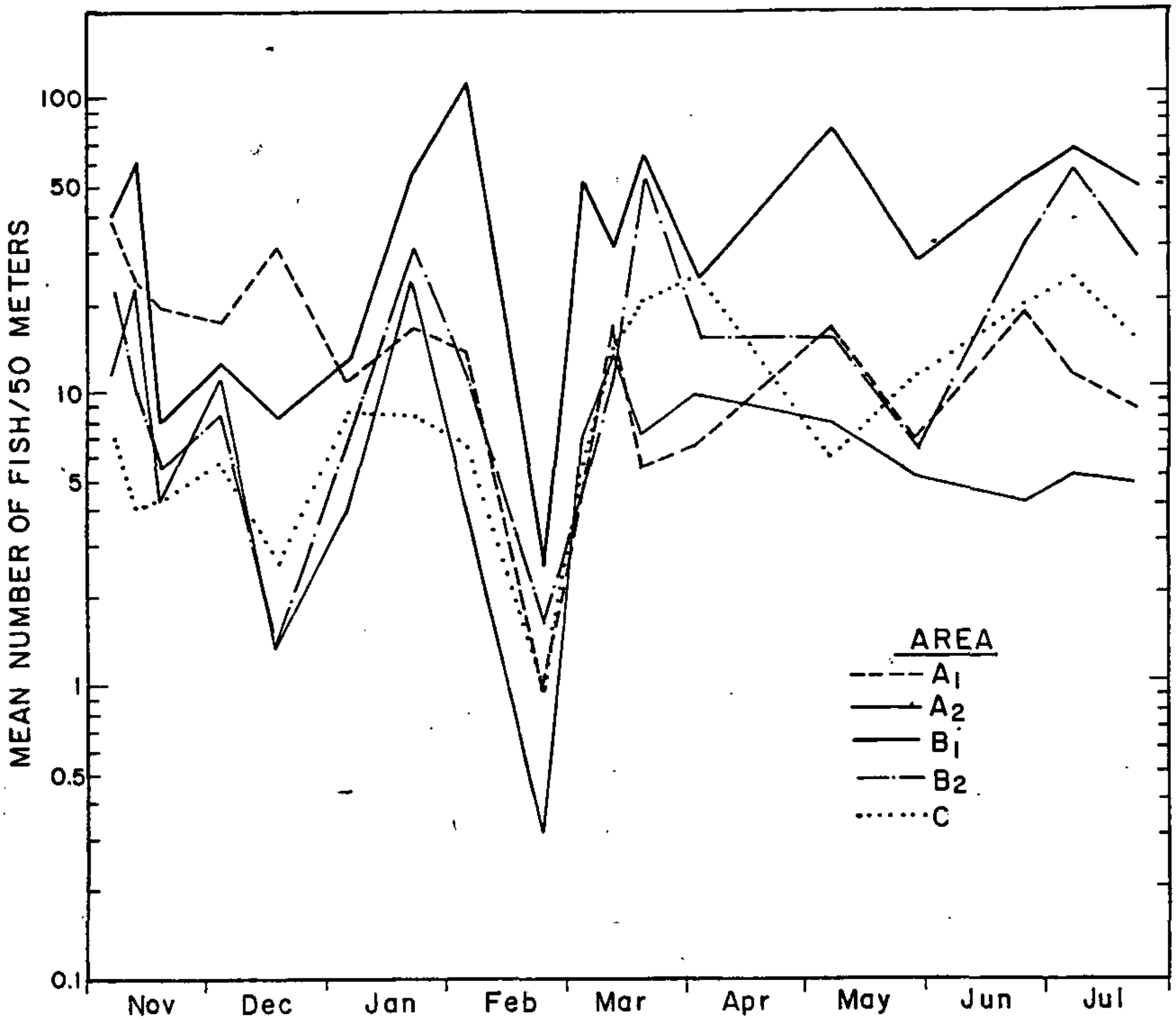

FIGURE 5.2-2. Mean number of fish, per 50-m transect, collected in areas of the Steel Creek swamp, November 1981 - July 1982

Subsequent to removing the nets on April 30, a small run of American shad was detected. Nineteen American shad were collected with electrofishing gear on May 6 and another 14 on May 11. Many shad were seen, but were not captured because of the swift current in lower Steel Creek. On May 12, no shad were captured and only two were seen, and by May 13 no shad were observed. The run was small and the fish occupied the river swamp for a short time. On May 6 a large striped bass was observed, but not collected in lower Steel Creek, near the swamp.[7]

Ichthyoplankton collections were taken on two dates (May 13 and May 21) following the run of American shad, however too few eggs or larvae were collected to determine whether the shad actually spawned. A total of two fish eggs and one larva were found in eight samples. Neither the eggs nor the larvae were identified because of the small sample size and poor condition of the specimens.[7]

Although the extent which blueback herring and American shad use the swamp for spawning is still unknown, the 1982 sampling provided some information on what areas of the Steel Creek system are used by these species. The majority of fish were collected in lower Steel Creek channel with some fish being collected from the fast water areas of the swamp. Loesch and Lund found that blueback herring preferred fast water areas for spawning sites.[8] It is likely that the locations of capture of clupeids this past year represent the preferred spawning areas in the Steel Creek system.[7]

Other migratory fish collected were the Atlantic needlefish and striped mullet, however only Atlantic needlefish were collected in the fyke nets. One Atlantic needlefish was captured in the swamp (Area A_1) by electrofishing on May 6. Although no striped mullet were found in the fyke nets, more than 40 were captured while electrofishing. Striped mullet were frequently observed jumping, in both the lower creek and the swamp; this species may jump over the nets rather than being channeled into them by the wings. The striped mullet appeared to concentrate in Areas A_2, B_2 and C and were never captured or observed in Area B_1.[7]

5.3 Savannah River Sports Fishing

The Fisheries Section of the Georgia Department of Natural Resources recently published the results (Table 5.3-1) of a fisheries study conducted on the Savannah River during the period 7/1/81-6/30/82.[6] The study consisted of a creel survey of sports anglers and an electrofishing study. Together these studies provide data on the fish species most sought by anglers and the probabilities of catching those species.

TABLE 5.3-1

Sports Fishing on the Savannah River below New Savannah Bluff Lock and Dam*

Number of trips	70,054 - 85,848
Number of hours	305,398 - 399,222
Number of fish caught	456,235 - 644,329
Kilograms of fish	86,585 - 120,779
Total anglers	3,006 - 6,164
Trips per angler	12 - 22

* Range is one standard deviation about the mean.

Anglers in the freshwater section of the Savannah River fish predominantly for bream and largemouth bass. Based upon electrofishing results, the relative abundance of bream in the freshwater section of the river is high as is the actual angler success rate. The lesser abundance of largemouth bass in the freshwater section results in a relatively low angler harvest of this species.

Anglers in the estuarine section of the Savannah fish predominantly for sea trout and striped bass. Electrofishing results indicate that these two species are not very abundant in the estuary. Actual angler success rates for these species are low.

5.3.1 Survey Methods

The Savannah River was divided into two sections for the studies — a freshwater section (river km 301.2 to 34.8 for creel surveys, km 301.2 to 40.2 for electrofishing) and an estuarine section (below river km 34.8 for creel surveys and 40.2 for electrofishing). The creel survey consisted of a roving survey in the estuary and an access point survey in the freshwater section. Both used nonuniform probability sampling. Survey periods consisted of two-week intervals. All but one weekend each month and three randomly chosen weekdays per week were sampled. Data on fishing effort, harvest, species sought, habitat or location fished, and angler origin were collected from sport anglers. The electrofishing study consisted of quarterly sampling at 38 permanent electrofishing stations (including alternate stations and creeks to be sampled on a rotating basis). The minimum number of these stations to be sampled each quarter was set at 28. The species, length, and weight of each fish captured were reported.[6]

5.3.2 Anglers

Approximately 4,600 anglers fish in the freshwater section of the Savannah River. Georgia residents comprise 68.2% of these anglers. The anglers fish in both the mainstream (58.2%) and the oxbows, creeks, and lakes (41.8%) of the Savannah. Preferred fishing methods are pole and line (88%), casting (11.4%) and trolling (0.6%).

Approximately 900 anglers fish in the estuarine section of the Savannah River. Again, Georgia residents predominate (97.7%). Most of the anglers fish in the Back River* (46.6%), the North Channel (22.2%) and the intracoastal waterway (16.5%). Two additional sections fished are the South Channel (8.4%) and the Middle River or New Cut (6.3%). The preferred fishing methods are pole and line (83.5%), casting (11%) and trolling (5.5%).

Figure 5.3-1 compares the freshwater angler fishing effort and relative harvest (catch) by fish species. Freshwater anglers spend the most time (43.8%) trying to catch fish in the bream category — i.e., bluegill, redbreast sunfish, warmouth, redear sunfish, and spotted sunfish. Bream account for 73% of the fish caught. Largemouth bass is the next most fished for species (38% of the time); however, success is low (2.5% of the fish caught). The fishing effort and relative catch of crappie, catfish, yellow perch, and shad are comparable. The fishing effort for striped bass is low (1.8% of the time) and harvest is even lower (0.2% of the fish). Although there is no fishing effort for chain pickerel, hybrid bass, or additional species, these represent 4.1% of the harvest.

Figure 5.3-2 presents the fishing effort and relative harvest of anglers in the estuarine section of the Savannah River. Most notable is the high-fishing effort for sea trout and striped bass (42.1% and 29.9% respectively, of the effort), and the low harvest of these two species (8% and 2.5% respectively). The red drum harvest is also less than the fishing effort. The harvest of additional species,** white catfish, croaker/spot, and silver perch far outstrips the effort expended upon these species. The fishing effort and relative harvest of flounder and hybrid bass are comparable.

Figure 5.3-3 presents the freshwater angler success rates (number/hr and kg/hr). The total success rate is 1.56 fish/hr, which represents 0.29 kg/hr. Anglers catch a greater number of bream, catfish, and crappie per hour than fish in the remaining species. The total weight of bream caught per hour is also greater than that of the other species.

Figure 5.3-4 presents the estuarine angler's success rates (number/hr and kg/hr). The total success rate is 0.81 fish/hr, which represents 0.24 kg/hr. The anglers catch lower numbers of striped bass, flounder, and hybrid bass per hour than other fish. The total weight of flounder, silver perch, and hybrid bass caught per hour is lower than that of the other fish. The angler fish catch rate in the estuary is less than that in the freshwater section; however, the weight of fish caught per hour in the two sections is comparable.

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* Defined as Corp of Engineers Tide Gate, Seaboard Coastline Railroad Trestle and other back-river sections.

** See Table 5.3-2 for list of species in "additional" category.

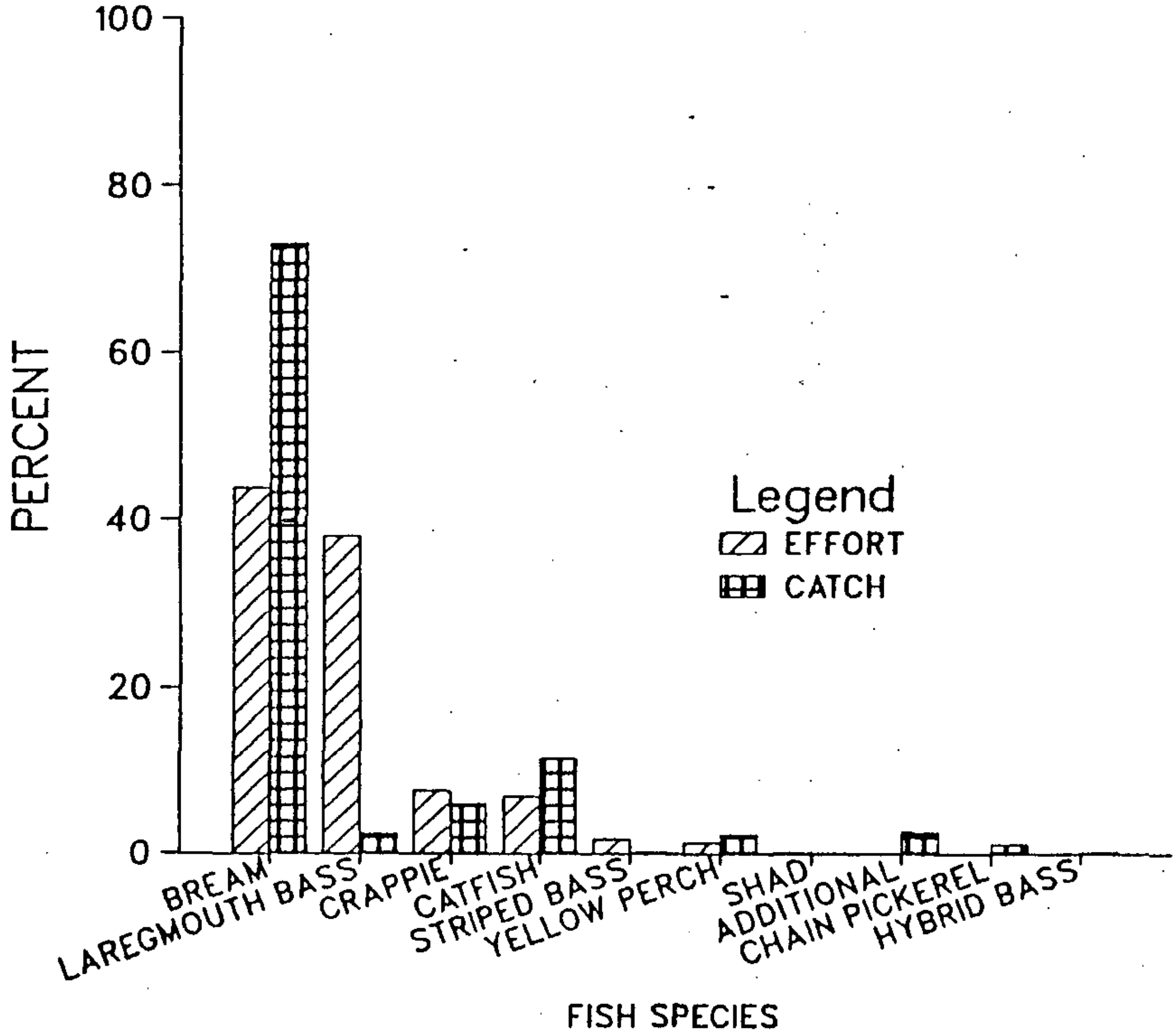

Figure 5.3-1. Comparison of freshwater angler relative fishing effort and fish harvest by species

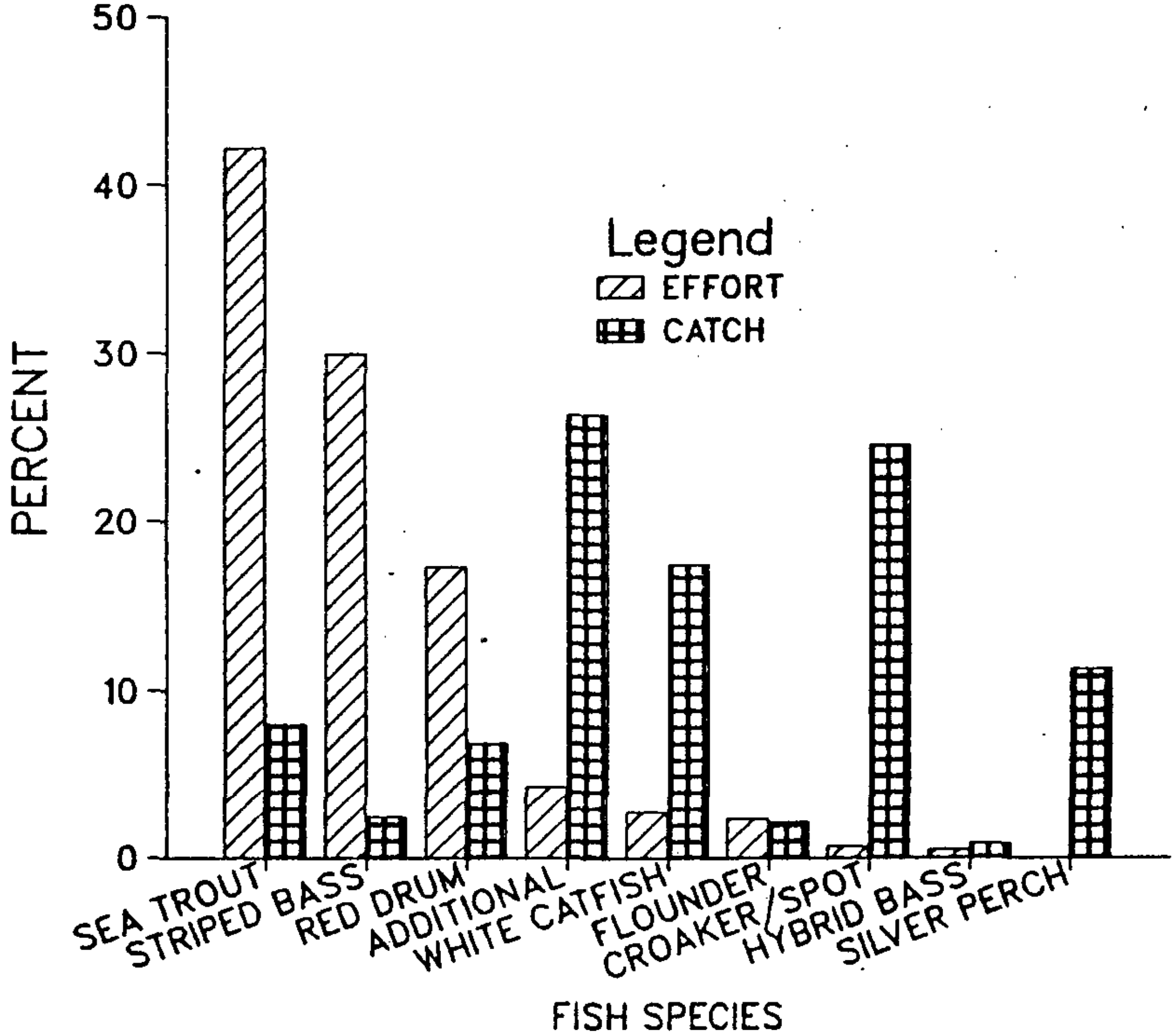

Figure 5.3-2. Comparison of estuarine angler relative fishing effort and fish harvest by species

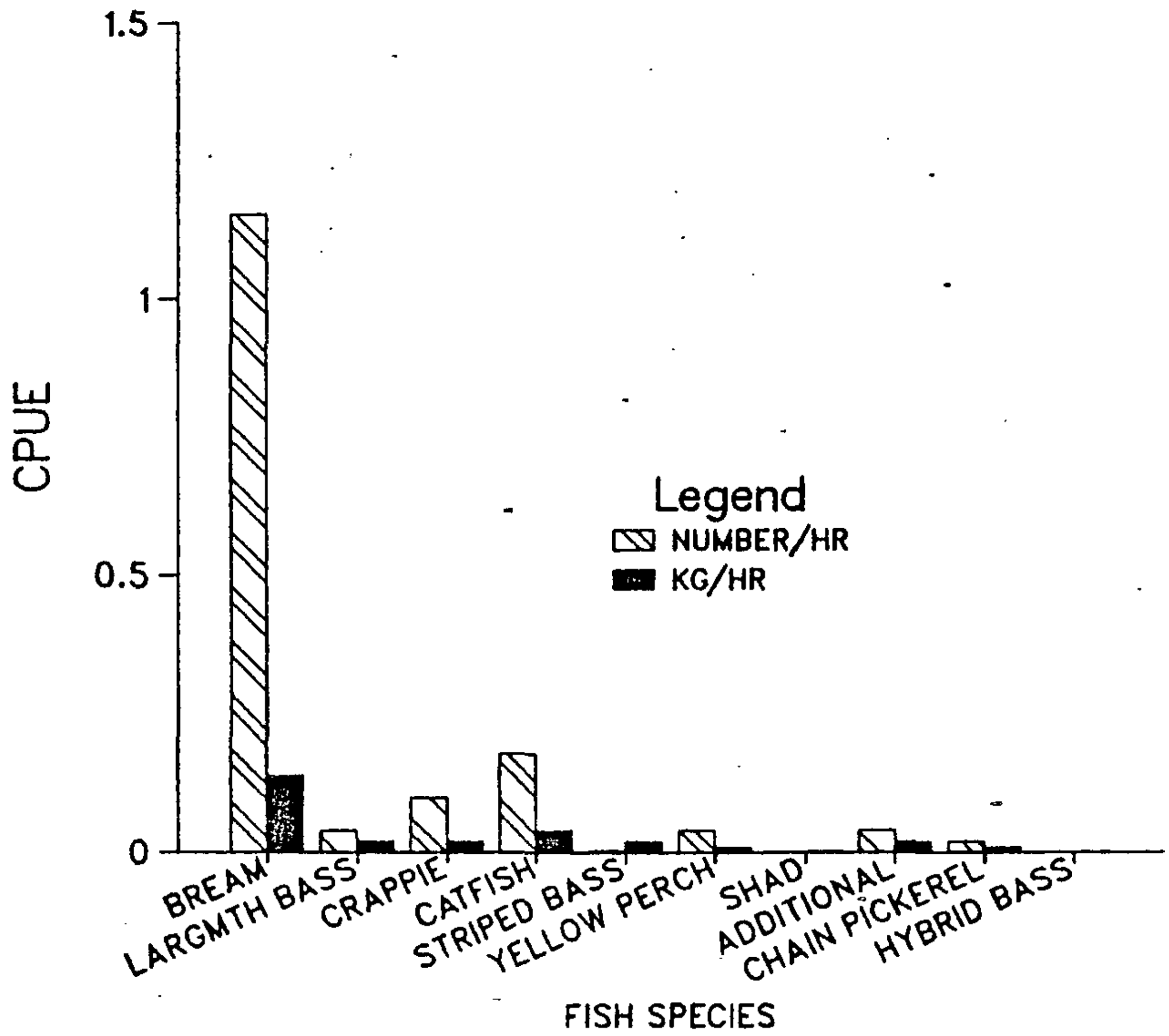

Figure 5.3-3. Freshwater angler catch rates and harvest rates by species

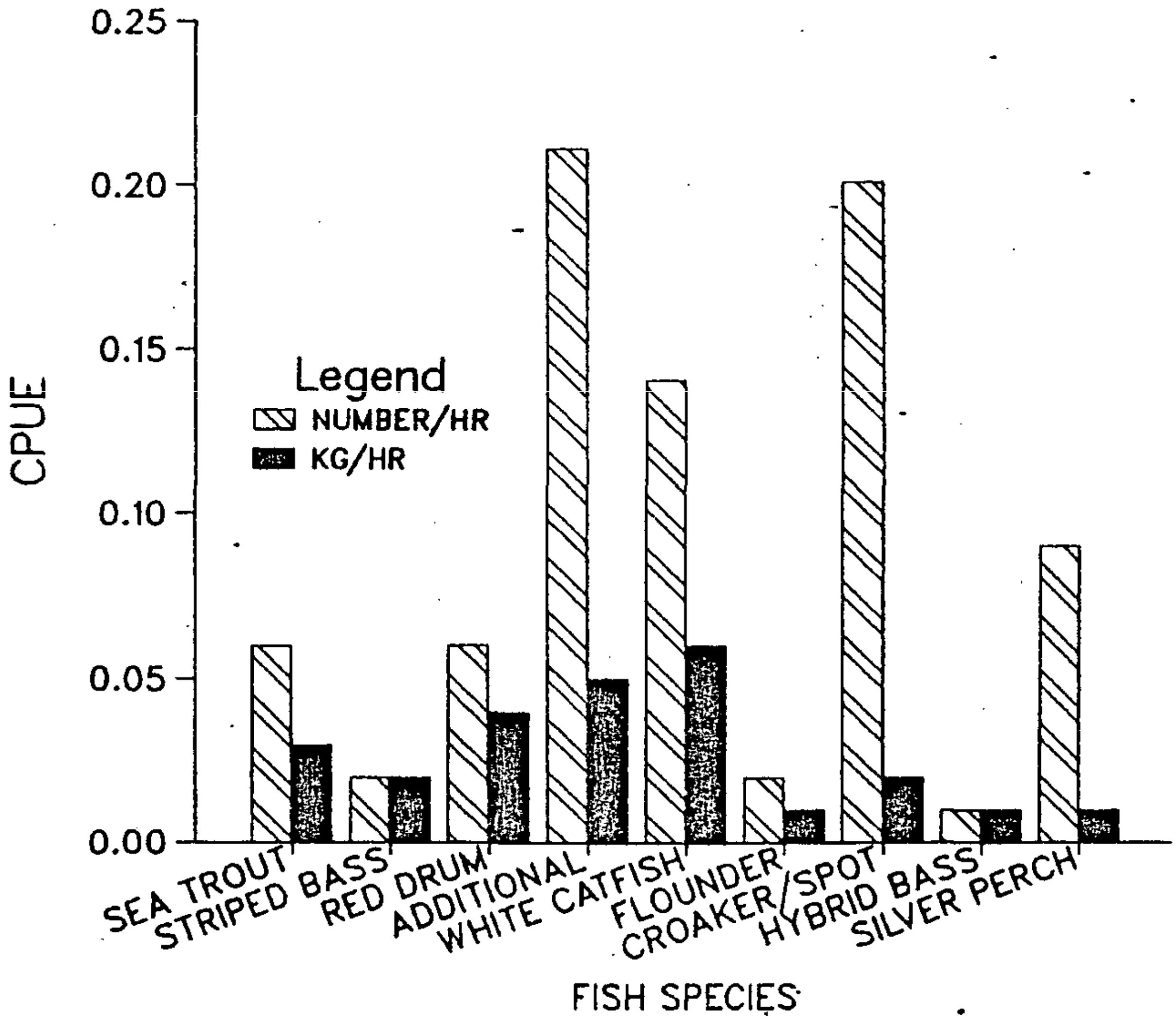

Figure 5.3-4. Estuarine angler catch rates and harvest rates by species

TABLE 5.3-2

Percent Composition of the "Additional" Category*

Estuary Species	Percent by Number	Freshwater Species	Percent by number
Channel catfish	22.7	Flier	34.5
Sea catfish	21.9	American eel	32.2
Striped mullet	15.2	Bowfin	19.1
American eel	9.3	Striped mullet	6.1
Bluefish	8.0	Golden shiner	3.1
Largemouth bass	5.5	Sucker	1.4
Black drum	3.4	Redfin pickerel	0.9
Toadfish	3.0	Spot	0.6
Black sea bass	2.5	Unidentified	0.6
Black crappie	2.1	Pumpkinseed	0.3
Gafftopsail catfish	1.7	Croaker	0.3
Stingray	1.3	Gar	0.3
Kingfish	1.3	Chubsucker**	0.3
Crevalle jack	0.4	White bass**	0.3
Ladyfish	0.4		100.0
Pigfish	0.4		
Shortnose sturgeon (endangered)	0.4		
Shark	0.4		
Sheepshead	0.025		
Atlantic sturgeon	0.025		
Bowfin	0.025		
Carp	0.025		
	100.00		

* The values in this table are based on unexpanded creel data, and should therefore be considered approximations.

** Although these fish do occur in the Savannah River, the possibility of misidentification by the creel clerk cannot be discounted, in view of the fact that no chubsuckers or white bass have occurred in electrofishing samples.

5.3.3 Electrofishing

Figure 5.3-5 presents electrofishing catch per unit effort (CPUE) (number/hr and kg/hr) for the freshwater section of the Savannah River. The total CPUE* for the freshwater section is 98.15 fish/hr, or 24.5 kg/hr. This CPUE is comparable to the CPUE reported in Section 5.1.3.4 for the SRP Biological Measurements Program. The catch rate of forage fish is the highest, and the predatory game fish catch rate is the lowest. The total weight of forage fish caught per hour is the lowest, while that of nonpredatory food fish is the highest. The eight most abundant species in the freshwater electrofishing samples were (in descending order) miscellaneous minnows, redbreast sunfish, striped mullet, spotted sucker, bluegill, gizzard shad, largemouth bass, and bowfin. The eight species comprising the greatest biomass in freshwater electrofishing samples were (in descending order) bowfin, common carp, spotted sucker, striped mullet, largemouth bass, silver redhorse, gizzard shad, and white catfish. The overall electrofishing catch rates in freshwater oxbow/creek habitats were higher than in the mainstream habitat.

Figure 5.3-6 presents electrofishing CPUE (number/hr and kg/hr) for the estuary section of the Savannah. The total CPUE for the estuary section is 70.24 fish/hr, or 46.74 kg/hr. The catch rates for nonpredatory food fish (both number/hr and kg/hr) are the highest. The catch rates for nonpredatory game and forage fish (both number/hr and kg/hr) are the lowest. In this section of the river, the eight most abundant species in electrofishing samples were (in descending order) the striped mullet, common carp, largemouth bass, bowfin, channel catfish, white catfish, spotted/Florida gar, and American eel. The eight species comprising the greatest biomass in estuarine electrofishing samples were (in descending order) the common carp, striped mullet, bowfin, striped bass, channel catfish, largemouth bass, spotted sea trout, and striped bass X white bass hybrid. The fact that the species which were most abundant or which comprised the highest biomass in estuarine samples where primarily freshwater species is indicative of the difficulties encountered in brackfish water electrofishing.

Electrofishing in the freshwater section resulted in higher CPUE (number/hr) than in the estuarine section. The biomass caught (CPUE, kg/hr) in the estuary was almost twice that of the freshwater.

Figure 5.3-7, presents freshwater electrofishing CPUE (number/hr and kg/hr) for the species of special interest to freshwater anglers, i.e., those species for which fishing effort

* Total CPUE for freshwater section is an area-weighted average of the mainstream and oxbow/creek CPUE.

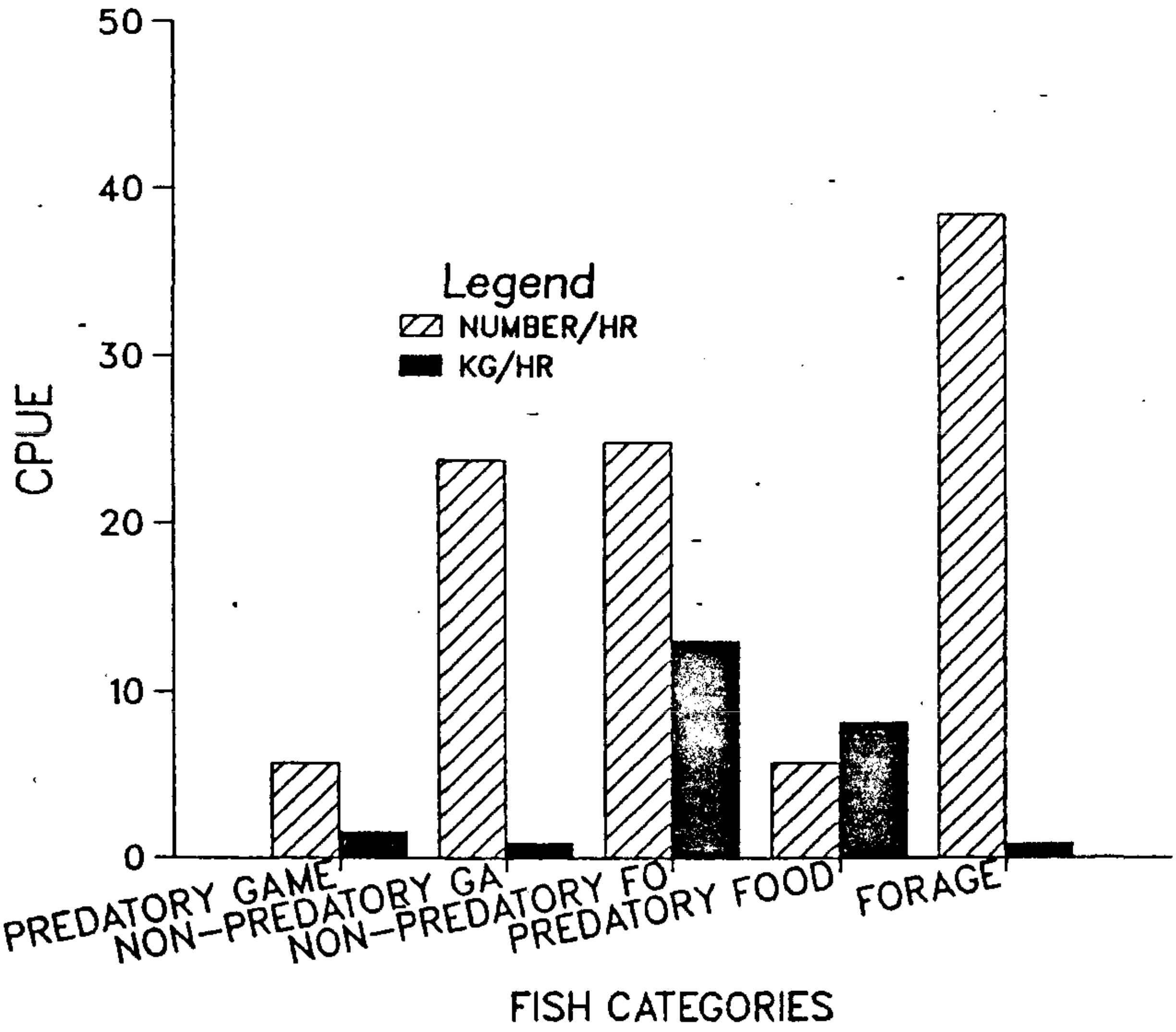

Figure 5.3-5. Freshwater electrofishing catch rates and harvest rates by fish category

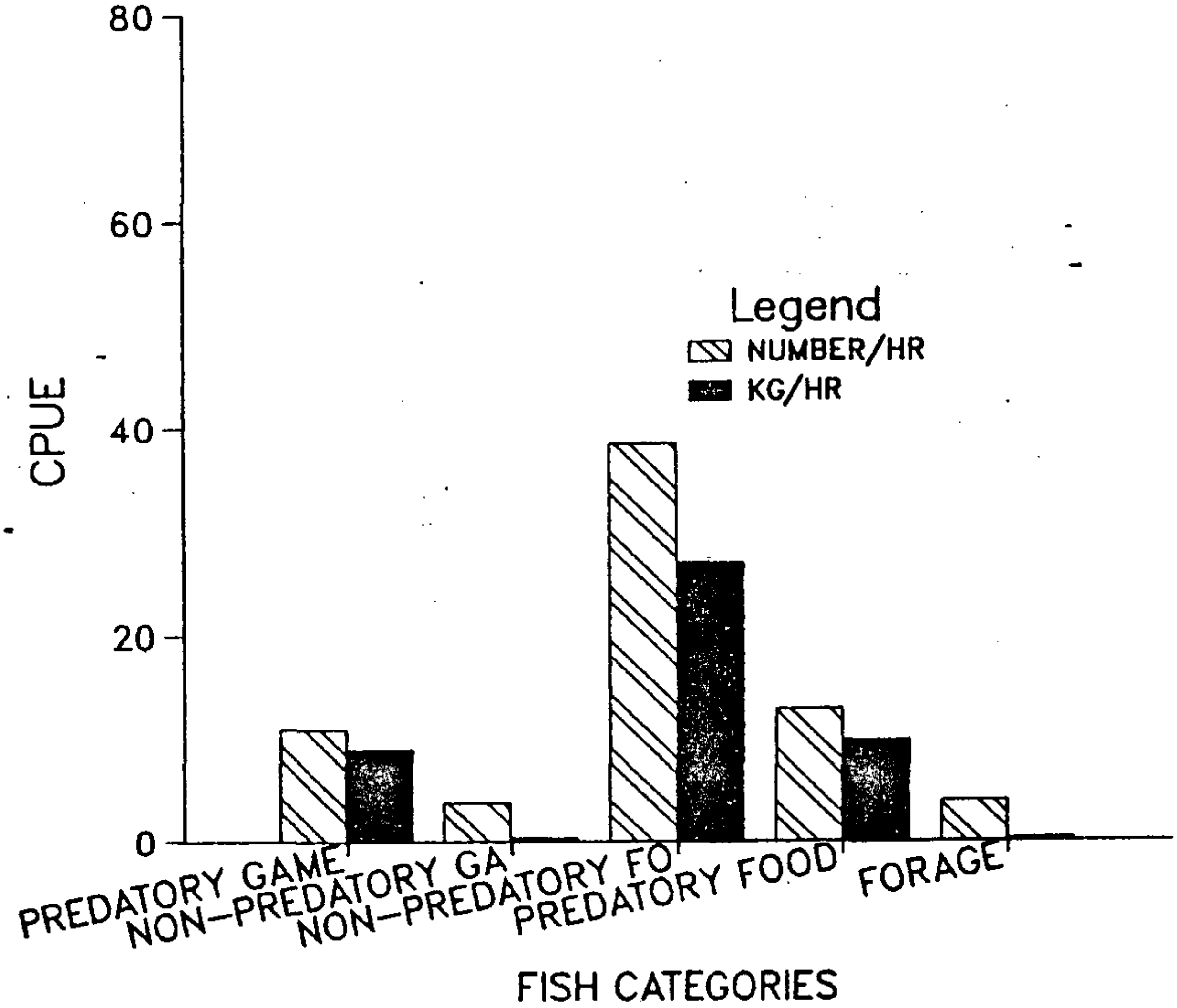

Figure 5.3-6. Estuarine electrofishing catch rates and harvest rates by fish category

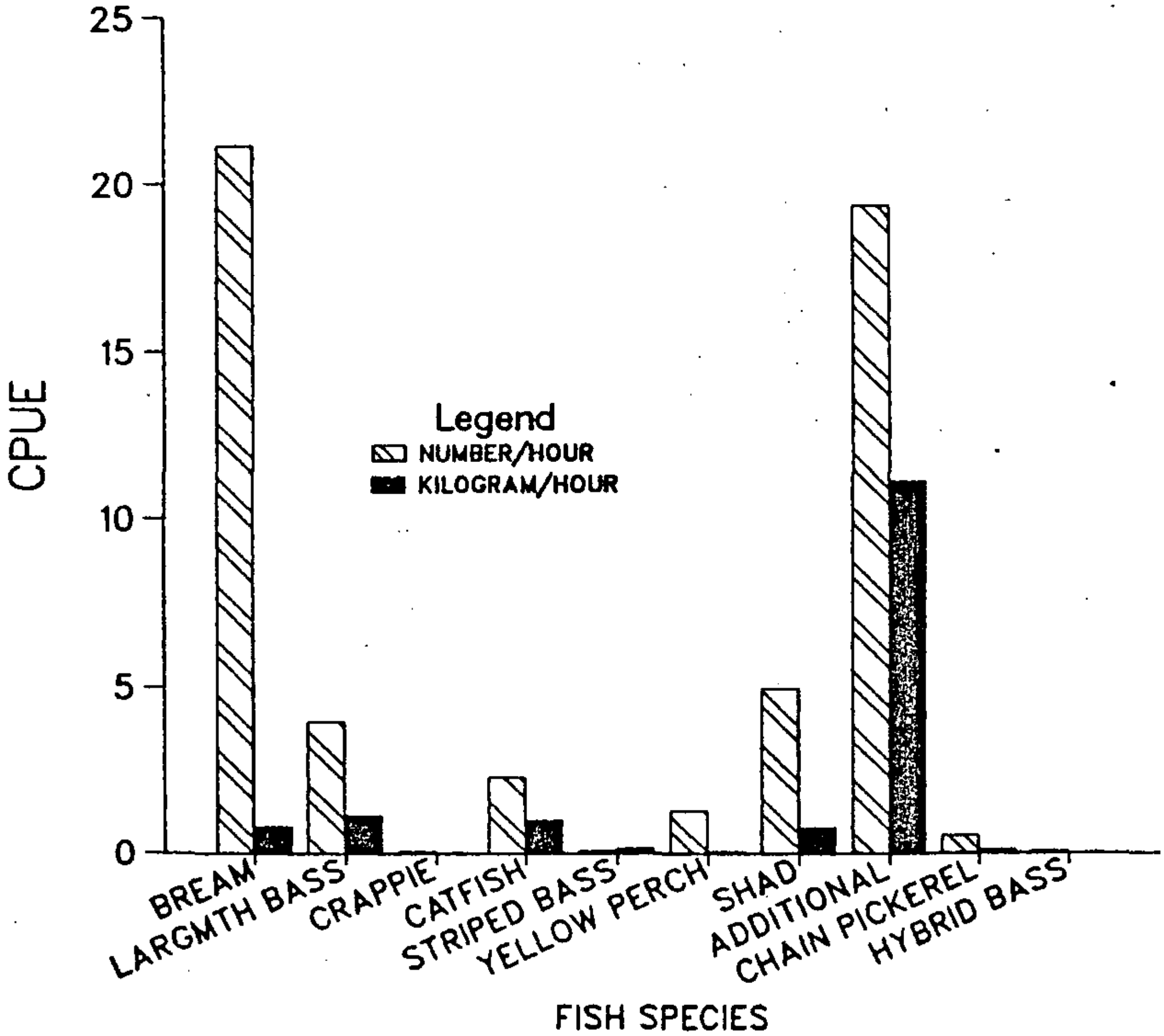

Figure 5.3-7. Freshwater electrofishing catch rates and harvest rates for fish species of interest to anglers

is high. The harvest rates (number/hr) for the bream and additional species categories are the highest. The additional species category also represents the highest sampling biomass harvest (kg/hr). Electrofishing CPUE provide a basis for the number of fish in the river which are available to anglers. Comparing angler success rates with the CPUE shows that anglers generally catch very few of the fish that are available. The angler success rates for crappie (number/hr) and biomass for catfish (kg/hr) are similar to the electrofishing CPUE of the freshwater section. The angler success rates for the other species range from 0.02% to 8% (number/hr) and 0.2 to 18% (kg/hr) of the respective electrofishing CPUE (Table 5.3-3).

The two most fished for species in the freshwater section are bream and largemouth bass. The angler harvest of bream is comparable to the effort expended; however, largemouth bass harvest is much less than its fished-for effort. Electrofishing results indicate bream is the most abundant species in the freshwater section. Largemouth bass is the third most abundant species; however, it is approximately an order of magnitude less than bream. Largemouth bass and bream represent the second and fourth greatest biomass catch rate (kg/hr) in electrofishing samples.

Figure 5.3-8 presents the electrofishing CPUE (number/hr and kg/hr) for the species of interest to estuarine anglers. The harvest rates (both number/hr and kg/hr) of fish in the additional species category are an order of magnitude above those of the other species. Comparing angler success rates with the electrofishing CPUE shows anglers catch few of the fish available. The angler success rate (kg/hr) for croaker/spot is 62% of its electrofishing CPUE. The success rates of the other species range from 0.2% to 12% (number/hr) and 0.2% to 14% (kg/hr) of the respective electrofishing CPUE (Table 5.3-4).

The two most fished for species in the estuarine section are the sea trout and the striped bass. Electrofishing results indicate sea trout and striped bass are not very abundant in the estuary — ranking eighth and ninth out of the 10 species of interest to anglers. Striped bass and sea trout represent the second and third largest biomass catch rate (kg/hr) in electrofishing samples. The lack of abundance of these two species indicate angler harvest will be low. This is supported by the actual angler success rates, which are low.

TABLE 5.3-3

Comparison of Freshwater Angler Success Rates to Electrofishing CPUE, %*

Fish Species	Number Basis	Weight Basis
Bream	5	17
Largemouth Bass	1	2
Crappie	−143	100
Catfish	8	4
Striped Bass	3	12
Yellow Perch	3	18
Shad	0.02	0.3
Additional species	0.2	0.2
Chain Pickerel	4	8
Hybrid Bass	1	10

* (Angler success rate/Electrofishing CPUE) x 100

TABLE 5.3-4

Comparison of Estuarine Angler Success Rates to Electrofishing CPUE, %*

Fish Species	Number Basis	Weight Basis
Sea Trout	5	2
Striped Bass	2	0.6
Red Drum	12	3
Additional	0.4	0.2
White Catfish	5	10
Flounder	0.2	14
Croaker/Spot	16	62
Hybrid Bass	6	0.8
Silver Perch	-	-

* (Angler success rate/Electrofishing CPUE) x 100

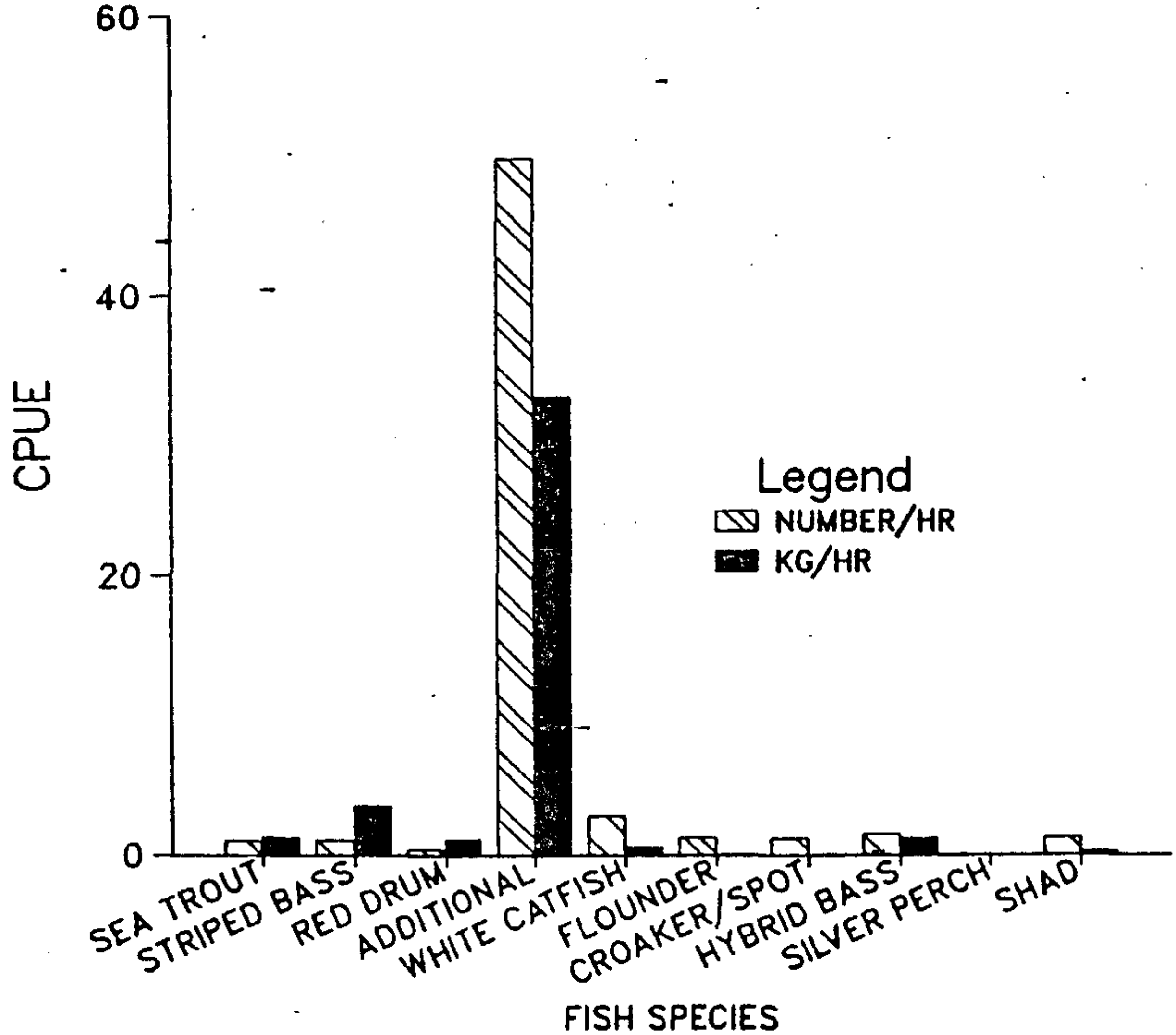

Figure 5.3-8. Estuarine electrofishing catch rates and barvest rates for fish species of interest to anglers

5.4 Temperatures in the Vicinity of Boggy Gut Creek

The mouth of Boggy Gut Creek is located about 0.3 miles downstream of the mouth of Steel Creek on the South Carolina side of the Savannah River. This small offsite creek has about 231 acres of wetlands adjacent to the creek and flows across Creek Plantation Swamp before entering the Savannah River. Its flow rate is probably only a few cubic feet per second. Temperatures and temperature profiles for the Savannah River were calculated at low flow (6200 cfs) during the major spawning months of March through June and for L Reactor discharging or K and L Reactors both discharging. Profiles at this low flow rate would represent conservative conditions since river flows tend to be closer to or above the average river flow of 10,400 cfs in the spring. The temperatures in Figure 5.4-1 indicate that this minor tributary to the Savannah River could be blocked by the thermal plume during the spring spawning period (Figure 5.1-3) when temperatures near the Boggy Gut Creek mouth exceed typical spawning temperatures for anadromous fish in the Savannah River.[1] Figures 5.4-2 and 5.4-3 indicate that a zone of passage still remains on the Georgia side of the river near Boggy Gut.

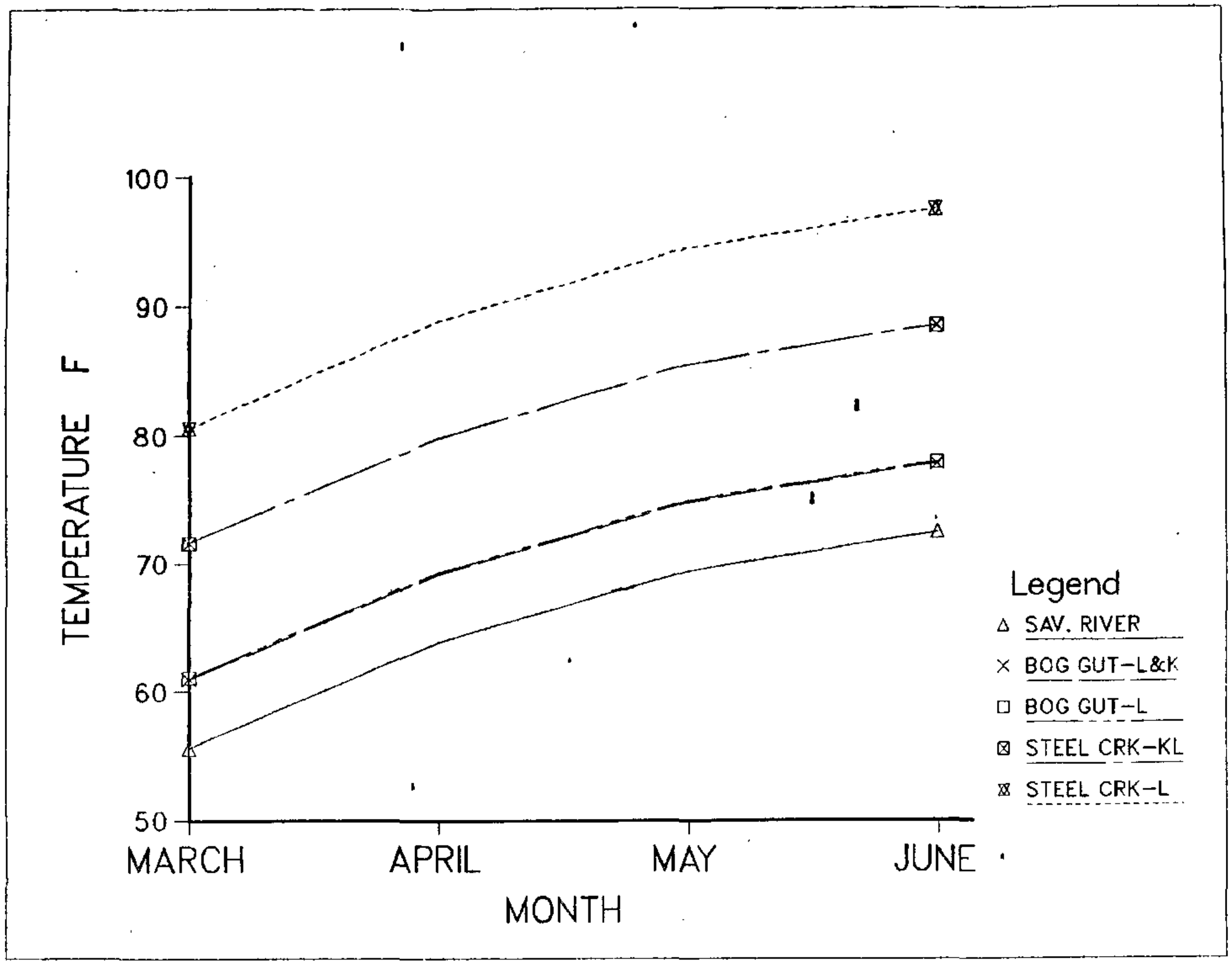

Figure 5.4-1. Monthly water temperatures for the Savannah River, the Steel Creek mouth (L-Reactor operating), the Steel Creek mouth (K and L-Reactors operating), and Boggy Gut Creek area with either L Reactor or both K and L-Reactors operating

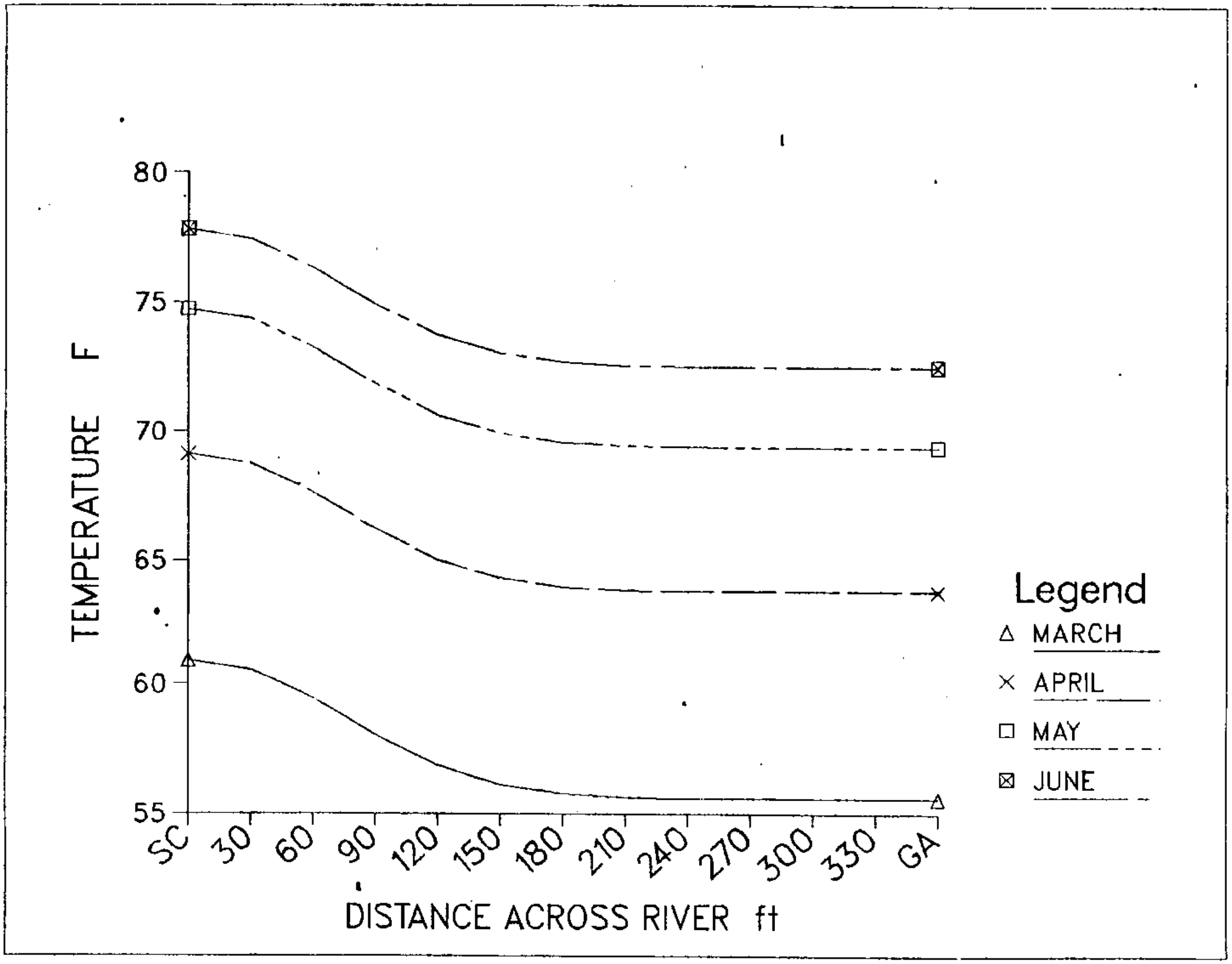

Figure 5.4-2. **Temperatures across the Savannah River in the vicinity of Boggy Gut Creek with L-Reactor operating**

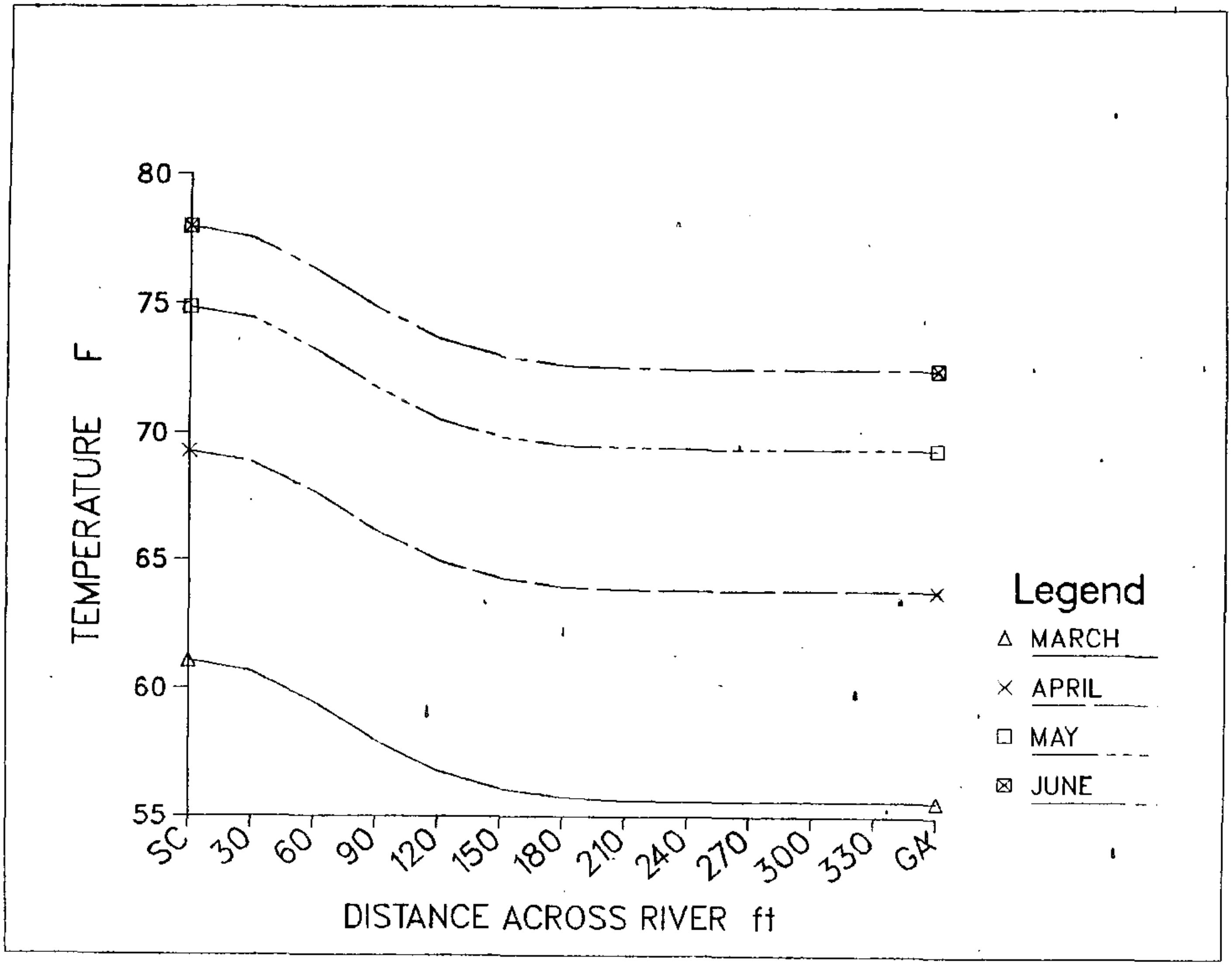

Figure 5.4-3. **Temperatures Across the Savannah River in the vicinity of Boggy Gut Creek with L and K-Reactors operating**

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5.5 REFERENCES

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6. MITIGATION AND MONITORING

The environmental monitoring program for L-Reactor Restart will monitor both routine radionuclide releases from L Area and the potential effects of once-through cooling water effluents. Cooling water effects will include both onsite and offsite monitoring related to cooling water withdrawal including impingement and entrainment of fish and icthyoplankton, the thermal plume in the Savannah River at the Steel Creek mouth, wetlands effects including the biota of the Steel Creek area, and cesium-137 transport and redistribution.

6.1 Biological Measurements Program — Savannah River

The objective of the SRP biological measurements program is to provide additional data to evaluate the effect of L-Reactor startup on the aquatic ecology of the Savannah River adjacent to the SRP. Initial emphasis of the program was on fish impingement and icthyoplankton entrainment, primarily near the cooling water intake canals. Emphasis was also placed on quantifying the thermal effects of L-Reactor startup; therefore, collection stations were established near and in the mouths of Upper Three Runs Creek, Four Mile Creek, and Steel Creek. An interim report describing results of the first three months of the program was issued in the fall of 1982.[1] The first semiannual report was issued in the spring of 1983.[2] Data from these reports are summarized in Section 5.1.

The scope of the fisheries program (Table 6.1-1) has been expanded to monitor not only L-Reactor effects, but the effects of SRP operating reactors in a comprehensive manner as prescribed in Sections 316 (a) and (b) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). A Section 316 (a) type study evaluates the potential thermal effects of cooling water discharges in nearfield (near SRP) and farfield (more remote from SRP) areas of the Savannah River. A Section 316 (b) type study evaluates nearfield impingement and entrainment effects of the cooling water intake. The expanded program will address the additional 316 (b) requirements and the farfield 316 (a) requirements as they relate to SRP operating reactors.

The primary objective of the farfield study will be to evaluate fish spawning in the Savannah River from Augusta to near the coast and in 28 tributaries of Savannah River. This farfield program will provide spawning habitat information for fish such as

TABLE 6.1-1

Biological Measurements Program on the Savannah River*

I. Nearfield Monitoring Program

A. Sample Collection Stations (14)

- near or in the pumphouse intake canals
- mouth of tributaries UTRC, FMC, SC
- above and below tributaries UTRC, FMC, SC

B. Sample Collection Frequency

- icthyoplankton — biweekly (1982) or weekly (1983) (February - July)
- adult fish populations — quarterly
- macroinvertebrates (fixed samplers) — monthly
- impinged fish — 100 times/year

II. Three-Year Monitoring Program

A. Program in I Above

B. Additional Nearfield Studies (Phased in February 1, 1983)

- icthyoplankton at BDC and LTRC
- adult fish at BDC and LTRC
- macroinvertebrate (fixed samplers) monthly at UTRC, BDC, and LTRC
- sex and breeding condition of impinged fishes
- determine periphyton taxa near all tributaries
- *macroinvertebrate drift (plankton) at all stations*

C. Farfield Studies (Phased in February 1, 1983)

Weekly icthyoplankton samples will be collected from February to July between Augusta and Savannah (River Mile 40) at stations located in:

- Savannah River every 10 miles
- mouths of 28 tributaries

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* Creeks

UTRC — Upper Three Runs Creek
FM — Four Mile Creek
SC — Steel Creek
BDC — Beaver Dam Creek
LTRC — Lower Three Runs Creek

the blueback herring and American shad. These data will permit a comparison of the importance of offsite and onsite streams for fish reproduction.

The program for the 316 (a) and (b) type studies is outlined in Table 6.1-1 and in Appendix I. All or part of the expanded program may be extended through 1985 to ensure completeness. To characterize the spawning season prior to L-Reactor restart, the expanded program began in early February 1983.

6.2 Thermal Plume Monitoring — Savannah River

Temperature and flow will be measured by the United States Geological Survey (USGS) at the locations given in Table 6.2-1. Thermal plume dimensions (surface and cross-sectional area) will be measured quarterly (winter, spring, summer, and fall) in the Savannah River below Beaver Dam Creek, Four Mile Creek, and Steel Creek mouths. Daily temperature measurements and flow data will be evaluated monthly to determine continued compliance with NPDES permit requirements.

Biological studies outlined in Section 6.1 will examine fish use and condition in and near the plumes. Fixed bottom samplers will be used to evaluate effects on macroinvertebrate within plume areas (Table 6.1-1 and Appendix I).

TABLE 6.2-1

Temperature and Flow Measurements Near SRP

Location	Temperature	Flow
1. Jackson, River Mile 156.8	X	X
2. Beaver Dam Creek Mouth	X	-
3. Four Mile Creek Mouth	X	-
4. Hattieville Bridge on Steel Creek	-	X
5. Steel Creek Mouth	X	-

6.3 Wetlands

6.3.1 American Alligator

The inland South Carolina population of American alligator is federally listed as endangered (Sections 4.3.1 and 7.5.1). Studies begun in 1980 indicate that there are approximately 25 alligators inhabiting the Steel Creek area; both juveniles and adults have been observed.[3-5] Radiotelemetric studies have been conducted on adult male and female alligators in the Steel Creek corridor and delta to evaluate their behavior and movements (Section 4.3.1). Consultation with the U.S. Fish and Wildlife Service in the fall of 1982 outlined several steps to mitigate potential effects of L-Reactor startup on the Steel Creek alligator population (Appendix K).

Fall is considered to be the optimal time for startup because eggs from nests in the area would have hatched and juvenile alligators would be sufficiently mobile to escape direct thermal discharges. Also, it is prior to the onset of colder winter temperatures, when torpid individuals wintering along Steel Creek or in the delta might not arouse in time to escape potentially lethal water temperatures. Two lagoons (backwater areas) adjacent to SRP Road A (Highway 125), in which both juveniles and adults have frequently been observed, have been protected from thermal effluent by repair of three small breaks in berms between the lagoons and Steel Creek (Figure 6.3-1). In addition, the Steel Creek corridor will continue to be monitored to assess effects upon the alligator population. Radiotelemetric studies which have already been initiated with adult alligators will continue at least through the winter following L-Reactor restart to determine the response of the Steel Creek alligator population to the startup.

6.3.2 Wood Duck

The restart of L-Reactor will make 27 wood duck nest boxes in Steel Creek and Steel Creek Delta (lines F, G, H, F; Figure 6.3-2) unsuitable for use because they are located in aquatic habitats where water temperatures will be elevated. Wood ducks laid eggs in 11 of these 27 boxes in 1982.[5] Possible mitigation of the loss of these nesting sites could include erection of additional nest boxes in suitable habitats in the vicinity of Steel Creek.

Data from previous studies indicate that wood ducks readily colonize new boxes if they are placed in suitable habitats.[5] When nest boxes were first erected along Steel Creek and in Steel Creek Delta in 1973, 26% of the boxes were used in the first year and 68% were occupied by the third year.[6] A nest box erected in Steel Creek Bay (a Carolina bay adjacent to Steel Creek) in 1982 was used by

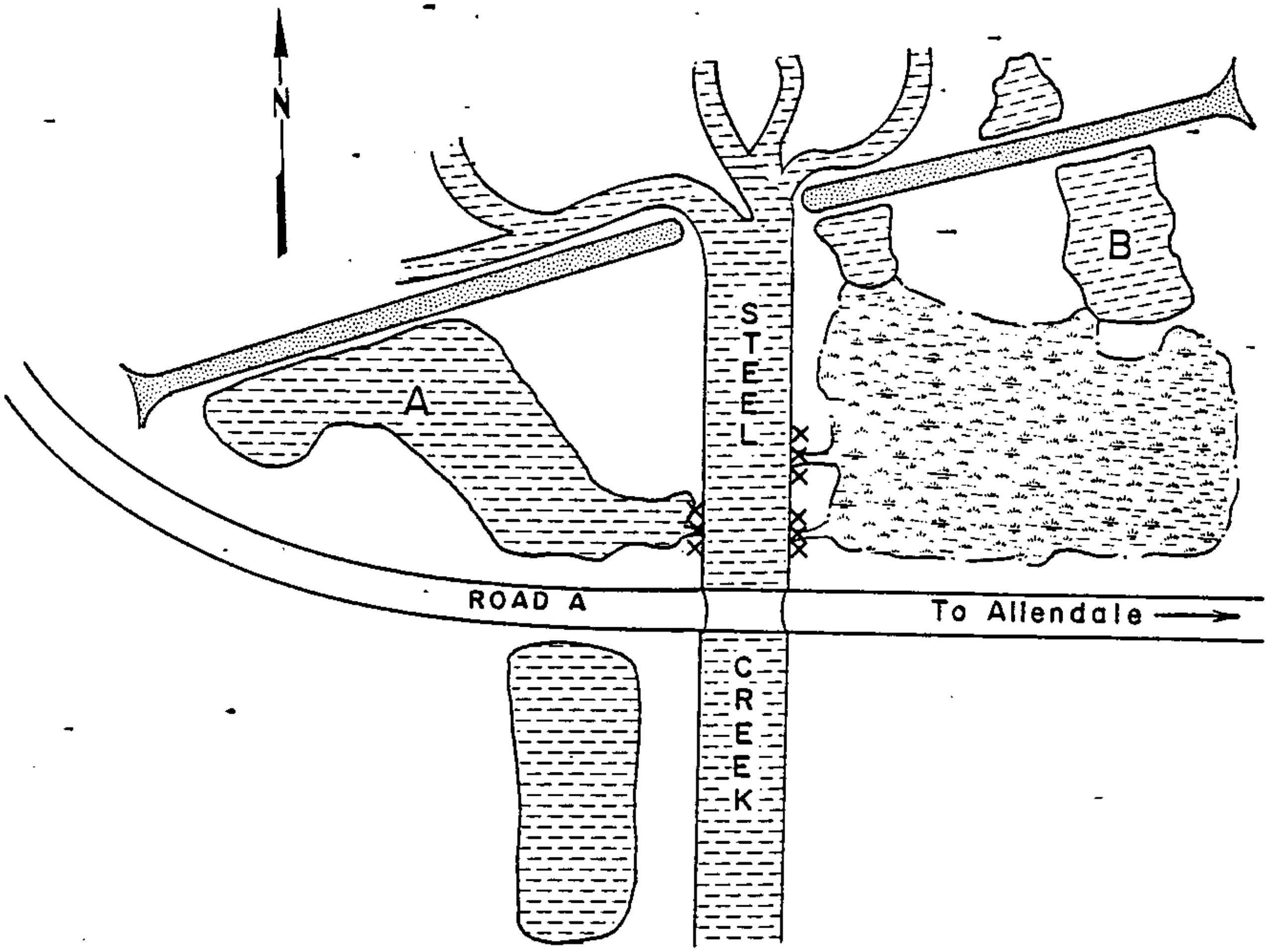

Figure 6.3-1. Lagoons at SRP Road A, showing location of breaks in the berms which have been repaired

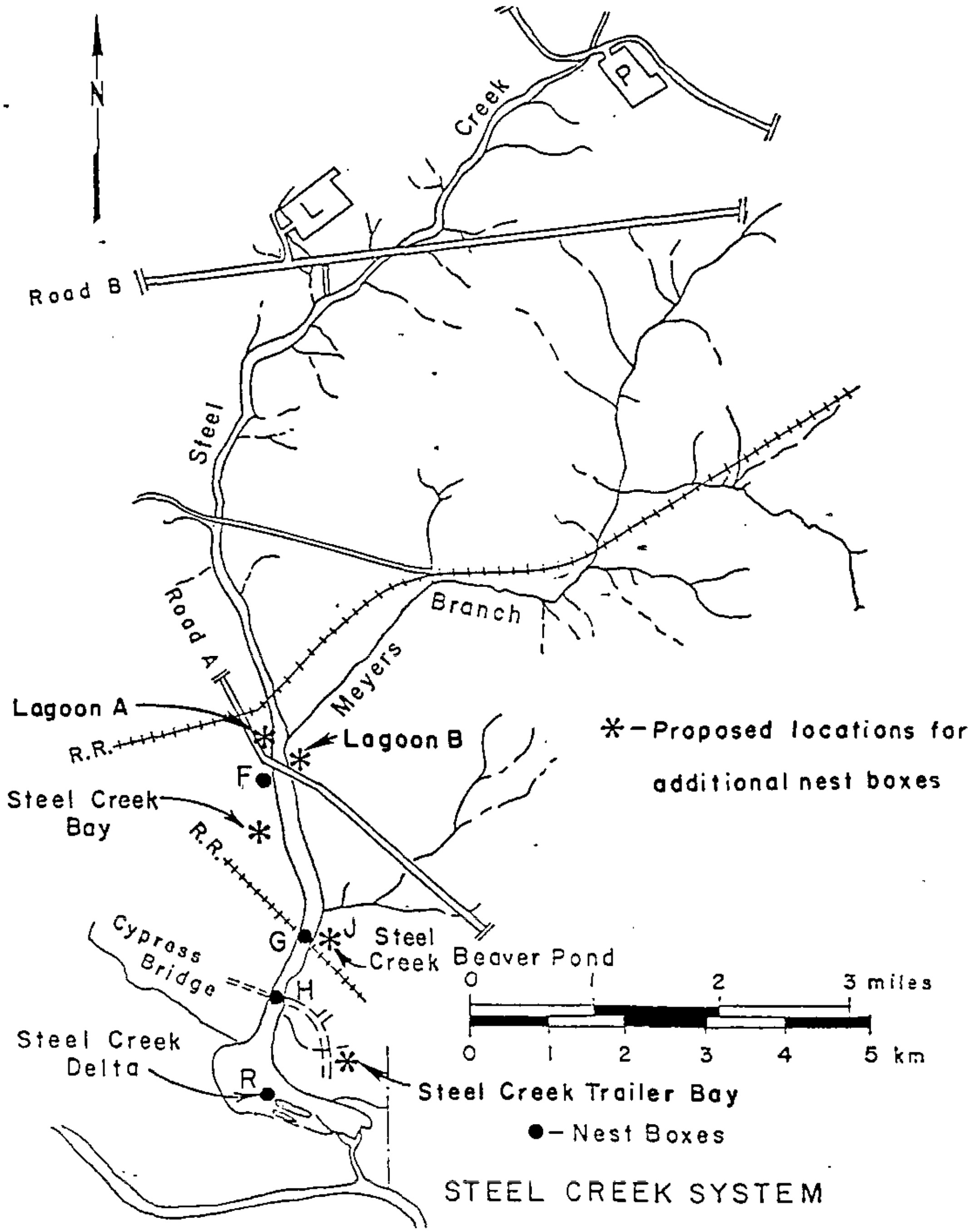

Figure 6.3-2. Location at each line of wood duck nest boxes in the Steel Creek drainage system during 1979-1982 and proposed locations for additional boxes

two different female ducks in that year and resulted in the production of 16 ducklings. These ducks were probably two-year olds hatched from eggs in one of the Steel Creek boxes that were nesting for their first time.[5]

Female wood ducks that have previously nested usually return to the same line of nest boxes and often to the same box in subsequent years. However, there has been some interchange of ducks between lines of nest boxes in Steel Creek. Of 13 female wood ducks that were banded and recaptured in successive years in Steel Creek boxes, three have changed lines. In one case, a female nested in a box in Steel Creek Delta (line R) in 1979, but then moved to the Steel Creek Beaver Pond (line J) in 1980 and 1981. The distance between these two lines is approximately 2 km. In the other two cases, the interchange was between the Steel Creek Railroad Trestle (line G) and the Steel Creek Beaver Pond (line J), a distance of approximately 300 m. These observations suggest that new boxes erected in suitable habitats should be used by female wood ducks nesting for the first time and possibly by females that have previously nested in Steel Creek once that habitat is lost.[5]

Suitable habitat in which new boxes could be placed is available in five areas adjacent to Steel Creek (Figure 6.3-2). These areas and the proposed number of boxes to be placed in each are listed in Table 6-3. The proposed boxes have been erected and will be monitored for use by wood ducks for two years following L-Reactor restart.

TABLE 6.3-1

Potential Wood Duck Mitigation Areas and Proposed Number of Nest Boxes to be Placed in Each

Areas	Number Boxes
Steel Creek Bay	15
Steel Creek Trailer Bay	15
Lagoon A	5
Lagoon B	5
Steel Creek Beaver Pond	5
Total	45

6.3.2 Wood Stork

The wood stork has been proposed for listing as an endangered species by the U.S. Fish and Wildlife Service.[7] Individuals and small groups of birds have been observed during 1981 and 1982 roosting and feeding in the Steel Creek Delta area.[5] No nesting has been reported on the SRP. The nearest rookery is located 28 miles southwest of SRP at Millen, Georgia, within the feeding range of this species. The thermal effluents from L Reactor would eliminate potential feeding habitat in the Steel Creek Delta for this wading bird.

Both aerial and ground surveys will be used to define the use of the SRP swamp system and any nearby rookeries, including the Millen rookery. In addition, use of other feeding areas by the Millen wood stork population will be evaluated. Previous survey information,[5] along with these expanded studies, will be used to formulate a biological assessment and support consultation with the U.S. Fish and Wildlife Service.

6.3.3 Wetlands Effects

Discharge of once-through cooling water from L Reactor is expected to effect about 1000 acres of the Steel Creek floodplain and associated biota. Additional wetlands habitat is expected to be modified at a rate of 7 to 10 acres per year due to the thermal discharges. The wetlands area effected and the growth rate will be monitored initially with both ground surveys and remote sensing. The ground surveys will be directed toward measuring the extent of effects on Representative and Important Species (Table 6.3-2) selected from previous survey results[3-5] and by regulatory requirements. Remote sensing will be used to evaluate changes in vegetation patterns over larger survey areas and to estimate delta growth rates.

6.4 Archeology

The archeological survey of the Steel Creek area is summarized in Reference 8. With the reactivation L Reactor and the flooding of the Steel Creek floodplain by thermal effluent, the major effect will be the possible erosion of terrace edges.

Since exact water levels resulting from discharge from the L-Reactor operation were not available at the time the archeological study began, the entire floodplain and terrace edge zones along Steel Creek from L Area to the Steel Creek Delta were examined. A combination of field survey and aerial photographic survey was employed to determine the presence of archeological

TABLE 6.3-2

Representative and Important Species for L-Reactor Environmental Monitoring Studies

Species		Organization: Savannah River Ecology Laboratory	Organization: Savannah River Laboratory
Plants			
Bald cypress	(Taxodium distichum)	X	--
Water tupelo	(Nyssa aquatica)	X	--
Invertebrates			
Caddis flies	(Trichoptera, Hydropsychidae)	X	--
Fish			
Shiner	(Notropis spp.)	X	--
Mosquito fish	(Gambusia affinis)	X	--
Largemouth bass	(Micropterus salmoides)	X	--
Blueback herring	(Alosa aestivalis)	X	X
American shad	(Alosa sapidissima)	X	X
Striped bass	(Morone saxatilis)	X	X
Shortnose sturgeon	(Acipenser brevirostrum)	--	X
Reptiles			
American alligator	(Alligator mississippiensis	X	--
Pond slider	(Pseudemys scripta)	X	--
Brown watersnake	(Nerodia taxispilota)	X	--
Birds			
Wood duck	(Aix sponsa)	X	--
Prothonotary warbler	(Pronotaria citrea)	X	--
Wood stork	(Mycteria americana)	X	--

resources. Projected water levels were approximated using a set of aerial photographs taken during 1961 that illustrate water levels during a period when both L and P Reactors were discharging into Steel Creek. The water levels in these photographs indicate the maximal flood limits within the floodplain and the potential areas of erosion relative to archeological resources.

The four historic floodplain sites (38BR112, 38BR269, 38BR286, and 38BR288, Figure 6.4-1) are earthen structures in the floodplain and would be subject to the increased water flow. Each site was inspected to determine the amount of erosion from previous flooding. No erosion was noted because the tree and vegetation cover on the features seemed to stabilize the effects of erosion by holding the compacted fill together, preserving the dams and roadway. The vegetation cover on the four features prohibits excessive erosion and should remain intact.

A prehistoric site (Site 38BR55) at the confluence of Steel Creek and Meyers Branch, is in close proximity to the floodplain (Figure 6.4-1). The aerial photographs of high water levels illustrate the presence of water adjacent to the terrace edge. The site extends for almost 600 m along the terrace edge. Although no direct evidence of adverse erosive was noticed during field inspections at the site, the site should be inspected monthly to determine the amount of erosion once L Reactor restarts.

The archeological resources along Steel Creek below L Reactor have the greatest potential for adversity from erosion. Since no direct evidence of prior erosion at the sites has been observed, erosion may not result from the discharge associated with L-Reactor reactivation. *For this reason, a mitigation plan for* the five sites (38BR55, 38BR112, 38BR269, 38BR286, and 38BR288) is recommended as follows:

Monitoring

Monitoring would be the only action required if erosion along the floodplain and terrace edge are restricted to areas impacted during previous discharges to Steel Creek. It is not expected that Steel Creek will be subjected to water levels in excess of those during the 1960s when two reactors discharged thermal effluent into the stream. As an initial protective measure, each of the five sites will be monitored by the Institute of Archeology and Anthropology, University of South Carolina, on a monthly basis during the first two years of the L-Reactor operation to determine whether erosion occurs.

The four floodplain sites (38BR112, 38BR269, 38BR286, and 38BR288) should be allowed to remain exactly as they exist at present. No vegetation should be removed from the earthen

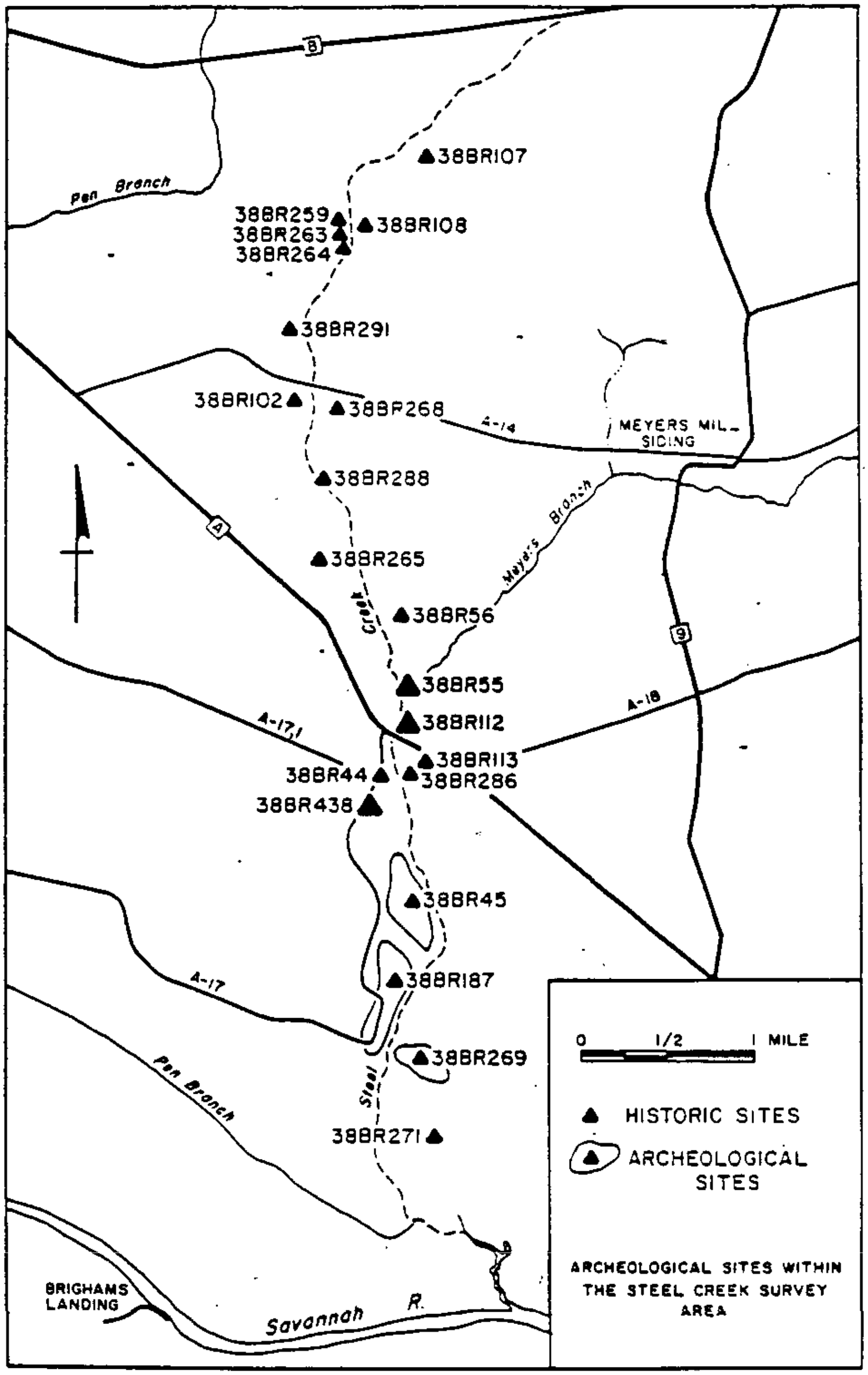

Figure 6.4-1. General map of the Steel Creek area showing archeological site locations

structures so that erosion will be minimal. Monitoring should consist of the placement of control stakes along the upstream edges of the structures and the monthly checking of the structures for erosion. In the event that erosion begins to remove segments of the sites, the active protection of the structures would become necessary requiring the implementation of the second stage. If no erosion is evident at the end of the two year monitoring period, then the sites should be considered sufficiently protected to assure preservation.

Site 38BR55, which is situated on the terrace of Steel Creek, should be monitored in a manner similar to that employed at the four floodplain sites. It is recommended that 10 staked lines be placed at 50 m intervals perpendicular to the terrace edge in order to measure the occurrence of any erosion along the western edge of the site. Further, no vegetation along the terrace edge should be removed so that the terrace edge is not unnecessarily subject to erosion. The root systems of the trees should fortify the terrace edge and aid in protecting the site from adverse erosive activity. Monitoring of the site should be conducted on a monthly basis over the same two year period as the other sites. As with the other sites, active erosion protection will be required in the event that adverse erosion threatens the integrity of the site.

Erosion Protection

If any of the sites show adverse effects due to erosion, it would be necessary to control the problem through some form of stabilization. The most reliable method would be the installation of erosion resistant barriers along the eroding surface. Such barriers should be suitable to protect the site for the entire duration the reactor will be operated. The barriers are likely to control erosion, and therefore protect the sites from any further erosion.

Data Recovery

Data recovery would be required only in the event that the erosion barriers were not able to control adverse effects on the sites. In the case of the floodplain sites, data recovery would involve the detailed mapping of the structures and partial excavation in the areas where the mill houses were placed. At 38BR55 data recovery would require excavation of the area along the terrace edge to obtain the prehistoric information within the site. As mentioned, the probability of data recovery becoming necessary is low, given the fact that previous water levels in the floodplain did not affect the site.

6.5 Radiological Monitoring

Several radiological monitoring programs will be undertaken for the resumption of L-Reactor operation. The following sections describe these programs.

6.5.1 Effluent Monitoring

Air and water samples from L Reactor will be monitored routinely to detect radioactive releases. Reference 9 describes monitoring points for atmospheric releases and for liquid releases to streams and seepage basins.

Air and water are the major dispersal media for SRP radioactive emissions. Most components of the environment that could be affected by such emissions are monitored and sampled. The radiation monitoring program includes the monitoring of air on and off the site, water from SRP streams and the Savannah River, and samples of soil, vegetation, food, animals, and fish for their radionuclide content. The radiation monitoring program is described in the Du Pont DPSPU 30-1 series.

Permanent wells will be established to monitor any radionuclide transport in the groundwater around the L-Reactor Area low-level seepage basin. Radioactivity levels, both alpha and nonvolatile beta, will be determined. These data will be used as source terms for performing dose assessments.

6.5.2 Cesium-137 Monitoring

Special studies will be conducted to determine the movement and redistribution of radiocesium after L-Reactor startup to aid in assessing the doses to individuals and populations offsite. Suspended solids, total Cs-137, and soluble and suspended Cs-137 will be measured in Steel Creek, which carries L-Reactor effluent to the Savannah River. Tests will be conducted during preoperational cold water flow in 1983 and/or 1984 and again following startup for a period of one year. The results from these measurements during cold water flow tests will provide further information to confirm or improve the estimated effect of L-Reactor startup on the transport of Cs-137.

Results from measurements conducted following startup will provide the data necessary to evaluate immediate and long-range transport of Cs-137 to the Savannah River, to downstream river users, and to the Savannah River estuary. This monitoring program will include measurements of Cs-137 concentration in the Savannah River above and below the SRP, and water treatment plant raw and finished water above and below SRP. Any influx of surface water *into the* Beaufort-Jasper Canal will be determined. The Savannah River estuary and the Savannah River will be studied to determine any potential Cs-137 buildup in sediments. These measurements began in March 1983 and will continue for one year following L-Reactor startup.

Measurements in the Savannah River will provide a material balance of the total Cs-137 discharged and transported by the river. Measurements of raw river water and finished drinking water will provide absolute values of Cs-137 concentrations. Measurements of Cs-137 in the estuary will be compared to measurements made in 1965 to determine long-term trends. In situ sediment surveys may be used if needed to confirm absences of Cs-137 buildup in sediments.

Details of the sampling program are given in Appendix J.

6.6 REFERENCES

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7. PERMITS AND ENVIRONMENTAL COMPLIANCE

This chapter summarizes the current status of permits for the reactivation of L Reactor. Documentation, notification and/or mitigating actions needed prior to startup are also discussed. Table 7.1-1 summarizes the status of regulatory compliance requirements for L-Reactor restart.

7.1 National Environmental Policy Act Requirements

The National Environmental Policy Act (NEPA) requires federal agencies to incorporate environmental considerations into decisions made on actions with the potential to significantly affect the environment.[1] Preparation of NEPA documentation to support the reactivation of L Reactor has continued since the Environmental Information Document (EID) was published.[2] At the direction of the Department of Energy - Savannah River (DOE-SR), an Environmental Assessment (DOE/EA-0195) was completed by the NUS Corporation.[3] A Finding of No Significant Impact (FONSI), based on analyses in the Environmental Assessment, was subsequently published in the Federal Register in August 1982.[4]

The FONSI concluded that no significant difference should occur between expected environmental effects from renewed operations and those from prior operations during the period 1954-1968 (Appendix K.1). The FONSI was challenged in late 1982 by several environmental groups, principally the Natural Resources Defense Council (NRDC). A suit to enjoin the Department of Energy from proceeding with the L-Reactor reactivation was filed by NRDC in the Federal District Court for the District of Columbia (NRDC v. Vaughan, Roser, Hodel and the US Department of Energy).[5]

Following congressional action in June and July of 1983 and court action in July 1983, DOE has proceeded with preparation of an Environmental Impact Statement (EIS) for the restart of L Reactor. The EIS is to be completed between December 1, 1983, and January 1, 1984 (Appendix K.1.2).

TABLE 7.1-1

Regulatory Compliance for L-Area Reactor Startup

Facility/Action	Requirement	Agency	Status
NEPA	Environmental Documentation	DOE	EIS In Progress
Water			
Process sewer outfalls	NPDES Permit renewal	SCDHEC-IAWD	Negotiation In Progress
Cooling water intake and discharge	316(a) and 316(b) review	SCDHEC-IAWD	Studies In Progress
Oil Storage	SPCC Plan	EPA/SCDHEC	In Progress
Domestic Water Wells	Permit to Construct	SCDHEC-WSD	Received
Domestic Water Treatment and Distribution System	Permit to Construct	SCDHEC-WSD	Received
Domestic Sanitary Sewage Treatment Plant	Permit to Construct	SCDHEC-IAWD	Received
Air			
Oil-Fired Temporary Steam Boiler	Operation Permit	SCDHEC-BAQC	Received
Emergency Diesel Generators	Operation Permits	SCDHEC-BAQC	Received
F, H, M-Area Process Generators	Operation Permit Modifications	SCDHEC-BAQC	Received
Asbestos	Notification	SCDHEC	Ongoing

TABLE 7.1-1, Contd

Regulatory Compliance for L-Area Reactor Startup

Facility/Action	Requirement	Agency	Status
Endangered Species			
• American alligator	Biological Opinion and Consultation	USFWS	Completed, but renewed because of schedule change
• Shortnose sturgeon	Biological Opinion and Consultation		In Progress
• Wood stork	Undefined, Informal Consultation Begun		Studies in progress
Historic Preservation	Archeological Survey and Assessment	SC-HPO	Completed, Monitoring Program Implemented
Floodplain/Wetlands Impact	Assessment	DOE	Completed
Meteorological Tower	Notification	FAA	Letter of Exemption

Key:

NEPA - National Environmental Policy Act
DOE - Department of Energy
EIS - Environmental Impact Statement
SCDHEC - South Carolina Department of Health and Environmental Control
IAWD - Industrial and Agricultural Waste Water Division
EPA - Environmental Protection Agency
WSD - Water Supply Division
BAQC - Bureau of Air Quality Control
USFWS - United States Fish and Wildlife Service
SC-HPO - South Carolina Historic Preservation Officer
FAA - Federal Aviation Administration

7.2 Water

7.2.1 Clean Water Act Requirements

7.2.1.1 National Pollutant Discharge Elimination System

As stated in the L-Reactor EID, the basic regulatory mechanism for water pollution control is the National Pollutant Discharge Elimination System (NPDES) under the Federal Water Pollution Control Act (Clean Water Act) and amendments.[6] Under the NPDES program, the states, subsequent to Federal approval, are given the authority to establish effluent limitations and to issue permits to point source discharges consistent with established water quality criteria.

NPDES permitting authority was transferred from the Environmental Protection Agency (EPA) to the South Carolina Department of Health and Environmental Control (SCDHEC) effective 9/26/80. SRP has applied for a renewal and consolidation of the current NPDES permits. This request would result in the creation of one NPDES permit covering all SRP point source discharges.[7] Effluent limitations and monitoring requirements are based upon EPA recommendations and the State of South Carolina Water Classification Standards System.[8]

Normally, all SRP streams would have the stream classification of its terminus, the Savannah River, which is designated as a Class B stream. South Carolina Class B waters are defined as suitable for (1) secondary contact recreation, (2) drinking water supply after conventional treatment, (3) the survival and propagation of fish and other fauna and flora and (4) industrial and agricultural uses.

SRP's present NPDES permit was issued by EPA in 1976.[9] SRP streams receiving reactor cooling water effluents were exempted from South Carolina Class B standards. EPA chose to enforce temperature limitations for SRP streams receiving thermal effluents near their point of contact with the Savannah River. The provisions of the 1976 NPDES permit were administratively extended in July 1981 by SCDHEC pending the issuance of the new NPDES permit.

SRP requested in the June 1981 NPDES permit renewal application to SCDHEC a larger mixing zone in the Savannah River at the mouth of Steel Creek than is allowed under the current permit. The increased size of the mixing zone would accommodate the thermal effluent from L Reactor and K Reactor.

SCDHEC issued two draft permits in 1982 in response to the SRP permit application. The first SCDHEC draft permit, issued August 1982,[10] provided for thermal considerations similar to the existing

EPA NPDES permit. The second draft permit from SCDHEC, however, issued November 1982, mandated the application of South Carolina Class B stream criteria, including temperature limitations, to each of the reactor cooling water effluent streams onsite. SCDHEC thereby considers SRP onsite streams and ponds as Class B waters of the State.[11]

Resolution of this issue is anticipated later in 1983 or early 1984.

7.2.1.2 Savannah River Biological Measurements Program

The Savannah River Biological Measurements Program was initiated in March 1982 to monitor and study thermal effects on the aquatic ecosystem in the Savannah River and to monitor the impingement and entrainment of fishes, primarily in the pumphouse areas. The program will provide information similar to that necessary for Section 316(a) and 316(b) demonstrations under the Clean Water Act.

The program was designed to be implemented in two phases. The first phase was a six-month program which monitored the 1982 spring spawning season.[12] The second phase is a three-year monitoring program which began in August 1982. The second phase will continue phase one monitoring and has been expanded to include the addition of nearfield and farfield studies of icthyoplankton species on a weekly sampling frequency.

7.2.2 Spill Prevention Control and Countermeasure Plan (SPCC)

Under the Clean Water Act,[6] EPA requires a Spill Prevention Control and Countermeasure Plan (SPCC) for all facilities that handle oil in bulk quantities.[13] The purpose of SPCC planning is to prevent bulk oil quantities from reaching surface streams. SPCC plans should include discussion of prior spill events, potential spill scenarios, containment/diversionary structures or equipment, and contingency plans. EPA does not require submission of SPCC plans, although they do reserve the right to review these plans. The SRP SPCC plan covers the entire site, but is subdivided into plans specific to each area at SRP. Final approval of the SRP SPCC plan is expected in 1983.

7.2.3 Domestic Water Wells

In addition to the two wells previously used in L Area, two more domestic water wells have been drilled to support L-Area water needs. The appropriate permit which was issued to construct and drill these additional wells is included in Appendix K.2.1.[14]

7.2.4 Domestic Water Treatment and Distribution System

A permit to modify the L-Area existing water treatment facility was issued by the Water Supply Division of SCDHEC in early 1982, (Appendix K.2.2).[15] Modifications to the existing facility include two degasifers and associated auxilaries to neutralize and chlorinate the well water. All modifications to the domestic water system are expected to be completed by the end of June 1983.

7.2.5 Domestic Sanitary Sewage

The construction permit for a new sanitary waste water treatment plant in L Area is included in Appendix K.2.3.[16] The first phase of the sanitary plant construction is complete and the system is operating manually. The automatic chemical injection system, or second phase of the system, began operation in June 1983. Treated sanitary effluents will be discharged to NPDES outfall L-007-A under the pending SRP NPDES permit.

7.3 Air

This section updates actions associated with L-Reactor restart that may require SCDHEC air permits and/or permit revisions.

7.3.1 L-Area Steam and Electric Supplies

7.3.1.1 Primary Sources

L-Area steam demands will require the K-Area power plant to burn more coal, resulting in the release additional pollutants. This plant will be modified to increase coal combustion and steam export. No construction or operating permit review will be required.[17]

SCDHEC operating permits for SRP coal-fired power plants set an upper limit on air pollutant emissions based on the maximum generation capacity of the individual plant. Since SRP power plants usually operate below full power, annual air pollutant releases typically remain well below emission limits. Additional air emissions of SO_x, NO_x, total suspended particulates, and hydrocarbons resulting from L-Area power demand are expected to be small and will not cause total source releases to approach or exceed standards. A permit modification will not be required because there will be no change in the design capacity of any boilers. SCDHEC has reissued operational permits for the coal-fired boilers at SRP powerhouses. These permits are included in Appendix K.3.1 (O/P-02-263 through O/P-02-281).

7.3.1.2 Temporary Steam Supply

A temporary oil-fired package boiler provided heat to L Area during the winter months prior to the completion of the K to L steamline. The original permit for the temporary oil-fired boiler was issued on October 26, 1981. The reissuance of this permit (O/P-02-310) is specified in Appendix K.3.1. The new expiration date is May 31, 1983.

7.3.1.3 Emergency Diesel Generators

As described in the EID, L Area will have 14 diesel generators providing emergency electrical power.[2] Diesel generators are operated periodically for testing purposes.

SCDHEC air pollution regulations require both construction and operating permits for emergency diesel generators greater than 150 kW rated capacity. L Area will have three emergency diesel generators rated at more than 150 kW: two at 1000 kW and one at 536 kW.

All fourteen diesel generators are already in place and have been on standby since L-Area reactor operations were suspended in 1968. The permits necessary for the operation of the three generators greater than 150 kW have been received from SCDHEC. A copy of these permits is compiled in Appendix K.3.2 (O/P-02-354 through 356). These permits expire on November 30, 1987.

7.3.2 Process Facilities Affected

Additional processing of fuel and target materials from L Reactor will increase F-, H-, and M-Area production rates by approximately 33 percent. Unlike SRP coal-fired power plant operating limits, SCDHEC bases stack emission limitations for process facilities on average rates. Increased NO_x emissions will therefore require operating permit revisions. Completed permit revisions for affected process facilities reflecting emissions changes brought about by L Reactor restart and other projects are included in Appendix K.3.3 (O/P-02-284, O/P-02-285, I/O-02-018).

DOE asked SCDHEC to base limitations for process facilities on design capacity, similar to coal-fired boilers rather than on average operating rates to accomodate air emissions from increased future processing. Although SCDHEC has agreed to this request, the permits themselves are being revised in 1983 for changes in emissions calculations.

7.3.3 Asbestos

There have been no changes since the EID was published with regard to asbestos removal and disposal.[2] Permission has been obtained from SCDHEC to use the SRP disposal site for removed asbestos, and SCDHEC has been provided information on SRP asbestos disposal activities for the past several years.

7.4 Solid and Chemical Waste Disposal

L-Area restart activities have generated a variety of residuals defined as solid and chemical wastes under Federal law.[18] Disposal will take place at SRP. DOE will comply with all applicable Federal requirements for disposal of toxic and hazardous wastes at SRP.

7.5 Endangered Species

7.5.1 American Alligator (*Alligator mississippiensis*)

Formal Consultation under the Endangered Species Act was held in September 1982 with representatives of DOE-SR, Du Pont, NUS Corporation, the Savannah River Ecology Laboratory (SREL), and the U.S. Fish and Wildlife Service.[19] A Biological Opinion was received form the U.S. Fish and Wildlife Service on February 25, 1983 (Appendix K.4). The U.S. Fish and Wildlife Service agreed that protection of the lagoons at SRP Road A is sufficient mitigation for the American alligator potentially impacted by L-Reactor restart. Protection of these lagoons is completed. Reconsultation is planned because of the change in startup schedule to 1984.

7.5.2 Shortnose Sturgeon (*Acipenser brevirostrum*)

Sturgeon larvae were collected in the first phase of the biological measurements program from samples taken near the SRP pumphouses at the Savannah River. A few of these were determined to be the federally-endangered shortnose sturgeon (Appendix H).[19] Preparation of a Biological Assessment is in progress to support a Biological Opinion and formal consulation.

7.5.3 Wood Stork (*Mycteria americana*)

The wood stork has been proposed for listing as a federally endangered species by the U.S. Fish and Wildlife Service.[20] Expanded field studies are being conducted during the summer 1983. Informal consultation with the US FWS has begun.

7.5.4 Red-cockaded Woodpecker (*Picoides borealis*)

The U.S. Fish and Wildlife Service concurs with DOE that the red-cockaded woodpecker will be unaffected by L-Area operations (Appendix H).

7.6 Wetlands

Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands) require Federal agencies to incorporate floodplain and wetlands protection into the decision-making process. The Department of Energy published regulations based on both Executive Orders (10 CFR 1022).[21]

In order to comply with these Executive Orders and DOE regulations, the Department of Energy must prepare a wetlands assessment that describes the proposed action, the potential effects on floodplains and wetlands, and alternatives. The DOE wetlands notice regarding the reactivation of L Reactor was issued on July 14, 1982 and published in the Federal Register (Appendix K.5.1).[22]

The final notice of wetlands determination was published in the Federal Register on August 23, 1982 (Appendix K.5.2).[23] The notice concluded that because of cost and scheduled startup in October 1983, no practicable alternative exists to once-through cooling with direct discharge to Steel Creek.

7.7 Historic Preservation

The Historic Preservation Act of 1966 [16USC470(f)] requires Federal agencies with jurisdiction over a Federal "undertaking" to consult with appropriate state historic preservation offices prior to project initiation (56CFR800).[24] The Act emphasizes the protection of properties that might be eligible for inclusion in the National Register of Historic Places.

An archeological and historic survey of the Steel Greek terrace and floodplain system was completed in February 1981. The survey located one site that is considered eligible for nomination to the National Register of Historic Places and is therefore worthy of preservation from adverse effects. A monitoring plan has been developed to protect this site and four other sites that were identified as potentially significant.

The Department of Energy in conjunction with the Institute of Archeology and Anthropology, has developed a monitoring and mitigation plan for the five potentially affected sites. The State Historic Preservation Officer concurred in July 1982 with DOE-SR that these sites will not be impacted by L-Reactor restart provided that the proper erosion monitoring program is adopted (Appendix K.6).

7.8 FAA Notification

SRP has constructed a 200-foot (61-meter) meteorological tower near L Area. Operational checkout of this tower is expected by the end of August 1983. The FAA has exempted such towers at SRP up to 210 feet. The FAA letter of exemption for the L-Area meteorological tower is included in Appendix K.7.

7.9 REFERENCES

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9. NPDES Permit, Savannah River Plant, No. SC 0000175, U.S. Environmental Protection Agency-Region IV, Atlanta, GA (1977).

10. NPDES Draft Permit, Savannah River Plant, South Carolina Department of Health and Environmental Control, Columbia, SC (8/6/82).

11. NPDES Draft Permit, Savannah River Plant. South Carolina Department of Health and Environmental Control, Columbia, SC (11/16/82).

12. Environmental & Chemical Sciences, Inc. "Final Report on the Preliminary Biological Measurement Program in the Savannah River, March 1 through August 31, 1982, Volume I." DPST-83-439. Prepared for E. I. du Pont de Nemours & Co., SRL, Aiken, SC 29808 (January 1983).

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18. "Resource Conservation and Recovery Act of 1976." Environmental Reporter, 71:3101, The Bureau of National Affairs, Inc., Washington, DC (1981).

19. "Endangered Species Act." Environmental Reporter, 71:8021, The Bureau of National Affairs, Inc., Washington, DC (1980).

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21. "Department of Energy Rules and Regulations, Compliance with Floodplain/Wetlands Environmental Review Requirements." Federal Register, 44:12594-12599, U.S. Government Printing Office, Washington, DC (1979).

22. "DOE Floodplain/Wetlands Notice for L-Reactor Resumption of Operation," Federal Register, 47:30563, U.S. Government Printing Office, Washington, DC (1982).

23. "DOE: Floodplain/Wetlands Statement of Findings for the Proposed Operation of L Reactor at SRP," Federal Register, 47:36691-36692, U.S. Government Printing Office, Washington, DC (1982).

24. Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeologial, Architectural) Resources. Prepared by the National Park Service, Department of the Interior, Washington, DC (1974).

APPENDICES

A. Cesium-137

B. Georgia Fishery Data, Savannah River

C. Calculation of Freshwater Fish Consumption

D. Liquid Dose Assessment

E. Meteorological Method for Routine Releases of Radioactivity

F. Dose Methodology for Routine Releases of Radioactivity to the Atmosphere

G. Sampling Station Descriptions of Biological Measurement Program

H. Taxonomic Opinions — Sturgeon Larvae

I. Savannah River Biological Measurement Program

J. Cesium-137 Monitoring Program

K. Permits and Environmental Compliance Documents

APPENDIX A

CESIUM-137

A.1 Results of February-April 1982, Flow Tests

A.2 Results of 1965 Surveys

A.3 Cesium-137 Downstream Concentrations

A.4 Cesium-137 from Nuclear Fallout

A.1 RESULTS OF FEBRUARY-APRIL 1982, FLOW TESTS

Sampling

Water samples were collected at the Steel Creek mouth using automated samplers. These samplers are designed so that no settling of suspended solids occurs during the pumping of the water sample. The samplers were adjusted to obtain a 150 mL sample every two hours and to fill a bottle every six hours before changing to the next bottle. To obtain a daily water sample, four water samples representing six hours each were composited to yield from 1.6 to 1.8 L.

About 21 ±13% of the Cs-137 is lost between sampling and analysis. Most of this loss is probably due to sorption to bottle walls. This loss was measured by duplicating the time lapse between sampling, compositing, and analysis. Twenty bottles used in the collectors were filled with Savannah River water and each bottle was spiked with 12.1 pCi of Cs-137 and stored in the collector for five days, then composited and submitted for analysis. The samples were analyzed about 23 days later.

Analysis

The samples were analyzed by the SRP Environmental Monitoring Group. The radiochemical procedure is used routinely to measure the Cs-137 in surface water samples. The Cs-137 recovery for samples is based on spiked samples that are analyzed routinely along with the samples and the recovery factors are applied to correct the results for Cs-137 loss during analysis. The average recovery for the set of samples for this experiment was 68.7 ±11.5%.

Flow

Flows were required to estimate the total Cs-137 transport. A noon to noon average flow was calculated using fifteen minute data from the USGS maintained gauging station at Hattieville Bridge. The water sampler composites were on a near noon to noon (±2 hr) sampling interval. Since Pen Branch flow combines with Steel Creek, the Hattieville Bridge flows were increased by 450 cfs to obtain the correct flow at the mouth of Steel Creek. Flow and the periods of flow during the test period varied due to testing of various valves, headers, and pumps in L Area.

Results

The total Cs-137 concentrations were measured throughout the pump tests (Tables A-1, A-2, and A-3). Flows most similar to those expected during L-Reactor operation occurred during the week of March 21, 1982. During this week the average daily flow reached 218 cfs and the flow for the week exceeded any previous weekly flow since L Reactor was placed on standby in 1968.

The increase in Cs-137 concentration at the mouth of Steel Creek lagged the increase in pump test flow (Figures A-1 and A-2). The highest Cs-137 concentration occurred March 28, 1982, about three days after the flow decreased to about 74 cfs from the peak flow of 218 cfs. This concentration is probably a result of water draining from backwater areas of the floodplain and into the creek. Water in the back areas would have longer residence time and could accumulate higher Cs-137 concentrations.

The daily transport of Cs-137 was calculated using the daily averaged Cs-137 concentrations at the mouth of Steel Creek and the Steel Creek flow at Hattieville Bridge increased for flow from Pen Branch. The Cs-137 transport during the period of highest flow, March 21-28, 1982, was 1.96 ±1.53 mCi/day and at an average flow of 123 cfs (flow measured at Hattieville Bridge). Using these data, an estimate of 2.3 ±1.8 Ci of Cs-137 (1.96 x 400 cfs/123 cfs x 365 days/year) is obtained for the amount of cesium transport in the first year of L-Reactor operations.

TABLE A-1

Cs-137 Transport and Flow at Road B above Steel Creek

------------------------- LOC=ROAD B -------------------------

OBS	DATE	JULIAN	mCi/day CSTRANS	L/day T_FLOW
42	25FEB82	56	0.26041	48,224,822
43	26FEB82	57	0.24112	48,224,822
44	27FEB82	58	0.27970	48,224,822
45	28FEB82	59	0.20737	48,224,822
46	01MAR82	60	0.23630	48,224,822
47	02MAR82	61	0.21219	48,224,822
48	04MAR82	63	0.28453	48,224,822
49	05MAR82	64	0.33275	48,224,822
50	06MAR82	65	0.40509	48,224,822
51	07MAR82	66	0.43885	48,224,822
52	08MAR82	67	0.24112	48,224,822
53	09MAR82	68	0.39062	48,224,822
54	10MAR82	69	0.41473	48,224,822
55	11MAR82	70	0.54012	48,224,822
56	12MAR82	71	0.59317	48,224,822
57	13MAR82	72	0.37615	48,224,822
58	14MAR82	73	0.35686	48,224,822
59	15MAR82	74	0.34240	48,224,822
60	16MAR82	75	0.33757	48,224,822
61	17MAR82	76	0.32793	48,224,822
62	18MAR82	77	0.69444	48,224,822
63	19MAR82	78	0.38580	48,224,822
64	20MAR82	79	0.43402	48,224,822
65	21MAR82	80	0.52083	48,224,822
66	22MAR82	81	0.54012	48,224,822
67	23MAR82	82	0.51118	48,224,822
68	24MAR82	83	0.41473	48,224,822
69	25MAR82	84	0.50154	48,224,822
70	26MAR82	85	0.19772	48,224,822
71	27MAR82	86	0.67033	48,224,822
72	28MAR82	87	0.59317	48,224,822
73	29MAR82	88	1.38405	48,224,822
74	30MAR82	89	0.57870	48,224,822
75	31MAR82	90	1.22009	48,224,822
76	01APR82	91	0.49189	48,224,822
77	02APR82	92	0.57870	48,224,822
78	03APR82	93	0.46296	48,224,822
79	04APR82	94	0.42438	48,224,822
80	05APR82	95	0.42438	48,224,822
81	06APR82	96	0.31346	48,224,822
82	07APR82	97	0.19290	48,224,822
83	08APR82	98	0.41473	48,224,822
84	09APR82	99	0.02411	48,224,822
85	14APR82	104	0.03376	48,224,822

TABLE A-2

Cs-137 Concentrations and Flow at Hattieville Bridge on Steel Creek

------------------------ LOC=SC MOUTH ------------------------

OBS	DATE	JULIAN	mCi/day CSTRANS	L/day T_FLOW
161	01MAR82	60	0.12936	1,293,600,000
162	05MAR82	64	0.82614	1,376,900,000
163	06MAR82	65	1.66110	1,384,250,000
164	07MAR82	66	1.27008	1,411,200,000
165	08MAR82	67	1.93452	1,381,800,000
166	09MAR82	68	0.82614	1,376,900,000
167	10MAR82	69	1.51728	1,379,350,000
168	11MAR82	70	1.92423	1,374,450,000
169	12MAR82	71	1.93109	1,379,350,000
170	13MAR82	72	0.82467	1,374,450,000
171	14MAR82	73	1.51189	1,374,450,000
172	15MAR82	74	1.37690	1,376,900,000
173	16MAR82	75	1.93109	1,379,350,000
174	17MAR82	76	1.72872	1,440,600,000
175	18MAR82	77	1.21716	1,352,400,000
176	19MAR82	78	0.67130	1,342,600,000
177	20MAR82	79	1.38425	1,384,250,000
178	21MAR82	80	1.23921	1,376,900,000
179	22MAR82	81	2.12415	1,416,100,000
180	23MAR82	82	2.77438	1,460,200,000
181	24MAR82	83	1.47294	1,636,600,000
182	25MAR82	84	1.42835	1,428,350,000
183	26MAR82	85	2.12072	1,325,450,000
184	27MAR82	86	1.02704	1,283,800,000
185	28MAR82	87	3.51256	1,300,950,000
186	29MAR82	88	0.38734	1,291,150,000
187	30MAR82	89	1.70128	1,215,200,000
188	31MAR82	90	0.47726	1,193,150,000
189	01APR82	91	1.35828	1,234,800,000
190	02APR82	92	2.13003	1,183,350,000
191	03APR82	93	0.71295	1,188,250,000
192	04APR82	94	1.30438	1,185,800,000
193	05APR82	95	0.51744	1,293,600,000
194	06APR82	96	1.16228	1,452,850,000
195	08APR82	98	1.35019	1,227,450,000
196	09APR82	99	0.11956	1,195,600,000
197	10APR82	100	0.58922	1,178,450,000
198	11APR82	101	0.11735	1,173,550,000
199	13APR82	103	0.85235	1,217,650,000
200	14APR82	104	0.80850	1,347,500,000
201	16APR82	106	0.47628	1,190,700,000
202	18APR82	108	1.43766	1,198,050,000
203	20APR82	110	1.58613	1,220,100,000
204	22APR82	112	0.23569	1,178,450,000

TABLE A-3

Cs-137 Transport and Flow at Mouth of Steel Creek

------------------- LOC=SC MOUTH				
			pCi/L	ft^3/sec
OBS	DATE	JULIAN	TCS	H_FLOW
161	01MAR82	60	0.1	78
162	05MAR82	64	0.6	112
163	06MAR82	65	1.2	115
164	07MAR82	66	0.9	126
165	08MAR82	67	1.4	114
166	09MAR82	68	0.6	112
167	10MAR82	69	1.1	113
168	11MAR82	70	1.4	111
169	12MAR82	71	1.4	113
170	13MAR82	72	0.6	111
171	14MAR82	73	1.1	111
172	15MAR82	74	1.0	112
173	16MAR82	75	1.4	113
174	17MAR82	76	1.2	138
175	18MAR82	77	0.9	102
176	19MAR82	78	0.5	98
177	20MAR82	79	1.0	115
178	21MAR82	80	0.9	112
179	22MAR82	81	1.5	128
180	23MAR82	82	1.9	146
181	24MAR82	83	0.9	218
182	25MAR82	84	1.0	133
183	26MAR82	85	1.6	91
184	27MAR82	86	0.8	74
185	28MAR82	87	2.7	81
186	29MAR82	88	0.3	77
187	30MAR82	89	1.4	46
188	31MAR82	90	0.4	37
189	01APR82	91	1.1	54
190	02APR82	92	1.8	33
191	03APR82	93	0.6	35
192	04APR82	94	1.1	34
193	05APR82	95	0.4	78
194	06APR82	96	0.8	143
195	08APR82	98	1.1	51
196	09APR82	99	0.1	38
197	10APR82	100	0.5	31
198	11APR82	101	0.1	29
199	13APR82	103	0.7	47
200	14APR82	104	0.6	100
201	16APR82	106	0.4	36
202	18APR82	108	1.2	39
203	20APR82	110	1.3	48
204	22APR82	112	0.2	31

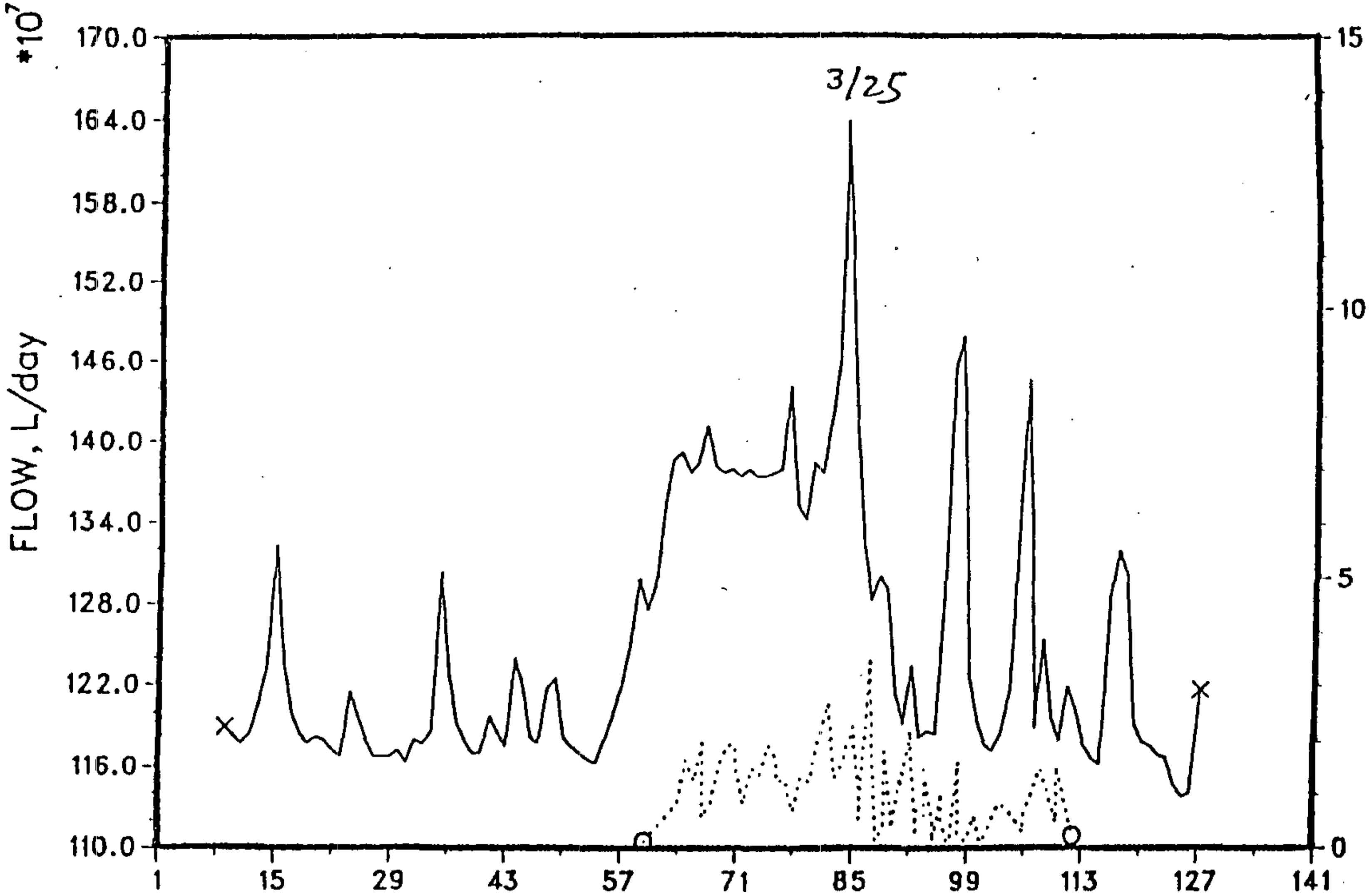

Figure A-1. Daily average of Hattieville discharge and total Cs-137 at Steel Creek mouth from January 8 - May 6, 1982

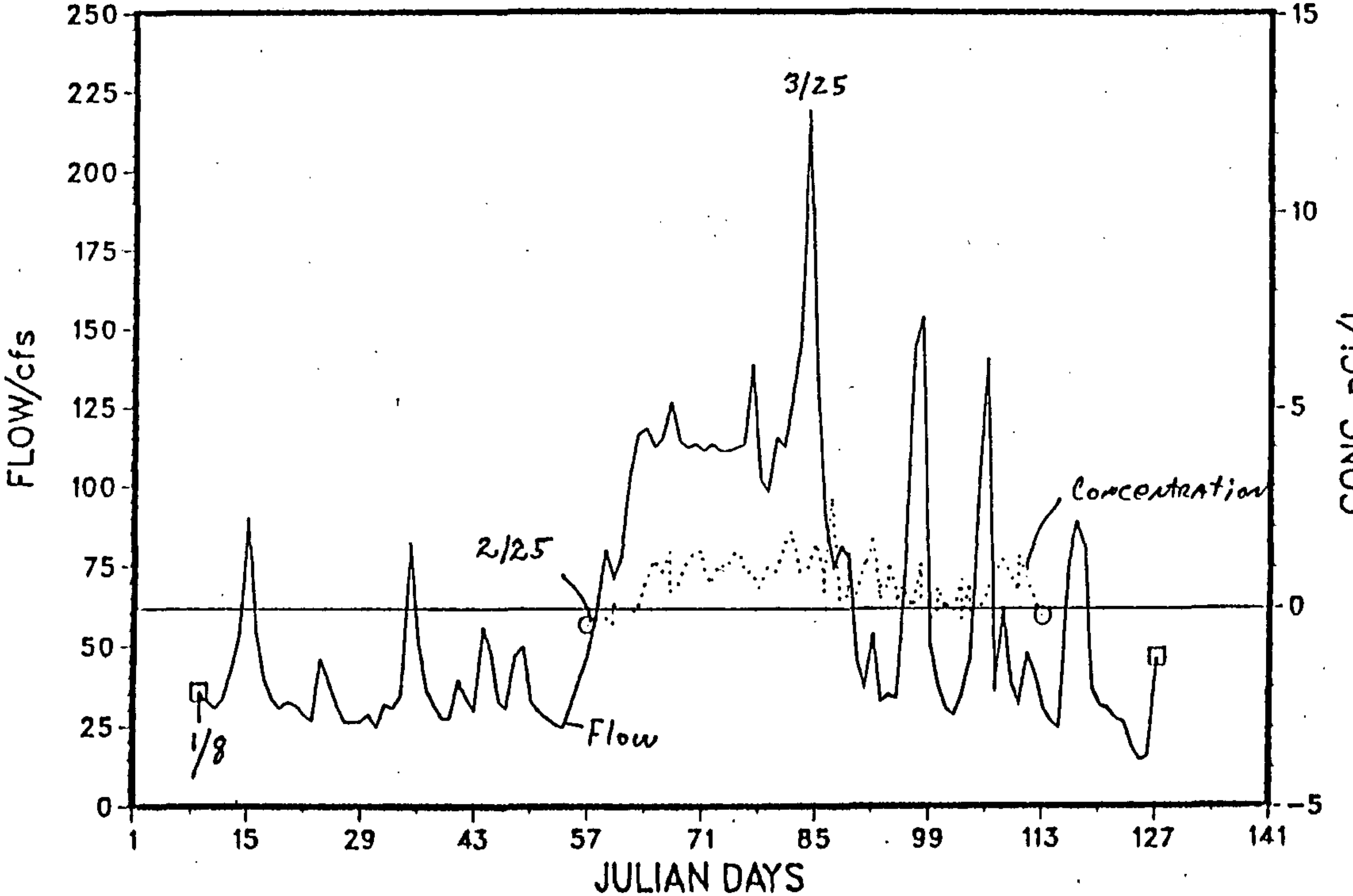

Figure A-2. Daily average discharge and cesium-137 transport at Steel Creek mouth from January 8 - May 6, 1982

A.2 RESULTS OF 1965 SURVEYS

In December 1965, surveys were made to determine the concentrations of Cs-137 in the Savannah River and the Beaufort-Jasper and Port Wentworth water treatment plants. These data were used to estimate Cs-137 reduction ratios for transport in the Savannah River and the Beaufort-Jasper canal system following L-Reactor restart.

The Savannah River Plant discharges small quantities of Cs-137 to several streams that drain surface waters from the site. Cesium-137 that is not retained by stream sediments flows into the Savannah River. Cesium-137 concentrations in the Savannah River were higher during the 1960s than they are now, due to fallout from the nuclear weapons tests and to releases from SRP (Figure A-3). The peak Cs-137 concentration in the Savannah River occurred in 1962 and it has steadily decreased since, due to the near cessation of atmospheric nuclear weapon testing and process improvements at SRP. The present Savannah River water concentration below the SRP is less than 0.1 pCi/L.

Cesium-137 concentration measurements made in 1965 are reported for the Savannah River above and below the SRP and for the Beaufort-Jasper and Port Wentworth water treatment plants down river. These concentrations, measured when four SRP reactors (C, K, L, and P) were operating, were used to estimate Cs-137 reduction ratios for transport in the Savannah River and across each water treatment plant. In 1965 there was a 48% reduction in the Cs-137 concentration in the Savannah River between Highway 301 and the water treatment plant inlet points.

Measured Cs-137 values in the finished water from Port Wentworth and the Beaufort-Jasper water treatment plants showed an 80% and 98% reduction in concentration level, respectively, when compared to Cs-137 concentration at Highway 301. The lower Cs-137 concentration (0.04 pCi/L) in the Beaufort-Jasper finished water is attributed to dilution in the canal (about 17-18 miles).

Using the 1965 data, maximum Cs-137 concentrations expected in finished water in the Beaufort-Jasper and Port Wentworth water treatment plants following L-Reactor startup were recalculated. The recalculated values are 0.01 and 0.09 pCi/L for Beaufort-Jasper and Port Wentworth, respectively, compared to the 1.05 pCi/L value in the L-Reactor Environmental Assessment.[1]

Sample Collection and Analysis

Two to three hundred liters of water were collected at three Savannah River locations and three water treatment plants over a

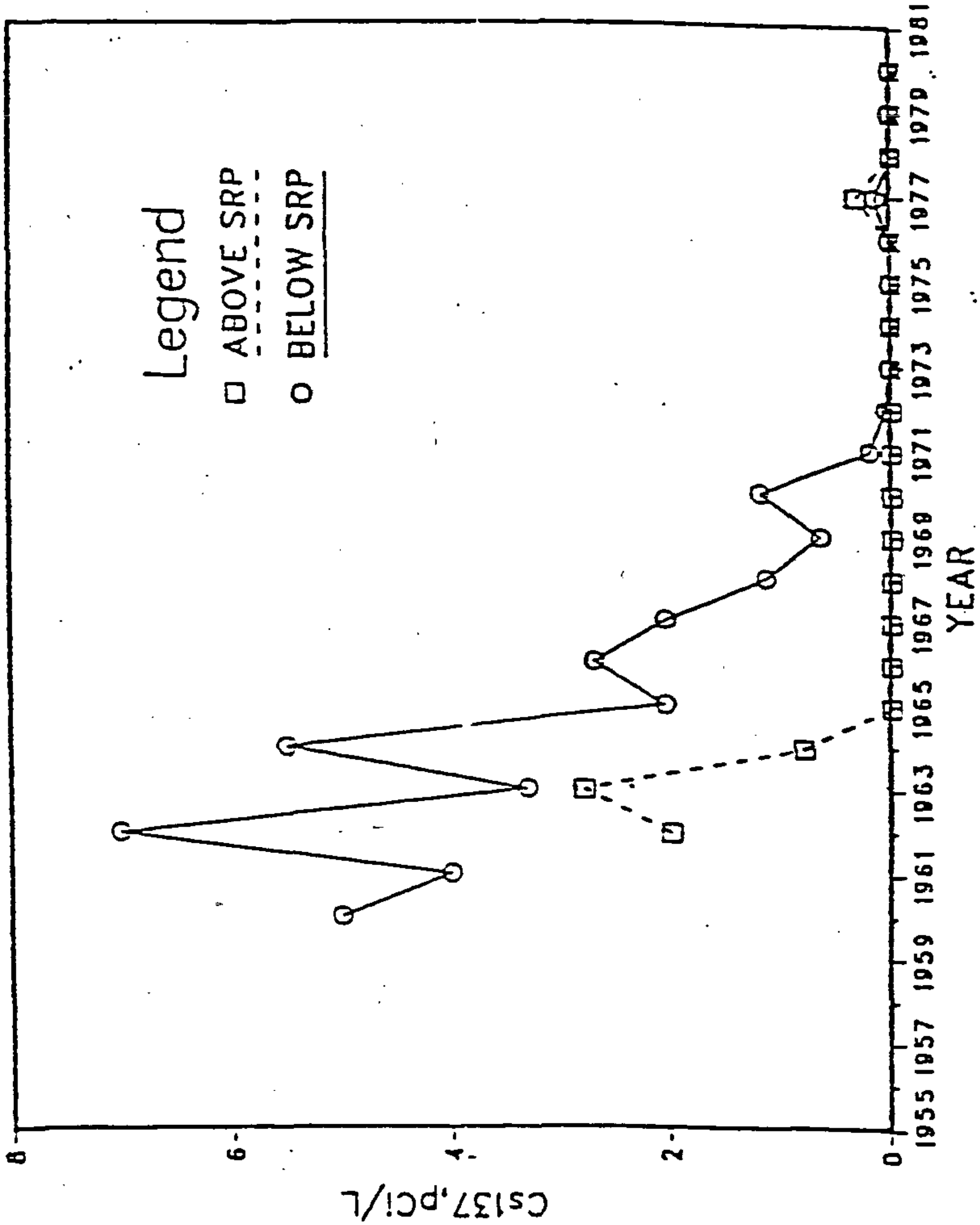

Figure A-3. Cs-137 concentrations in the Savannah River 1953-1981 period of one week (December 10-17, 1965). The Savannah River locations included Augusta, GA, above the SRP, and Highway 301 and Highway 17 below the SRP site. The water treatment plants were located at North Augusta and Beaufort-Jasper, SC, and Port Wentworth, GA.

The Beaufort-Jasper and Port Wentworth water treatment plants are located in the lower part of the Savannah River system (Figure 3.1-1). Highway 301 is about 10 miles below the last stream water effluent location from the Savannah River Plant, the mouth of Lower Three Runs Creek. Highway 17 was the closest sampling location to the water treatment plants. The Port Wentworth Plant is about seven miles upriver of Highway 17 and the Beaufort-Jasper pump station is about 17 miles upriver.

Water samples were passed through ion exchange columns at flow rates of between 20 to 50 mL/min and the recovery of the Cs-137 from fresh water using the potassium cobalt ferrocyanide columns is 99%. The sensitivity for Cs-137 measurements using a 9 x 9 in. NaI crystal with a 3 x 6 in. well is about 0.02 pCi/L for a 200 L sample.[2] The Cs-137 concentrations measured in these samples are given in Tables 3.1-2 and 3.1-3.

Results and Discussions

Savannah River

An increase in the Cs-137 concentrations from 0.03 pCi/L to 1.47 pCi/L occurred between the Augusta and Highway 301 locations due to SRP discharges. A decrease from 1.47 to 0.77 pCi/L, or about 47.7% in the Cs-137 concentration, occurred between Highway 301 and Highway 17. Most of the Cs-137 concentration decrease was probably due to sorption/deposition/re-equilibration with the river channel and tidal fresh water marshes and secondarily to an increase in flow.

The increase in water flow between Highway 301 and Highway 17 would reduce the Cs-137 concentration about 20%. As determined from USGS water flow data for the month of December 1965, the increase in water flow between Highway 301 and Cylo, midway between Highway 301 and Highway 17, is about 12.5% (Cylo-7940 cfs and Highway 301-7060 cfs). An estimate of the increase in waterflow below Cylo was based on the assumption that water yield to the river is proportional to the watershed area. The Savannah River watershed area below Clyo is 727 square miles and the watershed area between Highway 301 and Cylo is 1200 square miles. Therefore, the increase in flow between Highway 301 and Highway 17 is about 20.1% ((1200 + 727) x 12.5%/1200).[3] Since the increase in river flow accounts for 20% of the Cs-137 concentration reduction in the

Savannah River below SRP, the additional 28% reductioin in Cs-137 concentration must occur through deposition/sorption/re-equilibration with the river channel and floodplain.

The additional 28% Cs-137 reduction between Highway 301 and Highway 17 had to occur in the river channel and the fresh water tidal marshes. Cs-137 loss to the floodplain would not have occurred due to the low flow conditions. The Savannah River was in its channel above the tidal influence during the month of December 1965. The flow was below average (7060 cfs at Highway 301 vs. 12,780 cfs annual flow average). About half of the tidal fresh water marsh extends from Highway 17 upriver to the vicinity of Abercorn Creek (Abercorn Creek is inlet for the Port Wentworth water treatment plant). The 10,000 acres of marsh is covered twice a day by the tides with the largest fresh water tides of 6 ft in the vicinity of Highway 17. The spreading of the water out into the marsh, and its slow movement and nearly stagnant conditions during the change of the tides give adequate opportunity for sorption/deposition/re-equilibration reactions to occur. Ebb and flow conditions extend nearly 40 miles upriver from the mouth of the river.

Water Treatment Plants

As shown in Table 3.1-2, finished water from the Beaufort-Jasper water treatment plant had a lower Cs-137 concentration (0.036 pCi/L) compared to Port Wentworth (0.29 pCi/L). Since both water plants used the alum process for water treatment, similar process reduction factors may be expected for Cs-137. However, the water that is supplied to the Beaufort-Jasper plant travels through about 18 miles of open canal after it leaves the pump station on the Savannah River. During the two to five days of transit to the Beaufort-Jasper plant, the Cs-137 in the Savannah River water in the canal is reduced by local water inflow, deposition of particles containing Cs-137, and sorption of Cs-137 from the water to the sediments and the aquatic vegetation in the canal.

About 62% of the Cs-137 is removed in the Port Wentworth water treatment plant by the water clarification process. In the water clarification process, alum is added to the water and precipitated with lime. The resulting aluminum hydroxide carries the Cs-137 in the suspended sediment as well as sorbing some of the dissolved Cs-137. The 62% removal was calculated by assuming that the Cs-137 concentration measured at Highway 17 (0.77 pCi/L) represented the water that was undergoing processing. Highway 17 is about seven miles below the Abercorn Creek entrance which furnishes raw water to the Port Wentworth water treatment plant. The finished water concentration (0.29 pCi/L) represents a removal of 62% of the Cs-137 from the input as a result of processing.

Since the Cs-137 concentration in the Beaufort-Jasper finished water is lower than the Port Wentworth and similar to that measured in the finished water from the North Augusta water treatment plant above SRP, it is clear that the Cs-137 concentration is reduced by the processes of water inflow and deposition/sorption/re-equilibration reactions over the 18 miles of open canal. To estimate the Cs-137 concentrations at the input to the Beaufort-Jasper plant, the Cs-137 water clarification process removal factor of 62% was applied to the similar Beaufort-Jasper water treatment plant process. Using a finished water concentration of 0.036 pCi/L, this would indicate that 0.096 pCi/L was the raw river concentration prior to treatment.

Based on studies of tritium concentration at the Port Wentworth and the Beaufort-Jasper water treatment plants, about 40% of the Cs-137 reduction in the canal would be a result of dilution by water inflow. The rest of the Cs-137 concentration reduction is primarily by deposition/sorption/re-equilibration with the sediment in the canal. Since the canal was placed in operation in 1965, the same year the sampling was done, sediment rather than aquatic vegetation processes were probably more important in reducing the Cs-137 concentration. The aquatic vegetation had not established itself to the abundant level that presently exists in the canal and the sediment deposition was not sufficient to cover up the fresh soil that would be exposed to the canal water as a result of construction.

References

1. DOE. Environmental Assessment L-Reactor Operation Savannah River Plant, Aiken, SC. DOE/EA-0195 (August 1982).

2. A. L. Boni. "Rapid Ion Exchange Analysis of Radiocesium in Milk, Urine, Sea Water, and Environmental Samples." Analytical Chemistry 38: 89 (1966).

3. D. W. Hayes. "Examples of Savannah River Water Dilution Between the Savannah River Plant and the Beaufort-Jasper and Port Wentworth Water Treatment Plants." DPST-82-1076 (January 12, 1983).

A.3 CESIUM-137 DOWNSTREAM CONCENTRATIONS

The estimates reported in the L-Reactor Environmental Assessment of the maximum Cs-137 concentrations in the Savannah River and drinking water as a result of the restart of L Reactor were based on the expected first year release of 9.8 Ci and an average flow for the Savannah River.[1] In the light of the above data and a redetermined Cs-137 first year release of 4.4 Ci, a re-evaluation of these calculations was made to account for the non-conservative processes that affect the transport of Cs-137. The Cs-137 concentration calculations are as follows:

- Water

  - Highway 301

    4.4 Ci/9.306 x 10 E12 L (avg. annual flow) = 0.47 pCi/L

  - Highway 17

    0.47 pCi/L x 0.523 = 0.25 pCi/L

  - Finished Water — Port Wentworth

    0.47 pCi/L x 0.197 = 0.092 pCi/L

  - Finished Water — Beaufort-Jasper

    0.47 pCi/L x .0245 = .012 pCi/L

- Water Treatment Sludge

  Assume all of the Cs-137 is in the sediment and no credit is taken for Cs-137 that passes through the water treatment process and the increase in solids as a result of chemical additions at the plant. Suspended solids concentration of 15 m/L and the water concentration is as calculated above.

  - Sludge Port Wentworth (Highway 17, Cs-137 concentration used)

    Sludge (pCi/g) = 0.25 (pCi/L)/0.015 (g/L) = 17 pCi/g

  - Sludge Beaufort-Jasper

    The concentration of Cs-137 in the input water is calculated using the Cs-137 removal factor developed in the previous section on water treatment plants and the finished water concentration from above.

    Sludge (pCi/g) = 0.012 (pCi/L) x 2.66/0.015 (g/L) = 2.1

Reference

1. DOE. Environmental Assessment L-Reactor Operation Savannah River Plant, Aiken, SC. DOE/EA-0195 (August 1982).

A.4 CESIUM-137 FROM NUCLEAR FALLOUT

Fission products from nuclear weapons tests have been deposited across the earth's surface. Since testing began in the 1940s, approximately 680 megaton equivalents have been detonated in the earth's atmosphere.[1] As demonstrated by the results of the Health Protection Department (HP) onsite and offsite air monitoring program (Figures A-4 and A-5, the most intensive testing period occurred in the early 1960s. Both long-lived (Sr-90, Cs-137, Pu-139, etc.) and short-lived (Mn-54, Sr-89, I-131, etc.) radionuclides were deposited globally. Worldwide surveys have been conducted to determine the deposition and fate of these radionuclides. These studies indicated that a large fraction of the fallout debris was deposited in the northern hemisphere. In 1963, several of the countries engaged in weapons testing signed a moratorium on atmospheric testing. Since then, these agreement countries have conducted only underground weapons testing. This mode of testing results in only low levels of radioactivity being released to the atmosphere. Occasional atmospheric testing has been conducted since 1963 by the countries who did not sign the moratorium.

Atmospheric testing caused 25,600,000 Ci of Cs-137 to be deposited on the earth's surface.[2] About 104 mCi/km^2 of Cs-137 was deposited in the latitude band (30 to 40 North) where South Carolina is located.[2] The total resultant deposition was 2850 Ci and 80 Ci of Cs-137 in the 27,400 km^2 of the Savannah River watershed and the 780 km^2 of SRP, respectively. The deposited Cs-137 became attached to soil particles and has undergone only slow transport from the watershed. Results from the routine HP monitoring program indicate that since 1963 about 1% of the 2870 Ci of Cs-137 deposited on the total Savannah River watershed has been transported down the river.[3]

Recent onsite monitoring conducted by Health Protection Department shows that up to 53 mCi/km^2 of Cs-137 are in the upper 5 cm of the soil column.[4] This value is one-half of that amount originally deposited. The difference demonstrated that some of the radiocesium has moved down in the soil column and some has undergone hydrologic transport to the Savannah River.

Since SRP startup, approximately 500 Ci of Cs-137 have been discharged to the surface streams of SRP. This is about six times the amount that was deposited on the site as a result of nuclear weapons tests. Most of the released Cs-137 became bound to stream and lake sediments and remained onsite. Only about 20% (90 Ci) of the Cs-137 discharged has been measured in transport at Highway 301 and most of this transport was measured during the period of discharge. The amount of SRP contributed Cs-137 measured in the river is about three to four times the amount of fallout Cs-137

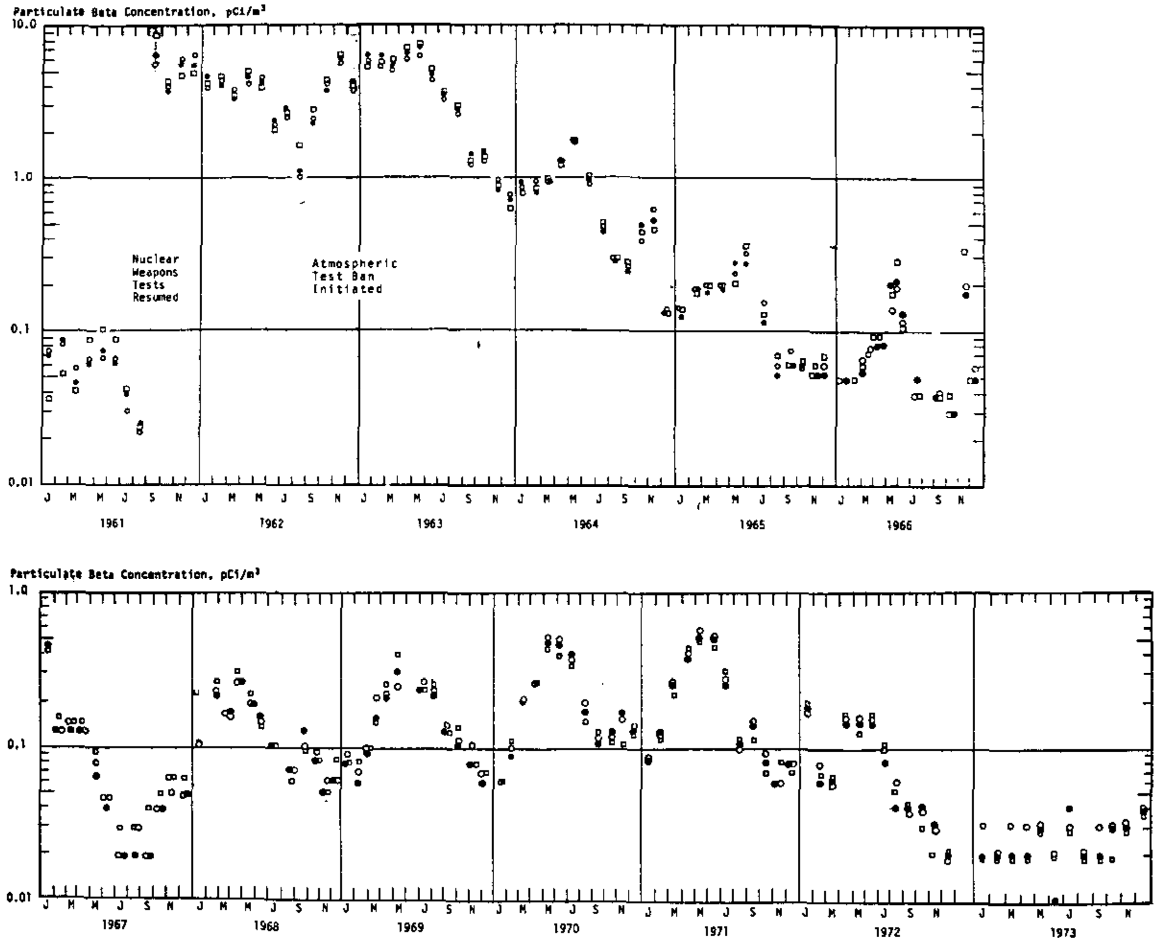

Figure A-4. Atmospheric radioactivity, 1961-1973

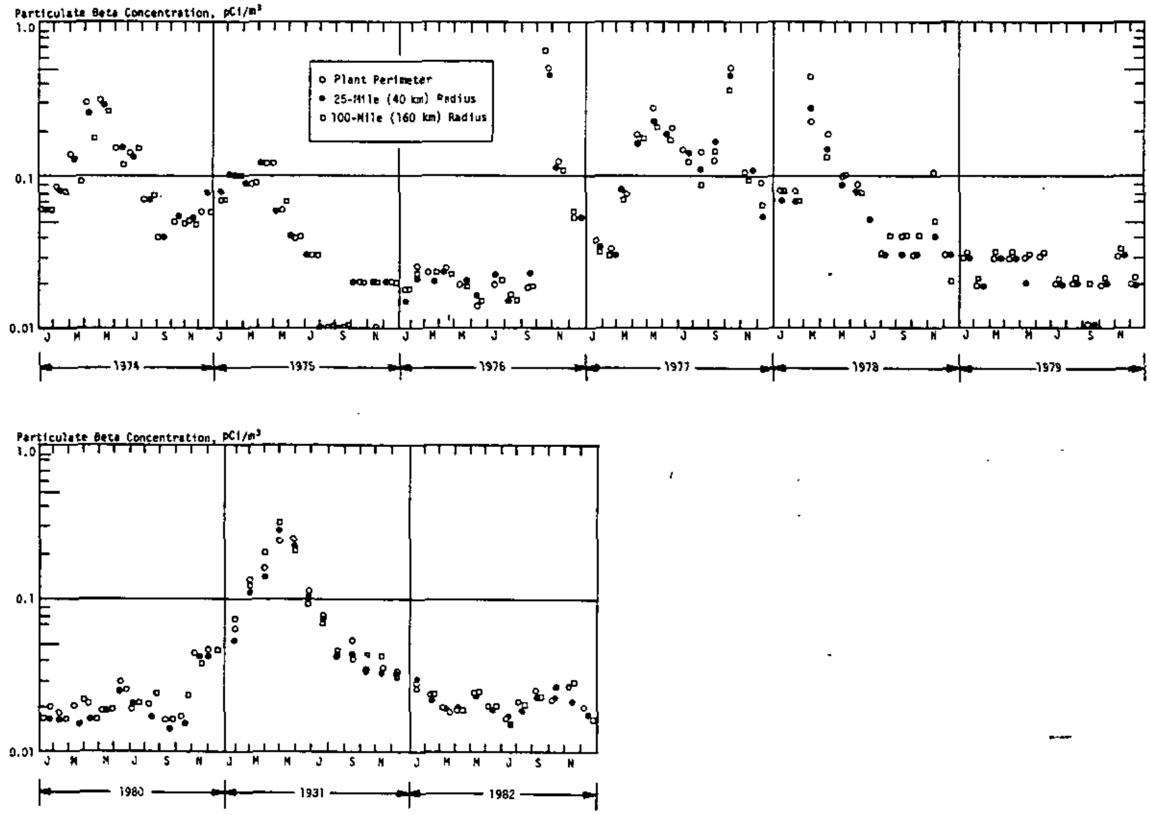

Figure A-5. Atmospheric radioactivity, 1974-1981 measured. Since 1971, very little Cs-137 has been transported past Highway 301 indicating that the removal process from stream sediments into the river is slow. The highest Cs-137 concentrations found in the river occurred in the early 1960s when SRP releases were highest and fallout was at a maximum.

REFERENCES

1. J. A. Miskel. Production of Tritium by Nuclear Weapons, Tritium, A. A. Moghissi and M. W. Carter Editors, Messenger Graphics, Phoenix, AZ (1973).

2. United Nations, Sources and Effects of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation, 1977 Report to the General Assembly, with Annexes, United Nations Sales Section, New York, NY (1977).

3. About 31.7 Ci Have Been Measured in Transport Above SRP. The Total Amount of Cs-137 on the Savannah River Watershed is 2850 Ci of Cs-137. Therefore, about 1.1% of the Cs-137 has moved downstream [(31.7/2850) x 100].

4. 1981 Annual Report on Environmental Monitoring at SRP. The Years of 1974 Through 1981 were Averaged (59, 72, 74, 54, 57, 52, 23, and 42 mCi/Square Kilometer, Respectively).

APPENDIX B

GEORGIA FISHERY DATA, SAVANNAH RIVER

GEORGIA FISHERY DATA, SAVANNAH RIVER

Table B-1 presents a summary of the Savannah River creel survey data for the period of July 1, 1981, to June 30, 1982.[1] These values represent the first available site-specific data on angler use on the Savannah River.

TABLE B-1

Creel Data Summary

Total trips	77,941 ±7,897*
Total angler hours	352,310 ±46,912
Total fish caught	550,282 ±94,047
Total fish weight (kg)	103,682 ±17,097
Trips per angler	17 ±5
Total anglers	4,585 ±1,579

* One standard deviation

Table B-2 presents the calculations used to derive a value for "average" angler fish consumption based upon the site-specific data presented in Table B-1.

TABLE B-2

Average Angler Fish Catch and Consumption

a. (103,682 kg)/(77,951 trip/$\overline{y}$r) = 1.33 kg/trip/yr
b. (1.33 kg/trip/yr)(17 trip/yr) = 22.6 kg/caught/yr
c. (22.6 kg caught/yr)(0.5 kg eaten/kg/caught)
   = 11.3 (±4.2 kg eaten/yr)

Table B-3 presents the calculations used to derive a value for "maximum" angler fish consumption based upon the site-specific data presented in Table B-1.

TABLE B-3

Maximum Angler Fish Catch and Consumption

a. (644,329 fish/305,398 hr) = 2.1 fish/hr
b. (399,222 hr)/(70,054 trip/yr) = 5.7 hr/trip/yr
c. (120,777 kg/456,235 fish) = 0.26 kg/fish
d. (2.1)(5.7)(0.26) = 3.1 kg caught/trip/yr
e. (3.1 kg caught/trip/yr)(22 trip/yr) = 68.5 kg caught/yr
f. (68.5 kg caught/yr)(0.5) = 34.2 kg eaten/yr

REFERENCE FOR APPENDIX B

1. J. H. Hornsby. Coastal Region Fisheries Investigations. Georgia Department of Natural Resources, Richmond Hill, GA. (October 10, 1983).

APPENDIX C

CALCULATION OF FRESHWATER FISH CONSUMPTION

CALCULATION OF FRESHWATER FISH CONSUMPTION

Table C-1 presents the calculation of both average and maximum fish consumption based on site-specific data[1] and the computational methods presented by Fletcher and Dotson.[2] The Fletcher-Dotson methodology is the basis for the NRC calculations of fish consumption values when site-specific data is available.

TABLE C-1

Calculation Procedure

I. <u>Prorated Population Weighted Average Fish Catch</u>

a. (550,282 fish/352,310 hr) = 1.56 fish/hr
b. (352,310 hr/77,951 trip) ≠ 4.52 hr/trip
c. (1.56 fish/hr)(4.52 hr/trip)(17 trip/yr/angler) = 120 fish/yr/angler
d. (120 fish/yr/angler)(.1 angler/person) = 12 fish/yr/person

II. <u>Fish Weight</u>

a. (103,682 kg/550,282 fish)(0.5 kg edible/kg) = 0.09 kg edible/fish

III. <u>Prorated Population Weighted Fish Consumption</u>

a. Average - (12 fish/hr/person)(0.09 kg edible/fish) = 1.08 kg edible/yr/person
b. Maximum - (1.08 kg edible/yr/person)(20) = 21.6 kg edible/yr/person

REFERENCES FOR APPENDIX C

1. J. H. Hornsby. Coastal Region Fisheries Investigations. Georgia Department of National Resources, Richmond Hill, GA. (October 10, 1983).

2. J. F. Fletcher and W. L. Dotson, "HERMES -- A Digital Computer Code for Estimating Regional Radiation Effects from the Nuclear Power Industry," HEDL-TME-71-168, Hanford, WA, pp. 141-142 (1971).

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APPENDIX D

LIQUID DOSE ASSESSMENT

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APPENDIX D

LIQUID DOSE ASSESSMENT

The following tables summarize the calculated expected doses resulting from liquid releases due to L-Reactor restart. These tables include estimates of doses from remobilization of cesium-137 and cobalt-60 from Steel Creek, routine releases from L Reactor to plant streams, and migration from low-level seepage basins.

TABLE D-1

LIQUID RELEASE DOSE SUMMARY

Cs-137 (4.4 Ci), Releases from Steel Creek — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	2.92E-3	3.87E+0	5.29E+0	3.47E+0	2.52E-3	1.80E+0	6.00E-1	1.05E-1
Teen	9.79E-2	3.99E+0	5.30E+0	1.85E+0	8.41E-3	1.81E+0	7.08E-1	8.37E-2
Child	2.04E-3	5.27E+0	5.05E+0	7.46E-1	1.77E-3	1.65E+0	5.93E-1	3.34E-2
Infant	-	8.14E-2	9.53E-2	6.75E-3	-	2.56E-2	1.04E-2	2.98E-4
Population, man-rem								
Port Wentworth*	-	8.00E-2	1.09E-1	7.17E-2	-	3.72E-2	1.24E-2	2.12E-3
Beaufort-Jasper*	-	1.92E-2	2.28E-2	1.03E-2	-	7.63E-3	2.64E-3	3.27E-4
Fish-Sport	-	1.30E-1	1.64E+1	8.50E+0	-	5.52E+0	1.90E+0	2.65E-1
Fish-Commercial	-	7.57E-1	9.53E-1	4.95E-1	-	3.21E-1	1.11E-1	1.54E-2
Salt Water Invert	-	1.90E-4	2.39E-4	1.23E-4	-	8.03E-5	2.77E-5	3.85E-6
Recreation	2.92E-2	-	-	2.52E-2	2.52E-2	-	-	-
Total	2.92E-2	1.39E+1	1.75E+1	9.10E+0	2.52E-2	5.89E+0	2.03E+0	2.83E-1

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

* Adjusted for Cs-137 DF across water treatment plants

TABLE D-2

LIQUID RELEASE DOSE SUMMARY

Cs-137 (4.4 Ci) Releases from Steel Creek —
Low River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	4.99E-3	6.61E+0	9.04E+0	5.92E+0	4.31E-3	3.07E+0	1.02E+0	1.79E-1
Teen	1.67E-2	6.81E+0	9.06E+0	3.16E+0	1.44E-2	3.09E+0	1.21E+0	1.43E-1
Child	3.49E-3	9.00E+0	8.62E+0	1.27E+0	3.03E-3	2.81E+0	1.01E+0	5.70E-2
Infant	-	1.39E-1	1.63E-1	1.15E-2	-	4.37E-2	1.77E-2	5.09E-4
Population, man-rem								
Port Wentworth*	-	1.37E-1	1.87E-1	1.22E-1	-	6.35E-2	2.11E-2	3.62E-3
Beaufort-Jasper*	-	3.28E-2	3.89E-2	1.76E-2	-	1.30E-2	4.51E-3	5.59E-4
Fish-Sport	-	2.22E+1	2.80E+1	1.45E+1	-	9.42E+0	3.25E+0	4.53E-1
Fish-Commercial	-	1.29E+0	1.63E+0	8.45E-1	-	5.48E-1	1.89E-1	2.64E-2
Salt Water Invert	-	3.24E-4	4.07E-4	2.11E-4	-	1.37E-4	4.73E-5	6.57E-6
Recreation	4.99E-2	-	-	4.32E-2	4.32E-2	-	-	-
Total	4.99E-2	2.36E+1	2.99E+1	1.55E+1	4.32E-2	1.00E+1	3.46E+0	4.84E-1

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 6,100 cfs

* Adjusted for Cs-137 DF across water treatment plants

TABLE D-3

LIQUID RELEASE DOSE SUMMARY

Co-60 (0.252 Ci) Releases from Steel Creek — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	3.49E-4	3.02E-4	4.41E-4	6.09E-4	3.02E-4	3.02E-4	3.02E-4	2.92E-3
Teen	1.17E-3	9.98E-4	1.13E-3	1.30E-3	9.98E-4	9.98E-4	9.98E-4	2.72E-3
Child	2.44E-4	2.13E-4	3.64E-4	6.60E-4	2.13E-4	2.13E-4	2.13E-4	1.05E-3
Infant	-	-	9.56E-5	2.26E-4	-	-	-	2.28E-4
Population, man-rem								
Port Wentworth	-	-	6.19E-4	1.37E-3	-	-	-	1.16E-2
Beaufort-Jasper	-	-	9.82E-4	2.40E-3	-	-	-	1.39E-2
Fish-Sport	-	-	2.94E-4	6.87E-4	-	-	-	4.65E-3
Fish-Commercial	-	-	1.71E-5	4.00E-5	-	-	-	2.70E-4
Salt Water Invert	-	-	1.03E-5	2.40E-5	-	-	-	1.62E-4
Recreation	5.59E-2	-	-	3.03E-3	-	-	-	-
Total	5.59E-2	-	1.92E-3	7.55E-3	-	-	-	3.06E-2

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-4

LIQUID RELEASE DOSE SUMMARY

Co-60 (0.252 Ci) Releases from Steel Creek –
Low River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	5.96E-4	5.15E-4	7.53E-4	1.04E-3	5.15E-4	5.15E-4	5.15E-4	4.99E-3
Teen	2.00E-3	1.71E-3	1.93E-3	2.21E-3	1.71E-3	1.71E-3	1.71E-3	4.65E-3
Child	4.17E-4	3.63E-4	6.22E-4	1.13E-3	3.63E-4	3.63E-4	3.63E-4	1.80E-3
Infant	–	–	1.63E-4	3.86E-4	–	–	–	3.89E-4
Population, man-rem								
Port Wentworth	–	–	1.06E-3	2.33E-3	–	–	–	1.99E-2
Beaufort-Jasper	–	–	1.68E-3	4.10E-3	–	–	–	2.37E-2
Fish-Sport	–	–	5.02E-4	1.17E-3	–	–	–	7.93E-3
Fish-Commercial	–	–	2.92E-5	6.82E-5	–	–	–	4.61E-4
Salt Water Invert	–	–	1.75E-5	4.10E-5	–	–	–	2.76E-4
Recreation	5.96E-3	–	–	5.16E-3	5.16E-3	–	–	–
Total	5.96E-3	–	3.29E-3	1.29E-2	5.16E-3	–	–	5.23E-2

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 6,100 cfs

TABLE D-5

LIQUID RELEASE DOSE SUMMARY

Co-60 (0.252 Ci) and Cs-137 (4.4 Ci) Releases from Steel Creek — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	3.28E-3	3.88E+0	5.30E+0	3.48E+0	2.83E-3	1.80E+0	6.01E-1	1.08E-1
Teen	1.10E-2	4.00E+0	5.31E+0	1.86E+0	9.42E-3	1.81E+0	7.11E-1	8.66E-2
Child	2.29E-3	5.28E+0	5.06E+0	7.48E-1	1.99E-3	1.65E+0	5.95E-1	3.45E-2
Infant	-	8.15E-2	9.55E-2	6.99E-3	-	2.56E-2	1.04E-2	5.26E-4
Population, man-rem								
Port Wentworth*	-	8.00E-2	1.10E-1	7.31E-2	-	3.72E-2	1.24E-2	1.40E-2
Beaufort-Jasper*	-	1.92E-2	2.38E-2	1.27E-2	-	7.63E-3	2.64E-3	1.39E-2
Fish-Sport	-	1.30E+1	1.64E+1	8.52E+0	-	5.53E+0	1.90E+0	2.70E-1
Fish-Commercial	-	7.58E-1	9.54E-1	4.96E-1	-	3.22E-1	1.11E-1	1.57E-2
Salt Water Invert	-	1.90E-4	2.49E-4	1.47E-4	-	8.03E-5	2.77E-5	1.65E-4
Recreation	3.28E-2	-	-	2.84E-2	2.84E-2	-	-	-
Total	3.28E-2	1.39E+1	1.75E+1	9.13E+0	2.84E-2	5.90E+0	2.03E+0	3.14E+1

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

* Adjusted for Cs-137 DF at water treatment plants.

TABLE D-6

LIQUID RELEASE DOSE SUMMARY

Co-60 (0.252 Ci) and Cs-137 (4.4 Ci) Releases
from Steel Creek — Low River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	5.59E-3	6.61E+0	9.04E+0	5.92E+0	4.82E-3	3.07E+0	1.02E+0	1.84E-1
Teen	1.87E-2	6.81E+0	9.06E+0	3.17E+0	1.61E-2	3.09E+0	1.21E+0	1.48E-1
Child	3.91E-3	9.01E+0	8.62E+0	1.28E+0	3.39E-3	2.82E+0	1.01E+0	5.88E-2
Infant	-	1.39E-1	1.63E-1	1.19E-2	-	4.37E-2	1.77E-2	8.97E-4
Population, man-rem								
Port Wentworth*	-	1.37E-1	1.88E-1	1.25E-1	-	6.35E-2	2.11E-2	2.40E-2
Beaufort-Jasper*	-	3.28E-2	4.05E-2	2.16E-2	-	1.30E-2	4.51E-3	2.38E-2
Fish-Sport	-	2.22E+1	2.80E+1	1.45E+1	-	9.42E+0	3.25E+0	4.61E-1
Fish-Commercial	-	1.29E+0	1.63E+0	8.45E-1	-	5.48E-1	1.89E-1	2.68E-2
Salt Water Invert	-	3.24E-4	4.25E-4	2.52E-4	-	1.37E-4	4.73E-5	2.82E-4
Recreation	5.59E-2	-	-	4.83E-2	4.83E-2	-	-	-
Total	5.59E-2	2.37E+1	2.99E+1	1.55E+1	4.83E-2	1.00E+1	3.46E+0	5.36E-1

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 6,100 cfs

* Adjusted for Cs-137 DF at water treatment plants.

TABLE D-7

LIQUID RELEASE DOSE SUMMARY

SRP Average Releases 1978-1980, Three Reactors Operating — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	4.06E-4	7.91E-1	4.26E-1	5.26E-1	2.51E-1	3.12E-1	2.70E-1	2.76E-1
Teen	1.36E-3	4.20E-1	3.54E-1	3.14E-1	1781E-1	2.40E-1	2.01E-1	1.97E-1
Child	2.84E-4	6.72E-1	4.98E-1	4.84E-1	3.31E-1	3.90E-1	3.51E-1	3.43E-1
Infant	-	2.28E-1	3.22E-1	3.75E-1	3.18E-1	3.24E-1	3.19E-1	3.23E-1
Population, man-rem								
Port Wentworth	-	2.18E+0	3.57E+0	4.12E+0	3 55E+0	3.58E+0	3.55E+0	3.68E+0
Beaufort-Jasper	-	3.67E+0	5.17E+0	6.08E+0	5.14E+0	5.19E+0	5.14E+0	5.31E+0
Fish-Sport	-	1.43E+0	5.71E-1	5.59E-1	2.84E-2	2.12E-1	9.14E-2	7.05E-2
Fish-Commercial	-	8.30E-2	3.32E-2	3.25E-2	1.65E-3	1.23E-2	5.32E-3	4.10E-3
Salt Water Invert	-	7.46E-4	7.07E-5	2.65E-4	5.14E-5	6.11E-5	5.23E-5	2.30E-4
Recreation	4.06E-3	-	-	3.51E-3	3.51E-3	-	-	-
Total	4.06E-3	7.36E+0	9.34E+0	1.08E+1	9.05E+0	8.99E+0	8.79E+0	9.06E+0

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-8

LIQUID RELEASE DOSE SUMMARY

L and Associated Areas, Average Year Releases — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	7.98E-5	2.88E-1	6.14E-2	1.19E-1	3.76E-2	4.65E-2	4.03E-2	4.65E-2
Teen	2.67E-4	1.35E-1	5.06E-2	6.57E-2	2.67E-2	3.57E-2	2.99E-2	3.35E-2
Child	5.59E-5	2.26E-1	7.24E-2	1.05E-1	4.97E-2	5.86E-2	5.23E-2	5.40E-2
Infant	-	9.18E-2	4.82E-2	7.08E-2	4.78E-2	4.96E-2	4.78E-2	4.94E-2
Population, man-rem								
Port Wentworth	-	8.85E-1	5.35E-1	7.61E-1	5 32E-1	5.44E-1	5.33E-1	5.86E-1
Beaufort-Jasper	-	1.49E+0	7.75E-1	1.15E+0	7.70E-1	7.90E-1	7.71E-1	8.38E-1
Fish-Sport	-	4.66E-1	7.80E-2	1.44E-1	4.25E-3	2.93E-2	1.28E-2	1.83E-2
Fish-Commercial	-	2.71E-2	4.54E-3	8.38E-3	2.47E-4	1.70E-3	7.45E-4	1.06E-3
Salt Water Invert	-	3.06E-4	1.16E-5	8.99E-5	7.71E-6	1.08E-5	7.83E-6	5.31E-5
Recreation	7.98E-4	-	-	6.89E-4	6.89E-4	-	-	-
Total	7.98E-4	2.87E+0	1.39E+0	2.06E+0	1.31E+0	1.37E+0	1.32E+0	1.44E+0

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

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TABLE D-9

LIQUID RELEASE DOSE SUMMARY

L and Associated Areas, Maximum Year Releases — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	6.11E-4	3.82E-1	9.39E-2	1.03E-1	5.32E-2	6.21E-2	5.59E-2	9.14E-2
Teen	2.05E-3	3.42E-1	8.04E-2	6.95E-2	3.90E-2	4.79E-2	4.21E-2	6.82E-2
Child	4.28E-4	4.77E-1	1.11E-1	1.07E-1	7.01E-2	7.90E-2	7.27E-2	8.36E-2
Infant	–	3.81E-2	6.77E-2	7.60E-2	6.71E-2	6.89E-2	6.71E-2	6.81E-2
Population, man-rem								
Port Wentworth	–	3.44E-1	7.52E-1	8.33E-1	7 48E-1	7.59E-1	7.48E-1	7.88E-1
Beaufort-Jasper	–	5.88E-1	1.09E+0	1.22E+0	1.08E+0	1.10E+0	1.08E+0	1.13E+0
Fish-Sport	–	8.22E-1	1.16E-1	1.05E-1	5.98E-3	3.10E-2	1.45E-2	7.38E-2
Fish-Commercial	–	4.30E-2	6.48E-3	5.92E-3	3.48E-4	1.80E-3	8.45E-4	3.87E-3
Salt Water Invert	–	4.02E-4	4.69E-5	9.12E-5	1.09E-5	1.39E-5	1.10E-5	3.26E-4
Recreation	6.11E-3	–	–	5.29E-3	5.29E-3	–	–	–
Total	6.11E-3	1.80E+0	1.96E+0	2.17E+0	1.84E+0	1.89E+0	1.84E+0	2.00E+0

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

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TABLE D-10

LIQUID RELEASE DOSE SUMMARY

L-Area Low-Level Seepage Basin Migration, Average Year, 4.4 x 10^0 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	7.02E-7	1.06E-6	7.68E-2	7.68E-2	7.68E-2	7.68E-2	7.68E-2	7.69E-2
Teen	2.35E-6	2.48E-6	5.43E-2	5.43E-2	5.43E-2	5.43E-2	5.43E-2	5.43E-2
Child	4.92E-7	1.61E-6	1.02E-1	1.02E-1	1.02E-1	1.02E-1	1.02E-1	1.02E-1
Infant	-	1.25E-6	9.78E-2	9.78E-2	9.78E-2	9.78E-2	9.78E-2	9.78E-2
Population, man-rem								
Port Wentworth	-	5.96E-6	1.09E+0	1.09E+0	1.09E+0	1.09E+0	1.09E+0	1.09E+0
Beaufort-Jasper	-	1.14E-5	1.58E+0	1.58E+0	1.58E+0	1.58E+0	1.58E+0	1.58E+0
Fish-Sport	-	9.01E-8	8.71E-3	8.71E-3	8.71E-3	8.71E-3	8.71E-3	8.72E-3
Fish-Commercial	-	5.23E-9	5.07E-4	5.07E-4	5.07E-4	5.07E-4	5.07E-4	5.07E-4
Salt Water Invert	-	5.56E-9	1.58E-5	1.58E-5	1.58E-5	1.58E-5	1.58E-5	1.68E-5
Recreation	7.02E-6	-	-	6.26E-6	6.26E-6	-	-	-
Total	7.02E-6	1.75E-5	2.68E+0	2.68E+0	2.69E+0	2.68E+0	2.68E+0	2.68E+0

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-11

LIQUID RELEASE DOSE SUMMARY

L-Area Low-Level Seepage Basin Migration, Average Year, 3.9 x 10^4 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	1.29E-10	6.89E-6	8.27E-7	1.81E-7	1.32E-11	7.70E-7	1.32E-11	6.33E-7
Teen	4.31E-10	5.11E-6	6.21E-7	1.34E-7	4.42E-11	5.73E-7	4.42E-11	4.72E-7
Child	9.00E-11	7.93E-6	8.48E-7	2.03E-7	9.23E-12	7.50E-7	9.23E-12	4.21E-7
Infant	-	5.10E-6	5.72E-7	1.31E-7	-	4.73E-7	-	2.55E-7
Population, man-rem								
Port Wentworth	-	8.76E-5	1.05E-5	2.31E-6	-	9.79E-6	-	8.04E-6
Beaufort-Jasper	-	1.24E-4	1.45E-5	3.25E-6	-	1.34E-5	-	1.02E-5
Fish-Sport	-	2.70E-6	3.21E-7	7.10E-8	-	2.96E-7	-	2.35E-7
Fish-Commercial	-	1.57E-7	1.87E-8	4.13E-9	-	1.72E-8	-	1.37E-8
Salt Water Invert	-	2.71E-7	3.21E-8	7.11E-9	-	2.96E-8	-	2.34E-8
Recreation	1.29E-9	-	-	1.32E-10	1.32E-10	-	-	-
Total	1.29E-9	2.15E-4	2.54E-5	5.64E-6	1.32E-10	2.35E-5	-	1.85E-5

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-12

LIQUID RELEASE DOSE SUMMARY

L-Area Low-Level Seepage Basin Migration, Maximum Year, 4.4 x 10^0 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	3.36E-4	2.91E-4	7.01E-2	7.03E-2	7.00E-2	7.00E-2	7.00E-2	7.25E-2
Teen	1.12E-3	9.61E-4	5.03E-2	5.05E-2	5.02E-2	5.02E-2	5.02E-2	5.19E-2
Child	2.35E-4	2.08E-4	9.25E-2	9.28E-2	9.23E-2	9.23E-2	9.23E-2	9.32E-2
Infant	-	3.30E-6	8.88E-2	8.89E-2	8.87E-2	8.87E-2	8.87E-2	8.89E-2
Population, man-rem								
Port Wentworth	-	1.57E-5	9.89E-1	9.90E-1	9.88E-1	9.88E-1	9.88E-1	1.00E-0
Beaufort-Jasper	-	3.00E-5	1.43E+0	1.43E+0	1.43E+0	1.43E+0	1.43E+0	1.44E+0
Fish-Sport	-	2.31E-7	8.18E-3	8.56E-3	7.90E-3	7.90E-3	7.90E-3	1.24E-2
Fish-Commercial	-	1.34E-8	4.76E-4	4.98E-4	4.60E-4	4.60E-4	4.60E-4	7.19E-4
Salt Water Invert	-	1.36E-8	2.42E-5	3.75E-5	1.43E-5	1.43E-5	1.43E-5	1.71E-4
Recreation	3.36E-3	-	-	2.90E-3	2.90E-3	-	-	-
Total	3.36E-3	4.60E-5	2.43E+0	2.43E+0	2.43E+0	2.43E+0	2.43E+0	2.45E-0

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-13

LIQUID RELEASE DOSE SUMMARY

L-Area Low-Level Seepage Basin Migration, Maximum Year, 3.9 x 10^4 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	1.54E-10	8.27E-6	9.93E-7	2.18E-7	1.58E-11	9.25E-7	1.58E-11	7.59E-7
Teen	5.27E-10	6.13E-6	7.45E-7	1.61E-7	5.30E-11	6.87E-7	5.30E-11	5.66E-7
Child	1.08E-10	9.51E-6	1.02E-6	2.44E-7	1.11E-11	9.00E-7	1.11E-11	5.05E-7
Infant	-	6.12E-6	6.87E-7	1.57E-7	-	5.67E-7	-	3.06E-7
Population, man-rem								
Port Wentworth	-	1.49E-4	1.74E-5	3.90E-6	-	1.60E-5	-	1.22E-5
Beaufort-Jasper	-	1.05E-4	1.26E-5	2.77E-6	-	1.18E-5	-	9.65E-6
Fish-Sport	-	3.25E-6	3.85E-7	8.52E-8	-	3.56E-7	-	2.82E-7
Fish-Commercial	-	1.89E-7	2.24E-8	4.96E-9	-	2.07E-8	-	1.64E-8
Salt Water Invert	-	3.25E-7	3.85E-8	3.53E-9	-	3.55E-8	-	2.81E-8
Recreation	1.54E-9	-	-	1.58E-10	1.58E-10	-	-	-
Total	1.54E-9	2.58E-4	3.04E-5	6.76E-6	1.58E-10	2.82E-5	-	2.22E-5

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-14

LIQUID RELEASE DOSE SUMMARY

M-Area Seepage Basin Migration, 4.2 x 10^3 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	8.76E-7	2.40E-3	6.47E-7	1.43E-4	6.47E-7	5.48E-4	6.47E-7	1.73E-4
Teen	2.94E-6	2.39E-3	2.16E-6	1.44E-4	2.16E-6	5.50E-4	2.16E-6	1.30E-4
Child	6.14E-7	6.82E-3	4.54E-7	4.05E-4	4.54E-7	1.09E-3	4.54E-7	1.18E-4
Infant	-	5.78E-3	-	4.30E-4	-	1.20E-3	-	7.38E-5
Population, man-rem								
Port Wentworth	-	3.24E-2	-	1.92E-3	-	7.40E-3	-	2.32E-3
Beaufort-Jasper	-	6.36E-2	-	3.77E-3	-	1.26E-2	-	2.95E-3
Fish-Sport	-	7.00E-4	-	4.15E-5	-	1.47E-4	-	3.88E-5
Fish-Commercial	-	4.07E-5	-	2.41E-6	-	8.57E-6	-	2.26E-6
Salt Water Invert	-	6.19E-6	-	3.67E-7	-	1.30E-6	-	3.38E-7
Recreation	8.76E-6	-	-	6.48E-6	6.48E-6	-	-	-
Total	8.76E-6	9.67E-2	-	5.74E-3	6.48E-6	2.02E-2	-	5.31E-3

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

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TABLE D-15

LIQUID RELEASE DOSE SUMMARY

Separation Areas Seepage Basin, 3.8 x 10^0 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	6.83E-5	3.01E-4	4.12E-2	4.13E-2	4.12E-2	4.16E-2	4.12E-2	5.70E-2
Teen	2.29E-4	4.37E-4	2.93E-2	2.93E-2	2.92E-2	2.97E-2	2.92E-2	4.11E-2
Child	4.78E-5	6.12E-4	5.44E-2	5.45E-2	5.44E-2	5.51E-2	5.44E-2	6.39E-2
Infant	-	5.99E-4	5.23E-2	5.24E-2	5.23E-2	5.30E-2	5 23E-2	5.74E-2
Population, man-rem								
Port Wentworth	-	2.25E-3	5.83E-1	5.83E-1	5.83E-1	5.87E-1	5.83E-2	7.45E-1
Beaufort-Jasper	-	4.41E-3	8.44E-1	8.45E-1	8.44E-1	8.51E-1	8.44E-1	1.05E+0
Fish-Sport	-	2.95E-4	4.89E-3	4.87E-3	4.66E-3	5.20E-3	4.66E-3	1.73E-2
Fish-Commercial	-	1.71E-5	2.84E-4	2.83E-4	2.71E-4	3.02E-4	2.71E-7	1.00E-3
Salt Water Invert	-	4.42E-5	1.84E-3	2.10E-5	8.44E-6	8.63E-5	8.44E-6	2.23E-3
Recreation	6.83E-4	-	-	5.86E-4	5.86E-4	-	-	-
Total	6.83E-4	7.02E-3	1.43E+0	1.43E+0	1.43E+0	1.44E+0	1.43E+0	1.82E+0

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

UNCLASSIFIED

TABLE D-16

LIQUID RELEASE DOSE SUMMARY

Separation Areas Seepage Basin, 1.5×10^3 Years Travel Time —
Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	2.07E-7	4.37E-3	5.53E-4	1.19E-4	1.49E-8	5.08E-4	1.49E-8	5.06E-4
Teen	6.83E-7	3.27E-3	4.19E-4	8.88E-5	5.00E-8	3.81E-4	5.00E-8	3.77E-4
Child	1.45E-7	5.34E-3	6.19E-4	1.42E-4	1.05E-8	5.16E-4	1.05E-8	3.36E-4
Infant	-	3.45E-3	4.04E-4	9.16E-5	-	3.26E-4	-	2.04E-4
Population, man-rem								
Port Wentworth	-	6.76E-2	-	4.00E-3	-	1.54E-2	-	4.85E-3
Beaufort-Jasper	-	1.33E-1	-	7.86E-3	-	2.63E-2	-	6.15E-3
Fish-Sport	-	1.73E-3	2.17E-4	4.68E-5	-	1.96E-4	-	1.88E-4
Fish-Commercial	-	1.01E-4	1.26E-5	2.73E-6	-	1.14E-5	-	1.09E-5
Salt Water Invert	-	1.29E-5	-	7.65E-7	-	2.70E-6	-	7.05E-7
Recreation	2.07E-6	-	-	1.49E-7	1.49E-7	-	-	-
Total	2.07E-6	2.02E-1	2.30E-4	1.19E-2	1.49E-7	4.19E-2	-	1.12E-2

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-17

LIQUID RELEASE DOSE SUMMARY

Separation Areas Seepage Basin, 2.5 x 10^4 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	8.26E-7	4.41E-4	4.03E-4	3.16E-5	7.20E-7	2.34E-4	7.20E-7	5.15E-5
Teen	2.77E-6	3.35E-4	3.10E-4	2.59E-5	2.40E-6	1.79E-4	2.40E-6	4.10E-5
Child	5.78E-7	3.91E-4	3.30E-4	2.92E-5	5.06E-7	1.77E-4	5.06E-7	2.66E-5
Infant	-	1.75E-4	1.50E-4	1.29E-5	-	7.75E-5	-	1.10E-5
Population, man-rem								
Port Wentworth	-	3.00E-3	2.75E-3	2.11E-4	-	1.59E-3	-	3.47E-4
Beaufort-Jasper	-	4.27E-3	3.83E-3	3.03E-4	-	2.17E-3	-	4.40E-4
Fish-Sport	-	6.63E-4	6.01E-4	4.69E-5	-	3.44E-4	-	7.23E-5
Fish-Commercial	-	3.86E-5	3.50E-5	2.73E-6	-	2.00E-5	-	4.20E-6
Salt Water Invert	-	4.65E-5	4.21E-5	3.29E-6	-	2.41E-5	-	5.04E-6
Recreation	8.26E-6	-	-	7.21E-6	7.21E-6	-	-	-
Total	8.26E-6	8.02E-3	7.26E-3	5.74E-4	7.21E-6	4.15E-3	-	8.69E-4

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-18

LIQUID RELEASE DOSE SUMMARY

Separation Areas Seepage Basin, 3.4 x 10^4 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	4.37E-9	2.34E-4	2.81E-5	6.17E-6	4.48E-10	2.62E-5	4.48E-10	2.15E-5
Teen	1.46E-8	1.74E-4	2.11E-5	4.57E-6	1.50E-9	1.95E-5	1.50E-9	1.60E-5
Child	3.06E-9	2.70E-4	2.88E-5	6.92E-5	3.14E-10	2.55E-5	3.14E-10	1.43E-5
Infant	-	1.73E-4	1.95E-5	4.44E-6	-	1.61E-5	-	8.68E-6
Population, man-rem								
Port Wentworth	-	2.98E-3	3.58E-4	7.84E-5	-	3.33E-4	-	2.73E-4
Beaufort-Jasper	-	4.23E-3	4.94E-4	1.11E-4	-	4.54E-4	-	3.47E-4
Fish-Sport	-	9.20E-5	1.09E-5	2.41E-6	-	1.01E-5	-	7.98E-6
Fish-Commercial	-	5.35E-6	6.34E-7	1.40E-7	-	5.86E-7	-	4.64E-7
Salt Water Invert	-	9.21E-6	1.09E-6	2.42E-7	-	1.01E-6	-	7.95E-7
Recreation	4.37E-8	-	-	4.48E-9	4.48E-9	-	-	-
Total	4.37E-8	7.31E-3	8.65E-4	1.92E-4	4.48E-9	7.99E-4	-	6.29E-4

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-19

LIQUID RELEASE DOSE SUMMARY

Central Shops Seepage Basin — Average Year, 3.3×10^0 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	2.76E-9	2.39E-9	5.01E-9	6.34E-9	3.91E-9	3.91E-9	3.91E-9	2.47E-8
Teen	9.26E-9	7.91E-9	1.00E-8	1.13E-8	8.98E-9	8.98E-9	8.98E-9	2.26E-8
Child	1.93E-9	1.68E-9	4.89E-9	7.24E-9	3.69E-9	3.69E-9	3.69E-9	1.04E-8
Infant	-	-	2.69E-9	3.72E-9	1.93E-9	1.93E-9	1.93E-9	3.74E-9
Population, man-rem								
Port Wentworth	-	-	2.64E-8	3.24E-8	2.15E-8	2.15E-8	2.15E-8	1.14E-7
Beaufort-Jasper	-	-	3.90E-8	5.02E-8	3.12E-8	3.12E-8	3.12E-8	1.41E-7
Fish-Sport	-	-	2.50E-9	5.62E-9	1.72E-10	1.72E-10	1.72E-10	3.70E-8
Fish-Commercial	-	-	1.45E-10	3.26E-10	1.00E-11	1.00E-11	1.00E-11	2.15E-9
Salt Water Invert	-	-	8.19E-11	1.92E-10	3.12E-13	3.12E-13	3.12E-13	1.28E-9
Recreation	2.76E-8	-	-	2.39E-8	2.39E-8	-	-	-
Total	2.76E-8	-	6.81E-8	1.13E-7	7.68E-8	5.29E-8	5.29E-8	2.95E-7

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-20

LIQUID RELEASE DOSE SUMMARY

Central Shops Seepage Basin — Average Year, 2.9 x 10^4 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	4.37E-13	2.34E-8	2.81E-9	6.17E-10	4.48E-14	2.62E-9	4.48E-14	2.15E-9
Teen	1.46E-12	1.74E-8	2.11E-9	4.57E-10	1.50E-13	1.95E-9	1.50E-13	1.60E-9
Child	3.06E-13	2.70E-8	2.88E-9	6.92E-10	3.14E-14	2.55E-9	3.14E-14	1.43E-9
Infant	-	1.73E-8	1.95E-9	4.44E-10	-	1.61E-9	-	8.68E-10
Population, man-rem								
Port Wentworth	-	2.98E-7	3.58E-8	7.84E-9	-	3.33E-8	-	2.73E-8
Beaufort-Jasper	-	4.23E-7	4.94E-8	1.11E-8	-	4.54E-8	-	3.47E-8
Fish-Sport	-	9.20E-9	1.09E-9	2.41E-10	-	1.01E-9	-	7.98E-10
Fish-Commercial	-	5.35E-10	5.34E-11	1.40E-11	-	5.86E-11	-	4.64E-11
Salt Water Invert	-	9.21E-10	1.09E-10	2.42E-11	-	1.01E-10	-	7.95E-11
Recreation	4.37E-12	-	-	4.48E-13	4.48E-13	-	-	-
Total	4.37E-12	7.32E-7	8.65E-8	1.92E-8	4.48E-13	7.99E-8	-	6.29E-8

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

TABLE D-21

LIQUID RELEASE DOSE SUMMARY

Central Shops Seepage Basin — Maximum Year, 3.3 x 10^0 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	4.65E-8	4.02E-8	6.78E-8	9.02E-8	4.92E-8	4.92E-8	4.92E-8	3.99E-7
Teen	1.56E-7	1.33E-7	1.57E-7	1.79E-7	1.39E-7	1.39E-7	1.39E-7	3.69E-7
Child	3.26E-8	2.83E-8	6.04E-8	9.99E-8	4.02E-8	4.02E-8	4.02E-8	1.52E-7
Infant	-	-	2.41E-8	4.15E-8	1.14E-8	1.14E-8	1.14E-8	4.17E-8
Population, man-rem								
Port Wentworth	-	-	2.09E-7	3.09E-7	1.27E-7	1.27E-7	1.27E-7	1.68E-6
Beaufort-Jasper	-	-	3.14E-7	5.04E-7	1.83E-7	1.83E-7	1.83E-7	2.03E-6
Fish-Sport	-	-	4.02E-8	9.27E-8	1.01E-9	1.01E-9	1.01E-9	6.21E-7
Fish-Commercial	-	-	2.34E-9	5.39E-9	5.89E-11	5.89E-11	5.89E-11	3.61E-8
Salt Water Invert	-	-	1.38E-9	3.23E-9	1.84E-12	1.84E-12	1.84E.12	2.16E-8
Recreation	4.65E-7	-	-	4.03E-7	4.03E-7	-	-	-
Total	4.65E-7	-	4.67E-7	1.32E-6	7.14E-7	3.11E-7	3.11E-7	4.39E-6

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

UNCLASSIFIED

TABLE D-22

LIQUID RELEASE DOSE SUMMARY

Central Shops Seepage Basin — Maximum Year, 2.9 x 10^4 Years Travel Time — Average River Flow

	Organ Dose Commitment							
	Skin	Bone	Liver	Body	Thyroid	Kidney	Lung	GI-LLI
Max Individual, mrem								
Adult	1.11E-12	5.92E-8	7.12E-9	1.56E-9	1.13E-13	6.63E-9	1.13E-13	5.44E-9
Teen	3.70E-12	4.40E-8	5.34E-9	1.16E-9	3.80E-13	4.93E-9	3.80E-13	4.06E-9
Child	7.74E-13	6.92E-8	7.29E-9	1.75E-9	7.94E-14	6.45E-9	7.94E-14	3.62E-9
Infant	-	4.38E-8	4.92E-9	1.12E-9	-	4.06E-9	-	2.19E-9
Population, man-rem								
Port Wentworth	-	7.53E-7	9.05E-8	1.98E-8	-	8.42E-8	-	6.92E-8
Beaufort-Jasper	-	1.07E-6	1.25E-7	2.80E-8	-	1.15E-7	-	8.77E-8
Fish-Sport	-	2.33E-8	2.76E-9	6.11E-10	-	2.55E-9	-	2.02E-9
Fish-Commercial	-	1.35E-9	1.60E-10	3.55E-11	-	1.48E-10	-	1.17E-10
Salt Water Invert	-	2.33E-9	2.76E-10	6.11E-11	-	2.55E-10	-	2.01E-10
Recreation	1.11E-11	-	-	1.13E-12	1.13E-12	-	-	-
Total	1.11E-11	1.85E-6	2.19E-7	4.85E-8	1.13E-12	2.02E-7	-	1.59E-7

Year: 1990-2020
50-Mile-Radius Population: 781,000
Beaufort-Jasper Population: 40,333
Port Wentworth Population: 29,167
River Flow Rate: 10,400 cfs

APPENDIX E

METEOROLOGICAL METHOD FOR ROUTINE RELEASES OF RADIOACTIVITY

METEOROLOGICAL METHOD FOR ROUTINE RELEASES OF RADIOACTIVITY

The Nuclear Regulatory Commission's computer program, XOQDOQ,[1] has been used to calculate the annual-average relative air concentration (χ/Q) and deposition (D/Q) factors for the dose assessment in Section 3.5. The XOQDOQ code implements the meteorological models in Section C (excluding C1a and C1b) of NRC Regulatory Guide 1.111.[2] The χ/Q and D/Q values presented in this appendix enable the dose calculations by the dose methodology described in Appendix F.

Table E-1 presents the meteorological joint frequency distribution (JFD) used in calculating the χ/Q and D/Q values. These stability-windrose statistics were derived by one-hour averaging of data collected at the 62-meter level of the SRP H-Area meteorological tower during the five-year period, 1975-1979, with stability class determined from the observed azimuthal and vertical standard deviations (σ_θ & σ_γ).[3] The data collected at this onsite tower is of higher quality than that from the offsite TV tower used in the previous assessment (Appendix B of the L-EID),[4] due to its more sophisticated instrumentation and nearer location to the release points.

Tables E-2 through E-5 present the calculated values of χ/Q and D/Q by compass sector and radial increment from an elevated (62-meter) stack release onto flat terrain. To offset the assumption of flat terrain, credit is not taken for momentum (or thermal) plume rise. A separate comparison of these calculated values with experimentally-determined values has validated their use for SRP 200-foot stack releases.[5]

In addition to 200-foot stack releases, which include almost all the atmospheric releases in the present assessment (Table 3.5-1), there are several small releases at or near ground level. Tables E-6 through E-9 present the calculated values of χ/Q and D/Q by compass sector and radial increment from a ground-level release.

In calculating doses to the 50-mile population, the compass-sector segment average values of χ/Q and D/Q that appear at the bottom of each of Tables E-2 through E-9 are used. Further, all the atmospheric release points are assumed to be at the center of the population and agricultural production distributions (Table 3.5-3). This is a reasonable assumption because there are no high population densities near the major release points in the SRP L-Area and Separations (F & H) Areas.

In determining the doses to the maximally-exposed individual on the SRP buffer-zone boundary, the spatial separation release points are used. Table E-10 presents the calculated values of χ/Q and D/Q contributed by the several release points at the location of maximum offsite individual impact.

REFERENCES FOR APPENDIX E

1. Sagendorf, J. F. and Goll, J. T., "χOQDOQ Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations." NUREG-0324 (Draft), U.S. Nuclear Regulatory Commission, Washington, DC (September 1977).

2. "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." Regulatory Guide 1.111 (Rev. 1), U.S. Nuclear Regulatory Commission, Washington, DC (July 1977).

3. M. M. Pendergast, "Existing Diffusion Coefficients for Meteorological Data." USDOE Report DP-MS-76-64. E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (1976).

4. Environmental Information Document, L-Reactor Reactivation. DPST-81-241. E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (April 1982).

5. W. L. Marter, "Environmental Dosimetry for Normal Operations at SRP." DPST-83-270, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (April 1983).

TABLE E-1

Joint Frequency Distribution for Data from the 62-Meter Level on the H-Area Meteorological Tower During 1975 through 1979, hours of occurrence*

Stability Class	Wind Speed, meters/sec	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0 - 2	113	91	112	96	93	109	117	114	107	102	115	115	162	176	132	111
	2 - 4	90	81	90	120	169	184	196	139	137	128	140	126	160	181	151	98
	4 - 6	11	13	14	23	52	44	24	24	27	38	50	35	26	26	40	24
	6 - 8	3	0	4	3	8	2	3	1	16	16	3	7	8	5	9	2
	8 - 12	0	0	0	1	0	0	0	2	4	4	4	3	2	2	3	0
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
B	0 - 2	27	29	49	36	49	53	39	33	42	31	33	64	62	65	56	38
	2 - 4	56	39	79	111	108	118	104	76	82	74	83	82	107	127	88	80
	4 - 6	15	14	21	75	77	61	38	34	60	69	51	49	46	81	77	51
	6 - 8	6	6	3	11	8	5	1	10	18	15	10	12	14	6	19	9
	8 - 12	0	0	1	2	1	0	0	1	3	2	0	0	1	5	6	2
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0 - 2	34	32	60	55	52	50	47	36	41	46	47	38	72	84	43	53
	2 - 4	57	55	112	178	197	167	129	134	84	103	115	110	189	171	142	101
	4 - 6	33	30	53	144	157	132	67	69	106	126	91	121	134	141	131	67
	6 - 8	3	7	11	51	41	7	17	24	20	32	31	44	51	51	105	56
	8 - 12	4	2	3	2	6	0	0	9	3	5	13	9	30	31	74	27
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3	0
D	0 - 2	32	29	48	53	49	41	52	51	49	50	47	67	90	93	62	43
	2 - 4	90	97	168	226	294	281	190	200	147	141	235	195	228	254	220	156
	4 - 6	45	47	94	235	223	194	164	179	178	267	211	211	239	328	350	119
	6 - 8	16	11	17	44	23	17	35	49	57	66	67	78	102	143	239	60
	8 - 12	0	0	3	2	0	1	2	7	12	14	22	24	70	105	134	43
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	5	4	15	7	0
E	0 - 2	13	30	47	16	25	17	43	24	55	23	34	45	51	41	31	25
	2 - 4	75	81	124	78	162	109	193	128	117	77	180	181	167	123	146	109
	4 - 6	61	56	106	198	167	157	186	185	186	230	265	212	247	242	165	107
	6 - 8	2	3	26	16	9	13	29	8	22	43	41	38	41	24	10	7
	8 - 12	0	0	0	0	0	0	0	0	0	0	0	0	2	7	0	0
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0 - 2	8	2	9	5	5	9	10	5	8	6	5	4	6	2	1	2
	2 - 4	44	24	32	7	29	9	62	27	22	13	26	27	29	34	9	21
	4 - 6	36	43	68	86	64	24	65	37	41	17	47	39	47	53	15	13
	6 - 8	3	1	8	9	4	2	9	6	7	5	11	1	9	7	0	2
	8 - 12	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0 - 2	1	2	4	0	3	1	12	0	0	0	1	0	14	0	1	0
	2 - 4	1	20	75	2	3	4	29	1	2	1	3	1	1	1	0	1
	4 - 6	0	0	19	4	0	3	10	2	4	3	1	0	1	4	0	2
	6 - 8	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
	8 - 12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	12 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(Column group heading: Wind Direction)

* Total number of hours = 28,732 based on one-hour averaging of collected data.

TABLE E-2

62-Meter Stack Release — Flat Terrain
χ/Q - No Decay, Undepleted

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.261E-07	1.474E-07	9.808E-08	7.645E-08	5.378E-08	4.038E-08	3.180E-08	2.594E-08	2.172E-08	1.856E-08	1.613E-08
SSW	2.797E-07	1.348E-07	9.419E-08	7.600E-08	5.500E-08	4.168E-08	3.291E-08	2.685E-08	2.247E-08	1.920E-08	1.667E-08
SW	3.892E-07	2.242E-07	1.633E-07	1.320E-07	9.450E-08	7.124E-08	5.612E-08	4.575E-08	3.831E-08	3.275E-08	2.846E-08
WSW	4.139E-07	2.753E-07	2.075E-07	1.649E-07	1.127E-07	8.213E-08	6.304E-08	5.032E-08	4.138E-08	3.483E-08	2.986E-08
W	4.636E-07	2.982E-07	2.244E-07	1.803E-07	1.254E-07	9.239E-08	7.142E-08	5.730E-08	4.730E-08	3.994E-08	3.432E-08
WNW	4.881E-07	2.835E-07	2.051E-07	1.617E-07	1.104E-07	8.041E-08	6.167E-08	4.918E-08	4.041E-08	3.398E-08	2.912E-08
NW	4.565E-07	2.409E-07	1.791E-07	1.492E-07	1.109E-07	8.514E-08	6.778E-08	5.561E-08	4.675E-08	4.007E-08	3.489E-08
NNW	3.982E-07	2.182E-07	1.659E-07	1.373E-07	9.935E-08	7.464E-08	5.838E-08	4.721E-08	3.920E-08	3.324E-08	2.866E-08
N	4.121E-07	2.226E-07	1.655E-07	1.374E-07	1.010E-07	7.674E-08	6.053E-08	4.926E-08	4.109E-08	3.498E-08	3.027E-08
NNE	3.937E-07	2.288E-07	1.732E-07	1.416E-07	1.006E-07	7.475E-08	5.800E-08	4.662E-08	3.852E-08	3.253E-08	2.796E-08
NE	4.217E-07	2.380E-07	1.861E-07	1.578E-07	1.174E-07	8.946E-08	7.058E-08	5.740E-08	4.786E-08	4.071E-08	3.520E-08
ENE	4.505E-07	2.592E-07	1.989E-07	1.664E-07	1.220E-07	9.226E-08	7.243E-08	5.870E-08	4.880E-08	4.141E-08	3.573E-08
E	5.782E-07	3.452E-07	2.618E-07	2.143E-07	1.528E-07	1.139E-07	8.862E-08	7.144E-08	5.918E-08	5.010E-08	4.316E-08
ESE	6.361E-07	3.778E-07	2.858E-07	2.314E-07	1.618E-07	1.191E-07	9.185E-08	7.351E-08	6.054E-08	5.100E-08	4.374E-08
SE	5.093E-07	3.087E-07	2.404E-07	1.974E-07	1.390E-07	1.023E-07	7.867E-08	6.277E-08	5.154E-08	4.329E-08	3.704E-08
SSE	3.900E-07	2.239E-07	1.619E-07	1.286E-07	8.886E-08	6.517E-08	5.020E-08	4.016E-08	3.307E-08	2.786E-08	2.390E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.423E-08	8.741E-09	6.137E-09	3.723E-09	2.626E-09	2.000E-09	1.601E-09	1.327E-09	1.127E-09	9.762E-10	8.586E-10
SSW	1.469E-08	8.991E-09	6.301E-09	3.816E-09	2.688E-09	2.047E-09	1.638E-09	1.357E-09	1.153E-09	9.990E-10	8.787E-10
SW	2.513E-08	1.549E-08	1.093E-08	6.695E-09	4.760E-09	3.650E-09	2.938E-09	2.446E-09	2.086E-09	1.814E-09	1.600E-09
WSW	2.603E-08	1.531E-08	1.044E-08	6.117E-09	4.235E-09	3.184E-09	2.523E-09	2.073E-09	1.749E-09	1.506E-09	1.318E-09
W	2.999E-08	1.776E-08	1.218E-08	7.169E-09	4.971E-09	3.742E-09	2.967E-09	2.439E-09	2.059E-09	1.774E-09	1.553E-09
WNW	2.539E-08	1.494E-08	1.020E-08	5.983E-09	4.143E-09	3.116E-09	2.470E-09	2.031E-09	1.715E-09	1.477E-09	1.294E-09
NW	3.082E-08	1.898E-08	1.335E-08	8.113E-09	5.721E-09	4.359E-09	3.490E-09	2.892E-09	2.457E-09	2.128E-09	1.872E-09
NNW	2.510E-08	1.496E-08	1.028E-08	6.059E-09	4.190E-09	3.147E-09	2.490E-09	2.044E-09	1.723E-09	1.482E-09	1.296E-09
N	2.659E-08	1.602E-08	1.108E-08	6.582E-09	4.568E-09	3.439E-09	2.726E-09	2.241E-09	1.891E-09	1.628E-09	1.424E-09
NNE	2.442E-08	1.441E-08	9.848E-09	5.766E-09	3.978E-09	2.982E-09	2.357E-09	1.933E-09	1.628E-09	1.400E-09	1.223E-09
NE	3.088E-08	1.850E-08	1.275E-08	7.532E-09	5.210E-09	3.912E-09	3.095E-09	2.539E-09	2.140E-09	1.840E-09	1.608E-09
ENE	3.132E-08	1.870E-08	1.286E-08	7.571E-09	5.224E-09	3.916E-09	3.094E-09	2.535E-09	2.134E-09	1.834E-09	1.602E-09
E	3.778E-08	2.251E-08	1.549E-08	9.169E-09	6.373E-09	4.806E-09	3.817E-09	3.143E-09	2.656E-09	2.291E-09	2.007E-09
ESE	3.814E-08	2.241E-08	1.527E-08	8.918E-09	6.145E-09	4.604E-09	3.637E-09	2.982E-09	2.511E-09	2.159E-09	1.886E-09
SE	3.222E-08	1.874E-08	1.268E-08	7.330E-09	5.014E-09	3.735E-09	2.938E-09	2.400E-09	2.015E-09	1.728E-09	1.507E-09
SSE	2.085E-08	1.228E-08	8.390E-09	4.919E-09	3.404E-09	2.558E-09	2.027E-09	1.665E-09	1.405E-09	1.210E-09	1.059E-09

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT — SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	9.942E-08	5.287E-08	3.174E-08	2.172E-08	1.615E-08	8.804E-09	3.772E-09	2.007E-09	1.329E-09	9.773E-10
SSW	9.513E-08	5.374E-08	3.282E-08	2.247E-08	1.669E-08	9.063E-09	3.867E-09	2.055E-09	1.360E-09	1.000E-09
SW	1.629E-07	9.250E-08	5.601E-08	3.832E-08	2.850E-08	1.560E-08	6.776E-09	3.661E-09	2.449E-09	1.815E-09
WSW	2.038E-07	1.107E-07	6.305E-08	4.144E-08	2.991E-08	1.553E-08	6.242E-09	3.200E-09	2.078E-09	1.508E-09
W	2.212E-07	1.229E-07	7.136E-08	4.735E-08	3.438E-08	1.800E-08	7.305E-09	3.760E-09	2.445E-09	1.777E-09
WNW	2.032E-07	1.085E-07	6.167E-08	4.047E-08	2.918E-08	1.515E-08	6.103E-09	3.132E-09	2.036E-09	1.480E-09
NW	1.796E-07	1.080E-07	6.754E-08	4.674E-08	3.492E-08	1.911E-08	8.213E-09	4.375E-09	2.897E-09	2.131E-09
NNW	1.648E-07	9.680E-08	5.825E-08	3.922E-08	2.870E-08	1.513E-08	6.167E-09	3.163E-09	2.049E-09	1.485E-09
N	1.657E-07	9.830E-08	6.035E-08	4.110E-08	3.030E-08	1.617E-08	6.688E-09	3.455E-09	2.246E-09	1.630E-09
NNE	1.715E-07	9.824E-08	5.792E-08	3.855E-08	2.800E-08	1.461E-08	5.878E-09	2.997E-09	1.938E-09	1.402E-09
NE	1.851E-07	1.140E-07	7.034E-08	4.786E-08	3.523E-08	1.870E-08	7.660E-09	3.931E-09	2.546E-09	1.843E-09
ENE	1.979E-07	1.186E-07	7.223E-08	4.881E-08	3.578E-08	1.891E-08	7.703E-09	3.936E-09	2.542E-09	1.837E-09

TABLE E-2, Contd

E	2.592E-07	1.492E-07	8.848E-08	5.922E-08	4.323E-08	2.278E-08	9.331E-09	4.829E-09	3.150E-09	2.294E-09
ESE	2.821E-07	1.583E-07	9.177E-08	6.061E-08	4.382E-08	2.274E-08	9.098E-09	4.628E-09	2.990E-09	2.162E-09
SE	2.365E-07	1.357E-07	7.860E-08	5.161E-08	3.711E-08	1.904E-08	7.490E-09	3.757E-09	2.407E-09	1.731E-09
SSE	1.609E-07	8.715E-08	5.018E-08	3.311E-08	2.394E-08	1.246E-08	5.017E-09	2.571E-09	1.669E-09	1.212E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	62.00	REP. WIND HEIGHT	(METERS)	62.0
DIAMETER	(METERS)	0.0	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(M/SEC)	0.0	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)
ELEVATED	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0

AT THE MEASURED WIND HEIGHT (62.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 0.0	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0	ABOVE 0.0

AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SSW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
WSW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
W	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
WNW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NNW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
N	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NNE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
ENE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
E	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
ESE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SSE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01

TABLE E-3

62-Meter Stack Release — Flat Terrain
χ/Q - 2.26 Day Decay, Undepleted

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.257E-07	1.471E-07	9.780E-08	7.617E-08	5.350E-08	4.011E-08	3.153E-08	2.568E-08	2.147E-08	1.832E-08	1.589E-08
SSW	2.794E-07	1.345E-07	9.392E-08	7.571E-08	5.470E-08	4.138E-08	3.262E-08	2.657E-08	2.220E-08	1.893E-08	1.641E-08
SW	3.887E-07	2.237E-07	1.628E-07	1.316E-07	9.400E-08	7.075E-08	5.564E-08	4.529E-08	3.786E-08	3.231E-08	2.804E-08
WSW	4.134E-07	2.754E-07	2.070E-07	1.645E-07	1.122E-07	8.167E-08	6.261E-08	4.991E-08	4.099E-08	3.445E-08	2.949E-08
W	4.632E-07	2.978E-07	2.239E-07	1.798E-07	1.249E-07	9.187E-08	7.093E-08	5.683E-08	4.685E-08	3.950E-08	3.391E-08
WNW	4.876E-07	2.830E-07	2.046E-07	1.612E-07	1.100E-07	7.996E-08	6.123E-08	4.877E-08	4.002E-08	3.361E-08	2.875E-08
NW	4.560E-07	2.405E-07	1.786E-07	1.488E-07	1.104E-07	8.462E-08	6.727E-08	5.511E-08	4.626E-08	3.959E-08	3.442E-08
NNW	3.978E-07	2.178E-07	1.655E-07	1.369E-07	9.891E-08	7.420E-08	5.796E-08	4.681E-08	3.881E-08	3.286E-08	2.830E-08
N	4.117E-07	2.222E-07	1.651E-07	1.370E-07	1.005E-07	7.625E-08	6.005E-08	4.879E-08	4.064E-08	3.454E-08	2.984E-08
NNE	3.933E-07	2.284E-07	1.728E-07	1.412E-07	1.002E-07	7.432E-08	5.760E-08	4.623E-08	3.814E-08	3.217E-08	2.761E-08
NE	4.213E-07	2.376E-07	1.857E-07	1.574E-07	1.169E-07	8.896E-08	7.009E-08	5.694E-08	4.741E-08	4.027E-08	3.477E-08
ENE	4.500E-07	2.588E-07	1.984E-07	1.659E-07	1.214E-07	9.169E-08	7.189E-08	5.817E-08	4.829E-08	4.092E-08	3.525E-08
E	5.776E-07	3.445E-07	2.612E-07	2.136E-07	1.520E-07	1.131E-07	8.793E-08	7.077E-08	5.854E-08	4.949E-08	4.257E-08
ESE	6.354E-07	3.771E-07	2.851E-07	2.306E-07	1.610E-07	1.183E-07	9.115E-08	7.285E-08	5.991E-08	5.039E-08	4.316E-08
SE	5.088E-07	3.081E-07	2.399E-07	1.969E-07	1.385E-07	1.017E-07	7.814E-08	6.227E-08	5.106E-08	4.284E-08	3.659E-08
SSE	3.895E-07	2.235E-07	1.615E-07	1.281E-07	8.843E-08	6.476E-08	4.981E-08	3.979E-08	3.272E-08	2.752E-08	2.357E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.400E-08	8.531E-09	5.942E-09	3.547E-09	2.462E-09	1.845E-09	1.454E-09	1.185E-09	9.909E-10	8.447E-10	7.311E-10
SSW	1.445E-08	8.767E-09	6.094E-09	3.631E-09	2.517E-09	1.886E-09	1.485E-09	1.211E-09	1.012E-09	8.630E-10	7.471E-10
SW	2.471E-08	1.511E-08	1.058E-08	6.380E-09	4.465E-09	3.372E-09	2.673E-09	2.191E-09	1.841E-09	1.576E-09	1.370E-09
WSW	2.568E-08	1.500E-08	1.017E-08	5.879E-09	4.017E-09	2.980E-09	2.330E-09	1.890E-09	1.574E-09	1.338E-09	1.156E-09
W	2.959E-08	1.741E-08	1.185E-08	6.884E-09	4.709E-09	3.497E-09	2.735E-09	2.218E-09	1.847E-09	1.570E-09	1.356E-09
WNW	2.503E-08	1.463E-08	9.919E-09	5.735E-09	3.915E-09	2.902E-09	2.267E-09	1.837E-09	1.529E-09	1.298E-09	1.121E-09
NW	3.037E-08	1.856E-08	1.296E-08	7.760E-09	5.392E-09	4.048E-09	3.193E-09	2.606E-09	2.182E-09	1.863E-09	1.614E-09
NNW	2.475E-08	1.464E-08	9.994E-09	5.808E-09	3.960E-09	2.932E-09	2.288E-09	1.852E-09	1.539E-09	1.306E-09	1.126E-09
N	2.617E-08	1.564E-08	1.074E-08	6.276E-09	4.288E-09	3.177E-09	2.479E-09	2.006E-09	1.667E-09	1.413E-09	1.217E-09
NNE	2.408E-08	1.412E-08	9.579E-09	5.531E-09	3.762E-09	2.781E-09	2.168E-09	1.753E-09	1.456E-09	1.235E-09	1.064E-09
NE	3.047E-08	1.813E-08	1.241E-08	7.236E-09	4.939E-09	3.659E-09	2.856E-09	2.312E-09	1.922E-09	1.631E-09	1.407E-09
ENE	3.085E-08	1.829E-08	1.248E-08	7.242E-09	4.924E-09	3.637E-09	2.832E-09	2.287E-09	1.897E-09	1.607E-09	1.383E-09
E	3.720E-08	2.199E-08	1.502E-08	8.749E-09	5.986E-09	4.443E-09	3.473E-09	2.814E-09	2.341E-09	1.987E-09	1.714E-09
ESE	3.758E-08	2.192E-08	1.483E-08	8.534E-09	5.795E-09	4.278E-09	3.331E-09	2.691E-09	2.234E-09	1.893E-09	1.630E-09
SE	3.179E-08	1.837E-08	1.235E-08	7.038E-09	4.747E-09	3.488E-09	2.706E-09	2.179E-09	1.805E-09	1.526E-09	1.312E-09
SSE	2.054E-08	1.201E-08	8.139E-09	4.700E-09	3.203E-09	2.371E-09	1.850E-09	1.496E-09	1.244E-09	1.055E-09	9.091E-10

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT — SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	9.914E-08	5.259E-08	3.148E-08	2.147E-08	1.591E-08	8.596E-09	3.597E-09	1.853E-09	1.188E-09	8.459E-10
SSW	9.485E-08	5.345E-08	3.254E-08	2.221E-08	1.643E-08	8.841E-09	3.683E-09	1.894E-09	1.213E-09	8.643E-10
SW	1.624E-07	9.201E-08	5.553E-08	3.787E-08	2.807E-08	1.523E-08	6.462E-09	3.384E-09	2.195E-09	1.578E-09
WSW	2.033E-07	1.103E-07	6.261E-08	4.105E-08	2.955E-08	1.523E-08	6.004E-09	2.997E-09	1.895E-09	1.340E-09
W	2.207E-07	1.224E-07	7.087E-08	4.690E-08	3.397E-08	1.765E-08	7.021E-09	3.515E-09	2.225E-09	1.573E-09
WNW	2.027E-07	1.080E-07	6.124E-08	4.008E-08	2.882E-08	1.485E-08	5.856E-09	2.918E-09	1.843E-09	1.301E-09
NW	1.791E-07	1.075E-07	6.703E-08	4.625E-08	3.445E-08	1.869E-08	7.863E-09	4.064E-09	2.612E-09	1.865E-09
NNW	1.644E-07	9.637E-08	5.783E-08	3.883E-08	2.833E-08	1.482E-08	5.917E-09	2.949E-09	1.857E-09	1.308E-09
N	1.653E-07	9.782E-08	5.987E-08	4.064E-08	2.987E-08	1.580E-08	6.384E-09	3.194E-09	2.012E-09	1.416E-09
NNE	1.711E-07	9.781E-08	5.751E-08	3.818E-08	2.765E-08	1.431E-08	5.644E-09	2.797E-09	1.758E-09	1.237E-09
NE	1.846E-07	1.135E-07	6.986E-08	4.741E-08	3.481E-08	1.833E-08	7.366E-09	3.679E-09	2.319E-09	1.634E-09
ENE	1.974E-07	1.181E-07	7.168E-08	4.831E-08	3.530E-08	1.850E-08	7.377E-09	3.658E-09	2.294E-09	1.610E-09

TABLE E-3, Contd

E	2.586E-07	1.484E-07	8.779E-08	5.858E-08	4.263E-08	2.227E-08	8.914E-09	4.466E-09	2.822E-09	1.990E-09
ESE	2.813E-07	1.575E-07	9.108E-08	5.998E-08	4.324E-08	2.225E-08	8.716E-09	4.304E-09	2.700E-09	1.896E-09
SE	2.359E-07	1.351E-07	7.808E-08	5.113E-08	3.666E-08	1.868E-08	7.199E-09	3.511E-09	2.187E-09	1.529E-09
SSE	1.604E-07	8.673E-08	4.979E-08	3.276E-08	2.362E-08	1.218E-08	4.799E-09	2.384E-09	1.501E-09	1.057E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	62.00	REP. WIND HEIGHT	(METERS)	62.0
DIAMETER	(METERS)	0.0	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(M/SEC)	0.0	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)
ELEVATED	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0

AT THE MEASURED WIND HEIGHT (62.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 0.0	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0	ABOVE 0.0

AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SSW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
WSW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
W	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
WNW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NNW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
N	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NNE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
ENE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
E	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
ESE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SSE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01

TABLE E-4

62-Meter Stack Release — Flat Terrain
χ/Q - 8.0 Day Decay, Depleted

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.231E-07	1.443E-07	9.547E-08	7.404E-08	5.162E-08	3.849E-08	3.014E-08	2.446E-08	2.040E-08	1.737E-08	1.504E-08
SSW	2.772E-07	1.320E-07	9.178E-08	7.373E-08	5.295E-08	3.988E-08	3.133E-08	2.545E-08	2.121E-08	1.806E-08	1.563E-08
SW	3.857E-07	2.196E-07	1.591E-07	1.281E-07	9.094E-08	6.814E-08	5.342E-08	4.336E-08	3.617E-08	3.082E-08	2.671E-08
WSW	4.101E-07	2.703E-07	2.022E-07	1.598E-07	1.080E-07	7.804E-08	5.946E-08	4.716E-08	3.856E-08	3.228E-08	2.754E-08
W	4.595E-07	2.923E-07	2.187E-07	1.748E-07	1.204E-07	8.801E-08	6.758E-08	5.390E-08	4.427E-08	3.720E-08	3.184E-08
WNW	4.837E-07	2.778E-07	1.998E-07	1.567E-07	1.059E-07	7.641E-08	5.815E-08	4.607E-08	3.763E-08	3.148E-08	2.684E-08
NW	4.524E-07	2.361E-07	1.747E-07	1.451E-07	1.070E-07	8.171E-08	6.474E-08	5.290E-08	4.431E-08	3.786E-08	3.287E-08
NNW	3.946E-07	2.140E-07	1.620E-07	1.334E-07	9.566E-08	7.132E-08	5.542E-08	4.457E-08	3.682E-08	3.107E-08	2.669E-08
N	4.084E-07	2.182E-07	1.615E-07	1.335E-07	9.740E-08	7.358E-08	5.773E-08	4.676E-08	3.885E-08	3.295E-08	2.841E-08
NNE	3.901E-07	2.243E-07	1.690E-07	1.375E-07	9.678E-08	7.132E-08	5.496E-08	4.391E-08	3.609E-08	3.033E-08	2.595E-08
NE	4.179E-07	2.334E-07	1.818E-07	1.536E-07	1.133E-07	8.580E-08	6.731E-08	5.448E-08	4.523E-08	3.832E-08	3.301E-08
ENE	4.464E-07	2.542E-07	1.942E-07	1.618E-07	1.177E-07	8.839E-08	6.900E-08	5.563E-08	4.604E-08	3.891E-08	3.344E-08
E	5.730E-07	3.383E-07	2.554E-07	2.081E-07	1.469E-07	1.087E-07	8.407E-08	6.739E-08	5.555E-08	4.682E-08	4.017E-08
ESE	6.304E-07	3.704E-07	2.788E-07	2.245E-07	1.554E-07	1.133E-07	8.675E-08	6.897E-08	5.647E-08	4.731E-08	4.038E-08
SE	5.047E-07	3.028E-07	2.348E-07	1.918E-07	1.336E-07	9.735E-08	7.429E-08	5.885E-08	4.801E-08	4.009E-08	3.411E-08
SSE	3.864E-07	2.193E-07	1.577E-07	1.246E-07	8.527E-08	6.203E-08	4.746E-08	3.773E-08	3.091E-08	2.591E-08	2.212E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.323E-08	8.003E-09	5.537E-09	3.280E-09	2.265E-09	1.694E-09	1.334E-09	1.082E-09	8.989E-10	7.625E-10	6.563E-10
SSW	1.373E-08	8.288E-09	5.731E-09	3.397E-09	2.348E-09	1.759E-09	1.387E-09	1.127E-09	9.386E-10	7.977E-10	6.879E-10
SW	2.351E-08	1.432E-08	9.989E-09	6.010E-09	4.205E-09	3.181E-09	2.529E-09	2.072E-09	1.737E-09	1.485E-09	1.288E-09
WSW	2.391E-08	1.379E-08	9.244E-09	5.268E-09	3.559E-09	2.621E-09	2.038E-09	1.636E-09	1.349E-09	1.137E-09	9.727E-10
W	2.771E-08	1.612E-08	1.088E-08	6.242E-09	4.233E-09	3.124E-09	2.435E-09	1.959E-09	1.618E-09	1.365E-09	1.170E-09
WNW	2.329E-08	1.342E-08	8.995E-09	5.118E-09	3.452E-09	2.538E-09	1.971E-09	1.580E-09	1.301E-09	1.094E-09	9.350E-10
NW	2.896E-08	1.761E-08	1.225E-08	7.312E-09	5.075E-09	3.813E-09	3.015E-09	2.459E-09	2.053E-09	1.749E-09	1.512E-09
NNW	2.328E-08	1.363E-08	9.224E-09	5.300E-09	3.586E-09	2.642E-09	2.056E-09	1.653E-09	1.363E-09	1.149E-09	9.836E-10
N	2.488E-08	1.477E-08	1.008E-08	5.850E-09	3.980E-09	2.944E-09	2.298E-09	1.852E-09	1.531E-09	1.292E-09	1.108E-09
NNE	2.257E-08	1.308E-08	8.786E-09	5.006E-09	3.373E-09	2.477E-09	1.922E-09	1.541E-09	1.268E-09	1.067E-09	9.120E-10
NE	2.887E-08	1.703E-08	1.158E-08	6.694E-09	4.542E-09	3.354E-09	2.614E-09	2.106E-09	1.740E-09	1.469E-09	1.259E-09
ENE	2.921E-08	1.716E-08	1.163E-08	6.685E-09	4.518E-09	3.326E-09	2.585E-09	2.078E-09	1.713E-09	1.443E-09	1.235E-09
E	3.503E-08	2.051E-08	1.391E-08	8.030E-09	5.463E-09	4.043E-09	3.158E-09	2.547E-09	2.107E-09	1.780E-09	1.528E-09
ESE	3.505E-08	2.017E-08	1.350E-08	7.650E-09	5.138E-09	3.765E-09	2.916E-09	2.333E-09	1.918E-09	1.612E-09	1.376E-09
SE	2.952E-08	1.679E-08	1.114E-08	6.232E-09	4.146E-09	3.016E-09	2.322E-09	1.849E-09	1.514E-09	1.267E-09	1.078E-09
SSE	1.922E-08	1.111E-08	7.452E-09	4.245E-09	2.863E-09	2.105E-09	1.635E-09	1.310E-09	1.078E-09	9.066E-10	7.745E-10

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT — SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	9.680E-08	5.077E-08	3.010E-08	2.041E-08	1.506E-08	8.068E-09	3.330E-09	1.702E-09	1.084E-09	7.636E-10
SSW	9.270E-08	5.176E-08	3.126E-08	2.122E-08	1.565E-08	8.362E-09	3.450E-09	1.767E-09	1.130E-09	7.988E-10
SW	1.587E-07	8.906E-08	5.332E-08	3.619E-08	2.674E-08	1.444E-08	6.092E-09	3.193E-09	2.075E-09	1.487E-09
WSW	1.985E-07	1.062E-07	5.949E-08	3.862E-08	2.760E-08	1.402E-08	5.392E-09	2.638E-09	1.642E-09	1.139E-09
W	2.156E-07	1.181E-07	6.755E-08	4.433E-08	3.190E-08	1.637E-08	6.379E-09	3.144E-09	1.965E-09	1.368E-09
WNW	1.980E-07	1.041E-07	5.819E-08	3.770E-08	2.690E-08	1.365E-08	5.239E-09	2.555E-09	1.585E-09	1.096E-09
NW	1.752E-07	1.042E-07	6.453E-08	4.431E-08	3.290E-08	1.775E-08	7.415E-09	3.830E-09	2.463E-09	1.751E-09
NNW	1.608E-07	9.323E-08	5.532E-08	3.684E-08	2.673E-08	1.382E-08	5.410E-09	2.659E-09	1.658E-09	1.151E-09
N	1.617E-07	9.484E-08	5.757E-08	3.886E-08	2.845E-08	1.493E-08	5.959E-09	2.962E-09	1.857E-09	1.294E-09
NNE	1.673E-07	9.451E-08	5.490E-08	3.613E-08	2.600E-08	1.328E-08	5.120E-09	2.494E-09	1.546E-09	1.069E-09
NE	1.807E-07	1.100E-07	6.711E-08	4.524E-08	3.305E-08	1.724E-08	6.824E-09	3.375E-09	2.112E-09	1.472E-09
ENE	1.931E-07	1.145E-07	6.882E-08	4.606E-08	3.349E-08	1.738E-08	6.820E-09	3.348E-09	2.084E-09	1.446E-09

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TABLE E-4, Contd

E	2.528E-07	1.435E-07	8.396E-08	5.561E-08	4.024E-08	2.080E-08	8.195E-09	4.068E-09	2.554E-09	1.783E-09
ESE	2.750E-07	1.520E-07	8.673E-08	5.655E-08	4.046E-08	2.051E-08	7.833E-09	3.791E-09	2.342E-09	1.615E-09
SE	2.308E-07	1.304E-07	7.426E-08	4.809E-08	3.418E-08	1.711E-08	6.395E-09	3.040E-09	1.857E-09	1.270E-09
SSE	1.567E-07	8.367E-08	4.746E-08	3.095E-08	2.217E-08	1.129E-08	4.344E-09	2.119E-09	1.314E-09	9.085E-10

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	62.00	REP. WIND HEIGHT	(METERS)	62.0
DIAMETER	(METERS)	0.0	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(M/SEC)	0.0	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)
ELEVATED	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0

AT THE MEASURED WIND HEIGHT (62.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 0.0	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0	ABOVE 0.0

AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SSW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
WSW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
W	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
WNW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NNW	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
N	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NNE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
NE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
ENE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
E	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
ESE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01
SSE	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01	6.200E+01

UNCLASSIFIED

TABLE E-5

62-Meter Stack Release — Flat Terrain - D/Q

******************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS ********************

DIRECTION FROM SITE	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
	DISTANCES IN MILES										
S	4.361E-09	2.437E-09	1.356E-09	8.814E-10	4.769E-10	3.033E-10	2.119E-10	1.577E-10	1.227E-10	9.855E-11	8.118E-11
SSW	3.867E-09	2.183E-09	1.227E-09	8.031E-10	4.373E-10	2.787E-10	1.948E-10	1.450E-10	1.128E-10	9.063E-11	7.464E-11
SW	5.967E-09	3.414E-09	1.946E-09	1.285E-09	7.056E-10	4.505E-10	3.152E-10	2.348E-10	1.826E-10	1.467E-10	1.208E-10
WSW	8.907E-09	5.164E-09	2.982E-09	1.986E-09	1.098E-09	7.025E-10	4.919E-10	3.665E-10	2.852E-10	2.291E-10	1.886E-10
W	9.957E-09	5.735E-09	3.291E-09	2.183E-09	1.203E-09	7.688E-10	5.381E-10	4.009E-10	3.119E-10	2.506E-10	2.063E-10
WNW	9.112E-09	5.243E-09	3.006E-09	1.992E-09	1.097E-09	7.014E-10	4.908E-10	3.656E-10	2.845E-10	2.286E-10	1.882E-10
NW	7.641E-09	4.392E-09	2.516E-09	1.666E-09	9.171E-10	5.860E-10	4.101E-10	3.055E-10	2.377E-10	1.910E-10	1.572E-10
NNW	6.964E-09	4.085E-09	2.387E-09	1.600E-09	8.906E-10	5.708E-10	3.998E-10	2.980E-10	2.319E-10	1.863E-10	1.534E-10
N	7.342E-09	4.238E-09	2.437E-09	1.618E-09	8.928E-10	5.708E-10	3.995E-10	2.977E-10	2.316E-10	1.861E-10	1.532E-10
NNE	7.798E-09	4.568E-09	2.665E-09	1.786E-09	9.931E-10	6.363E-10	4.457E-10	3.322E-10	2.585E-10	2.077E-10	1.710E-10
NE	7.784E-09	4.605E-09	2.712E-09	1.828E-09	1.021E-09	6.552E-10	4.592E-10	3.423E-10	2.664E-10	2.141E-10	1.762E-10
ENE	8.054E-09	4.742E-09	2.781E-09	1.869E-09	1.042E-09	6.681E-10	4.681E-10	3.489E-10	2.715E-10	2.182E-10	1.796E-10
E	1.053E-08	6.177E-09	3.608E-09	2.419E-09	1.346E-09	8.623E-10	6.041E-10	4.502E-10	3.504E-10	2.815E-10	2.318E-10
ESE	1.148E-08	6.872E-09	4.092E-09	2.775E-09	1.560E-09	1.002E-09	7.026E-10	5.239E-10	4.078E-10	3.276E-10	2.697E-10
SE	1.085E-08	6.618E-09	4.009E-09	2.747E-09	1.557E-09	1.003E-09	7.037E-10	5.249E-10	4.087E-10	3.283E-10	2.702E-10
SSE	7.036E-09	4.058E-09	2.331E-09	1.547E-09	8.532E-10	5.454E-10	3.818E-10	2.844E-10	2.213E-10	1.778E-10	1.464E-10

DIRECTION FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
	DISTANCES IN MILES										
S	6.819E-11	3.466E-11	2.186E-11	1.179E-11	7.776E-12	5.701E-12	4.477E-12	3.645E-12	3.075E-12	2.627E-12	2.278E-12
SSW	6.270E-11	3.183E-11	2.003E-11	1.076E-11	7.080E-12	5.186E-12	4.073E-12	3.321E-12	2.807E-12	2.404E-12	2.091E-12
SW	1.015E-10	5.144E-11	3.227E-11	1.726E-11	1.132E-11	8.283E-12	6.511E-12	5.324E-12	4.515E-12	3.881E-12	3.392E-12
WSW	1.584E-10	8.019E-11	5.018E-11	2.670E-11	1.744E-11	1.267E-11	9.867E-12	7.974E-12	6.677E-12	5.670E-12	4.887E-12
W	1.733E-10	8.777E-11	5.499E-11	2.933E-11	1.918E-11	1.396E-11	1.088E-11	8.800E-12	7.375E-12	6.266E-12	5.404E-12
WNW	1.580E-10	8.007E-11	5.017E-11	2.677E-11	1.751E-11	1.273E-11	9.908E-12	7.996E-12	6.684E-12	5.665E-12	4.870E-12
NW	1.320E-10	6.690E-11	4.193E-11	2.238E-11	1.467E-11	1.072E-11	8.414E-12	6.872E-12	5.821E-12	4.998E-12	4.365E-12
NNW	1.288E-10	6.513E-11	4.066E-11	2.155E-11	1.404E-11	1.020E-11	7.942E-12	6.429E-12	5.396E-12	4.594E-12	3.975E-12
N	1.287E-10	6.516E-11	4.081E-11	2.175E-11	1.423E-11	1.037E-11	8.099E-12	6.575E-12	5.533E-12	4.722E-12	4.093E-12
NNE	1.436E-10	7.261E-11	4.535E-11	2.404E-11	1.567E-11	1.137E-11	8.848E-12	7.151E-12	5.991E-12	5.091E-12	4.395E-12
NE	1.479E-10	7.475E-11	4.660E-11	2.464E-11	1.603E-11	1.164E-11	9.083E-12	7.376E-12	6.214E-12	5.312E-12	4.619E-12
ENE	1.508E-10	7.622E-11	4.756E-11	2.518E-11	1.640E-11	1.190E-11	9.277E-12	7.519E-12	6.320E-12	5.389E-12	4.672E-12
E	1.946E-10	9.840E-11	6.144E-11	3.257E-11	2.122E-11	1.541E-11	1.200E-11	9.706E-12	8.141E-12	6.927E-12	5.989E-12
ESE	2.264E-10	1.143E-10	7.111E-11	3.745E-11	2.429E-11	1.755E-11	1.359E-11	1.094E-11	9.123E-12	7.725E-12	6.644E-12
SE	2.268E-10	1.143E-10	7.092E-11	3.714E-11	2.399E-11	1.726E-11	1.330E-11	1.065E-11	8.836E-12	7.447E-12	6.373E-12
SSE	1.229E-10	6.226E-11	3.900E-11	2.079E-11	1.359E-11	9.883E-12	7.693E-12	6.211E-12	5.195E-12	4.406E-12	3.791E-12

*********************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS ***********************

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
	SEGMENT BOUNDARIES IN MILES									
S	1.385E-09	4.897E-10	2.146E-10	1.235E-10	8.152E-11	3.642E-11	1.224E-11	5.765E-12	3.666E-12	2.631E-12
SSW	1.251E-09	4.481E-10	1.972E-10	1.136E-10	7.496E-11	3.344E-11	1.118E-11	5.246E-12	3.340E-12	2.407E-12
SW	1.979E-09	7.211E-10	3.191E-10	1.839E-10	1.213E-10	5.404E-11	1.796E-11	8.384E-12	5.355E-12	3.888E-12
WSW	3.024E-09	1.120E-09	4.979E-10	2.870E-10	1.894E-10	8.423E-11	2.780E-11	1.282E-11	8.021E-12	5.678E-12
W	3.342E-09	1.228E-09	5.447E-10	3.139E-10	2.072E-10	9.220E-11	3.052E-11	1.412E-11	8.852E-12	6.275E-12
WNW	3.053E-09	1.120E-09	4.969E-10	2.864E-10	1.890E-10	8.411E-11	2.785E-11	1.288E-11	8.043E-12	5.673E-12
NW	2.555E-09	9.364E-10	4.152E-10	2.393E-10	1.579E-10	7.028E-11	2.330E-11	1.085E-11	6.912E-12	5.008E-12
NNW	2.415E-09	9.062E-10	4.047E-10	2.334E-10	1.540E-10	6.840E-11	2.246E-11	1.032E-11	6.468E-12	4.602E-12
N	2.473E-09	9.109E-10	4.045E-10	2.331E-10	1.539E-10	6.845E-11	2.264E-11	1.049E-11	6.614E-12	4.729E-12
NNE	2.697E-09	1.011E-09	4.511E-10	2.602E-10	1.717E-10	7.626E-11	2.506E-11	1.151E-11	7.194E-12	5.100E-12
NE	2.740E-09	1.038E-09	4.647E-10	2.682E-10	1.770E-10	7.851E-11	2.569E-11	1.179E-11	7.421E-12	5.323E-12
ENE	2.811E-09	1.059E-09	4.737E-10	2.733E-10	1.804E-10	8.005E-11	2.625E-11	1.205E-11	7.565E-12	5.399E-12
E	3.650E-09	1.369E-09	6.114E-10	3.527E-10	2.327E-10	1.033E-10	3.394E-11	1.559E-11	9.764E-12	6.939E-12
ESE	4.124E-09	1.582E-09	7.110E-10	4.104E-10	2.708E-10	1.200E-10	3.908E-11	1.776E-11	1.100E-11	7.739E-12
SE	4.028E-09	1.575E-09	7.119E-10	4.113E-10	2.714E-10	1.200E-10	3.880E-11	1.747E-11	1.072E-11	7.461E-12
SSE	2.366E-09	8.707E-10	3.865E-10	2.228E-10	1.470E-10	6.541E-11	2.164E-11	9.996E-12	6.248E-12	4.412E-12

TABLE E-6

Ground-Level Release

χ/Q - No Decay, Undepleted

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.380E-06	9.238E-07	4.401E-07	2.665E-07	1.368E-07	8.658E-08	6.115E-08	4.623E-08	3.659E-08	2.995E-08	2.513E-08
SSW	3.570E-06	9.892E-07	4.738E-07	2.878E-07	1.481E-07	9.389E-08	6.643E-08	5.029E-08	3.986E-08	3.265E-08	2.742E-08
SW	6.803E-06	1.908E-06	9.163E-07	5.582E-07	2.878E-07	1.828E-07	1.296E-07	9.831E-08	7.804E-08	6.403E-08	5.385E-08
WSW	5.794E-06	1.606E-06	7.701E-07	4.658E-07	2.362E-07	1.477E-07	1.033E-07	7.746E-08	6.086E-08	4.947E-08	4.126E-08
W	6.701E-06	1.864E-06	8.953E-07	5.422E-07	2.757E-07	1.729E-07	1.212E-07	9.106E-08	7.166E-08	5.834E-08	4.872E-08
WNW	5.639E-06	1.548E-06	7.394E-07	4.466E-07	2.265E-07	1.418E-07	9.923E-08	7.442E-08	5.850E-08	4.758E-08	3.970E-08
NW	7.657E-06	2.150E-06	1.035E-06	6.311E-07	3.256E-07	2.068E-07	1.466E-07	1.111E-07	8.815E-08	7.227E-08	6.075E-08
NNW	5.389E-06	1.498E-06	7.204E-07	4.372E-07	2.235E-07	1.407E-07	9.891E-08	7.445E-08	5.870E-08	4.787E-08	4.003E-08
N	5.765E-06	1.609E-06	7.755E-07	4.708E-07	2.409E-07	1.519E-07	1.069E-07	8.061E-08	6.363E-08	5.194E-08	4.348E-08
NNE	5.208E-06	1.444E-06	6.938E-07	4.203E-07	2.140E-07	1.344E-07	9.422E-08	7.077E-08	5.570E-08	4.534E-08	3.787E-08
NE	6.590E-06	1.848E-06	8.926E-07	5.427E-07	2.780E-07	1.753E-07	1.234E-07	9.304E-08	7.344E-08	5.993E-08	5.016E-08
ENE	6.614E-06	1.851E-06	8.931E-07	5.422E-07	2.768E-07	1.742E-07	1.224E-07	9.209E-08	7.258E-08	5.916E-08	4.946E-08
E	8.596E-06	2.396E-06	1.152E-06	6.993E-07	3.574E-07	2.251E-07	1.584E-07	1.193E-07	9.414E-08	7.681E-08	6.428E-08
ESE	8.183E-06	2.262E-06	1.085E-06	6.569E-07	3.339E-07	2.092E-07	1.465E-07	1.099E-07	8.642E-08	7.029E-08	5.865E-08
SE	6.684E-06	1.850E-06	8.888E-07	5.381E-07	2.732E-07	1.710E-07	1.195E-07	8.956E-08	7.032E-08	5.712E-08	4.761E-08
SSE	4.534E-06	1.247E-06	5.963E-07	3.601E-07	1.828E-07	1.145E-07	8.012E-08	6.010E-08	4.725E-08	3.843E-08	3.207E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	2.153E-08	1.203E-08	8.024E-09	4.596E-09	3.136E-09	2.339E-09	1.844E-09	1.510E-09	1.272E-09	1.093E-09	9.557E-10
SSW	2.351E-08	1.316E-08	8.784E-09	5.035E-09	3.434E-09	2.560E-09	2.017E-09	1.652E-09	1.390E-09	1.195E-09	1.044E-09
SW	4.622E-08	2.598E-08	1.740E-08	1.002E-08	6.851E-09	5.118E-09	4.041E-09	3.313E-09	2.792E-09	2.403E-09	2.102E-09
WSW	3.517E-08	1.924E-08	1.264E-08	7.099E-09	4.797E-09	3.551E-09	2.783E-09	2.268E-09	1.902E-09	1.629E-09	1.420E-09
W	4.157E-08	2.284E-08	1.504E-08	8.479E-09	5.733E-09	4.246E-09	3.329E-09	2.713E-09	2.275E-09	1.949E-09	1.699E-09
WNW	3.386E-08	1.860E-08	1.225E-08	6.911E-09	4.679E-09	3.470E-09	2.723E-09	2.222E-09	1.865E-09	1.600E-09	1.395E-09
NW	5.211E-08	2.919E-08	1.949E-08	1.117E-08	7.606E-09	5.662E-09	4.458E-09	3.646E-09	3.066E-09	2.633E-09	2.300E-09
NNW	3.419E-08	1.883E-08	1.242E-08	7.002E-09	4.724E-09	3.492E-09	2.734E-09	2.225E-09	1.864E-09	1.595E-09	1.389E-09
N	3.717E-08	2.057E-08	1.361E-08	7.706E-09	5.208E-09	3.854E-09	3.020E-09	2.460E-09	2.061E-09	1.765E-09	1.537E-09
NNE	3.230E-08	1.772E-08	1.166E-08	6.555E-09	4.421E-09	3.267E-09	2.557E-09	2.081E-09	1.743E-09	1.492E-09	1.299E-09
NE	4.286E-08	2.364E-08	1.561E-08	8.805E-09	5.936E-09	4.385E-09	3.430E-09	2.790E-09	2.336E-09	1.998E-09	1.738E-09
ENE	4.224E-08	2.327E-08	1.535E-08	8.647E-09	5.824E-09	4.299E-09	3.361E-09	2.732E-09	2.286E-09	1.955E-09	1.700E-09
E	5.494E-08	3.035E-08	2.007E-08	1.137E-08	7.698E-09	5.708E-09	4.480E-09	3.654E-09	3.067E-09	2.629E-09	2.292E-09
ESE	5.000E-08	2.739E-08	1.799E-08	1.010E-08	6.810E-09	5.032E-09	3.937E-09	3.205E-09	2.684E-09	2.297E-09	2.000E-09
SE	4.055E-08	2.211E-08	1.448E-08	8.087E-09	5.429E-09	3.999E-09	3.121E-09	2.535E-09	2.119E-09	1.810E-09	1.574E-09
SSE	2.735E-08	1.501E-08	9.883E-09	5.568E-09	3.769E-09	2.793E-09	2.191E-09	1.788E-09	1.500E-09	1.286E-09	1.121E-09

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT — SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.705E-07	1.433E-07	6.196E-08	3.681E-08	2.522E-08	1.236E-08	4.709E-09	2.353E-09	1.515E-09	1.095E-09
SSW	5.057E-07	1.551E-07	6.730E-08	4.009E-08	2.752E-08	1.351E-08	5.156E-09	2.576E-09	1.656E-09	1.197E-09
SW	9.776E-07	3.013E-07	1.313E-07	7.850E-08	5.404E-08	2.666E-08	1.025E-08	5.149E-09	3.322E-09	2.407E-09
WSW	8.207E-07	2.479E-07	1.048E-07	6.127E-08	4.144E-08	1.984E-08	7.307E-09	3.576E-09	2.276E-09	1.632E-09
W	9.536E-07	2.893E-07	1.230E-07	7.213E-08	4.892E-08	2.354E-08	8.718E-09	4.276E-09	2.722E-09	1.953E-09
WNW	7.890E-07	2.378E-07	1.007E-07	5.889E-08	3.987E-08	1.917E-08	7.106E-09	3.494E-09	2.229E-09	1.603E-09
NW	1.103E-06	3.407E-07	1.484E-07	8.866E-08	6.096E-08	2.997E-08	1.144E-08	5.699E-09	3.657E-09	2.638E-09
NNW	7.672E-07	2.342E-07	1.003E-07	5.907E-08	4.019E-08	1.939E-08	7.193E-09	3.517E-09	2.233E-09	1.598E-09
N	8.254E-07	2.524E-07	1.084E-07	6.403E-08	4.365E-08	2.117E-08	7.908E-09	3.881E-09	2.468E-09	1.769E-09
NNE	7.390E-07	2.245E-07	9.554E-08	5.606E-08	3.802E-08	1.827E-08	6.741E-09	3.291E-09	2.089E-09	1.495E-09
NE	9.494E-07	2.912E-07	1.251E-07	7.389E-08	5.035E-08	2.434E-08	9.042E-09	4.417E-09	2.800E-09	2.002E-09
ENE	9.499E-07	2.902E-07	1.241E-07	7.304E-08	4.966E-08	2.397E-08	8.882E-09	4.330E-09	2.742E-09	1.959E-09

TABLE E-6, Contd

E	1.227E-06	3.746E-07	1.605E-07	9.473E-08	6.453E-08	3.125E-08	1.167E-08	5.747E-09	3.666E-09	2.634E-09
ESE	1.156E-06	3.503E-07	1.486E-07	8.699E-08	5.889E-08	2.824E-08	1.039E-08	5.068E-09	3.216E-09	2.302E-09
SE	9.465E-07	2.866E-07	1.213E-07	7.079E-08	4.781E-08	2.282E-08	8.327E-09	4.029E-09	2.544E-09	1.814E-09
SSE	6.359E-07	1.918E-07	8.127E-08	4.757E-08	3.221E-08	1.548E-08	5.727E-09	2.813E-09	1.793E-09	1.288E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.0	REP. WIND HEIGHT	(METERS)	62.0
DIAMETER	(METERS)	0.0	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(M/SEC)	0.0	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)
ELEVATED	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0

AT THE MEASURED WIND HEIGHT (62.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 0.0	LESS THAN 0.0
MIXED	BETWEEN 0.0 AND 0.0	BETWEEN 0.0 AND 0.0
GROUND LEVEL	ABOVE 0.0	ABOVE 0.0

TABLE E-7

Ground-Level Release
χ/Q - 2.26 Day Decay, Undepleted

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.377E-06	9.223E-07	4.390E-07	2.657E-07	1.362E-07	8.603E-08	6.067E-08	4.579E-08	3.619E-08	2.957E-08	2.478E-08
SSW	3.567E-06	9.876E-07	4.726E-07	2.869E-07	1.474E-07	9.329E-08	6.590E-08	4.981E-08	3.942E-08	3.224E-08	2.703E-08
SW	6.798E-06	1.905E-06	9.142E-07	5.565E-07	2.865E-07	1.817E-07	1.286E-07	9.742E-08	7.722E-08	6.326E-08	5.313E-08
WSW	5.790E-06	1.604E-06	7.686E-07	4.646E-07	2.352E-07	1.470E-07	1.027E-07	7.686E-08	6.031E-08	4.896E-08	4.078E-08
W	6.697E-06	1.861E-06	8.934E-07	5.408E-07	2.746E-07	1.720E-07	1.204E-07	9.032E-08	7.099E-08	5.771E-08	4.813E-08
WNW	5.635E-06	1.546E-06	7.378E-07	4.453E-07	2.256E-07	1.410E-07	9.854E-08	7.380E-08	5.793E-08	4.705E-08	3.920E-08
NW	7.651E-06	2.147E-06	1.033E-06	6.292E-07	3.241E-07	2.056E-07	1.455E-07	1.101E-07	8.722E-08	7.141E-08	5.993E-08
NNW	5.385E-06	1.495E-06	7.189E-07	4.360E-07	2.225E-07	1.399E-07	9.823E-08	7.384E-08	5.814E-08	4.734E-08	3.954E-08
N	5.760E-06	1.607E-06	7.736E-07	4.693E-07	2.398E-07	1.510E-07	1.061E-07	7.986E-08	6.294E-08	5.130E-08	4.287E-08
NNE	5.204E-06	1.442E-06	6.924E-07	4.192E-07	2.132E-07	1.336E-07	9.358E-08	7.019E-08	5.517E-08	4.485E-08	3.740E-08
NE	6.585E-06	1.845E-06	8.908E-07	5.412E-07	2.769E-07	1.744E-07	1.226E-07	9.230E-08	7.276E-08	5.930E-08	4.957E-08
ENE	6.609E-06	1.848E-06	8.911E-07	5.406E-07	2.756E-07	1.732E-07	1.215E-07	9.129E-08	7.185E-08	5.848E-08	4.882E-08
E	8.589E-06	2.392E-06	1.149E-06	6.970E-07	3.557E-07	2.237E-07	1.571E-07	1.182E-07	9.308E-08	7.583E-08	6.336E-08
ESE	8.177E-06	2.259E-06	1.083E-06	6.550E-07	3.325E-07	2.080E-07	1.455E-07	1.090E-07	8.556E-08	6.949E-08	5.790E-08
SE	6.679E-06	1.847E-06	8.870E-07	5.367E-07	2.721E-07	1.701E-07	1.188E-07	8.885E-08	6.967E-08	5.652E-08	4.705E-08
SSE	4.530E-06	1.245E-06	5.949E-07	3.591E-07	1.820E-07	1.138E-07	7.953E-08	5.957E-08	4.677E-08	3.798E-08	3.165E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	2.120E-08	1.175E-08	7.774E-09	4.383E-09	2.943E-09	2.160E-09	1.676E-09	1.351E-09	1.119E-09	9.471E-10	8.149E-10
SSW	2.314E-08	1.285E-08	8.510E-09	4.802E-09	3.223E-09	2.365E-09	1.835E-09	1.479E-09	1.225E-09	1.037E-09	8.924E-10
SW	4.553E-08	2.540E-08	1.689E-08	9.581E-09	6.457E-09	4.754E-09	3.699E-09	2.989E-09	2.483E-09	2.106E-09	1.816E-09
WSW	3.471E-08	1.887E-08	1.231E-08	6.829E-09	4.556E-09	3.329E-09	2.575E-09	2.072E-09	1.715E-09	1.450E-09	1.248E-09
W	4.101E-08	2.238E-08	1.464E-08	8.139E-09	5.428E-09	3.965E-09	3.066E-09	2.465E-09	2.039E-09	1.723E-09	1.481E-09
WNW	3.339E-08	1.821E-08	1.191E-08	6.623E-09	4.420E-09	3.230E-09	2.499E-09	2.010E-09	1.662E-09	1.405E-09	1.208E-09
NW	5.133E-08	2.854E-08	1.891E-08	1.067E-08	7.159E-09	5.249E-09	4.070E-09	3.279E-09	2.717E-09	2.298E-09	1.977E-09
NNW	3.372E-08	1.844E-08	1.208E-08	6.717E-09	4.469E-09	3.258E-09	2.515E-09	2.019E-09	1.667E-09	1.408E-09	1.208E-09
N	3.660E-08	2.009E-08	1.320E-08	7.352E-09	4.892E-09	3.564E-09	2.749E-09	2.205E-09	1.820E-09	1.534E-09	1.316E-09
NNE	3.186E-08	1.736E-08	1.134E-08	6.289E-09	4.183E-09	3.049E-09	2.353E-09	1.889E-09	1.560E-09	1.317E-09	1.131E-09
NE	4.230E-08	2.318E-08	1.520E-08	8.462E-09	5.629E-09	4.103E-09	3.166E-09	2.542E-09	2.099E-09	1.772E-09	1.521E-09
ENE	4.163E-08	2.277E-08	1.491E-08	8.277E-09	5.494E-09	3.996E-09	3.079E-09	2.467E-09	2.034E-09	1.715E-09	1.470E-09
E	5.406E-08	2.962E-08	1.943E-08	1.082E-08	7.208E-09	5.257E-09	4.057E-09	3.255E-09	2.687E-09	2.266E-09	1.943E-09
ESE	4.929E-08	2.681E-08	1.749E-08	9.677E-09	6.430E-09	4.683E-09	3.612E-09	2.898E-09	2.392E-09	2.018E-09	1.732E-09
SE	4.001E-08	2.167E-08	1.410E-08	7.763E-09	5.140E-09	3.733E-09	2.873E-09	2.301E-09	1.897E-09	1.598E-09	1.370E-09
SSE	2.695E-08	1.468E-08	9.593E-09	5.325E-09	3.550E-09	2.591E-09	2.002E-09	1.609E-09	1.330E-09	1.123E-09	9.643E-10

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT — SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.694E-07	1.427E-07	6.148E-08	3.641E-08	2.487E-08	1.208E-08	4.497E-09	2.175E-09	1.355E-09	9.491E-10
SSW	5.045E-07	1.544E-07	6.677E-08	3.965E-08	2.713E-08	1.321E-08	4.925E-09	2.382E-09	1.484E-09	1.039E-09
SW	9.755E-07	2.999E-07	1.303E-07	7.768E-08	5.332E-08	2.609E-08	9.816E-09	4.786E-09	2.999E-09	2.110E-09
WSW	8.191E-07	2.470E-07	1.042E-07	6.072E-08	4.096E-08	1.948E-08	7.038E-09	3.355E-09	2.080E-09	1.454E-09
W	9.518E-07	2.882E-07	1.221E-07	7.145E-08	4.833E-08	2.308E-08	8.379E-09	3.996E-09	2.475E-09	1.727E-09
WNW	7.874E-07	2.368E-07	9.997E-08	5.832E-08	3.937E-08	1.879E-08	6.819E-09	3.255E-09	2.017E-09	1.408E-09
NW	1.101E-06	3.392E-07	1.474E-07	8.774E-08	6.015E-08	2.932E-08	1.094E-08	5.287E-09	3.291E-09	2.303E-09
NNW	7.657E-07	2.332E-07	9.959E-08	5.851E-08	3.969E-08	1.901E-08	6.910E-09	3.283E-09	2.027E-09	1.411E-09
N	8.235E-07	2.513E-07	1.076E-07	6.334E-08	4.304E-08	2.070E-08	7.557E-09	3.592E-09	2.214E-09	1.538E-09
NNE	7.375E-07	2.236E-07	9.490E-08	5.553E-08	3.756E-08	1.791E-08	6.477E-09	3.073E-09	1.896E-09	1.320E-09
NE	9.476E-07	2.901E-07	1.243E-07	7.322E-08	4.976E-08	2.388E-08	8.701E-09	4.135E-09	2.552E-09	1.776E-09
ENE	9.479E-07	2.890E-07	1.232E-07	7.231E-08	4.902E-08	2.347E-08	8.514E-09	4.028E-09	2.477E-09	1.719E-09

TABLE E-7, Contd

E	1.224E-06	3.729E-07	1.593E-07	9.367E-08	6.361E-08	3.052E-08	1.113E-08	5.297E-09	3.268E-09	2.271E-09
ESE	1.154E-06	3.488E-07	1.476E-07	8.613E-08	5.815E-08	2.766E-08	9.970E-09	4.721E-09	2.909E-09	2.023E-09
SE	9.447E-07	2.856E-07	1.205E-07	7.014E-08	4.725E-08	2.238E-08	8.005E-09	3.764E-09	2.310E-09	1.602E-09
SSE	6.345E-07	1.910E-07	8.068E-08	4.708E-08	3.179E-08	1.515E-08	5.484E-09	2.611E-09	1.615E-09	1.125E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.0	REP. WIND HEIGHT	(METERS)	62.0
DIAMETER	(METERS)	0.0	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(M/SEC)	0.0	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)			
ELEVATED	LESS THAN	0.0		
MIXED	BETWEEN	0.0	AND	0.0
GROUND LEVEL	ABOVE	0.0		

AT THE MEASURED WIND HEIGHT (62.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS				WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS			
ELEVATED	LESS THAN	0.0			LESS THAN	0.0		
MIXED	BETWEEN	0.0	AND	0.0	BETWEEN	0.0	AND	0.0
GROUND LEVEL	ABOVE	0.0			ABOVE	0.0		

TABLE E-8

Ground-Level Release
χ/Q - 8.0 Day Decay, Depleted

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.198E-06	8.432E-07	3.919E-07	2.331E-07	1.161E-07	7.156E-08	4.942E-08	3.662E-08	2.847E-08	2.291E-08	1.892E-08
SSW	3.378E-06	9.029E-07	4.219E-07	2.517E-07	1.256E-07	7.761E-08	5.369E-08	3.984E-08	3.100E-08	2.497E-08	2.065E-08
SW	6.437E-06	1.742E-06	8.160E-07	4.882E-07	2.441E-07	1.511E-07	1.048E-07	7.789E-08	6.072E-08	4.898E-08	4.056E-08
WSW	5.482E-06	1.466E-06	6.859E-07	4.074E-07	2.003E-07	1.222E-07	8.356E-08	6.140E-08	4.737E-08	3.787E-08	3.109E-08
W	6.341E-06	1.702E-06	7.973E-07	4.743E-07	2.339E-07	1.430E-07	9.802E-08	7.216E-08	5.577E-08	4.464E-08	3.671E-08
WNW	5.336E-06	1.413E-06	6.585E-07	3.906E-07	1.922E-07	1.172E-07	8.023E-08	5.897E-08	4.552E-08	3.641E-08	2.991E-08
NW	7.245E-06	1.963E-06	9.221E-07	5.520E-07	2.761E-07	1.710E-07	1.185E-07	8.802E-08	6.858E-08	5.529E-08	4.575E-08
NNW	5.099E-06	1.367E-06	6.416E-07	3.824E-07	1.896E-07	1.163E-07	7.996E-08	5.900E-08	4.568E-08	3.663E-08	3.016E-08
N	5.455E-06	1.469E-06	6.906E-07	4.117E-07	2.043E-07	1.256E-07	8.644E-08	6.386E-08	4.950E-08	3.973E-08	3.274E-08
NNE	4.928E-06	1.318E-06	6.179E-07	3.676E-07	1.816E-07	1.111E-07	7.617E-08	5.608E-08	4.335E-08	3.470E-08	2.853E-08
NE	6.235E-06	1.687E-06	7.950E-07	4.747E-07	2.358E-07	1.450E-07	9.981E-08	7.374E-08	5.715E-08	4.587E-08	3.780E-08
ENE	6.259E-06	1.689E-06	7.953E-07	4.742E-07	2.348E-07	1.440E-07	9.894E-08	7.297E-08	5.647E-08	4.527E-08	3.726E-08
E	8.134E-06	2.187E-06	1.026E-06	6.115E-07	3.031E-07	1.861E-07	1.280E-07	9.451E-08	7.322E-08	5.875E-08	4.840E-08
ESE	7.743E-06	2.065E-06	9.665E-07	5.745E-07	2.832E-07	1.730E-07	1.184E-07	8.710E-08	6.725E-08	5.378E-08	4.418E-08
SE	6.325E-06	1.689E-06	7.916E-07	4.707E-07	2.318E-07	1.413E-07	9.666E-08	7.098E-08	5.473E-08	4.372E-08	3.588E-08
SSE	4.290E-06	1.138E-06	5.310E-07	3.150E-07	1.550E-07	9.461E-08	6.477E-08	4.762E-08	3.676E-08	2.941E-08	2.416E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.598E-08	8.425E-09	5.342E-09	2.820E-09	1.799E-09	1.265E-09	9.463E-10	7.384E-10	5.944E-10	4.899E-10	4.113E-10
SSW	1.745E+08	9.214E-09	5.849E-09	3.089E-09	1.970E-09	1.385E-09	1.036E-09	8.079E-10	6.501E-10	5.357E-10	4.497E-10
SW	3.431E-08	1.820E-08	1.159E-08	6.150E-09	3.934E-09	2.773E-09	2.078E-09	1.624E-09	1.309E-09	1.080E-09	9.080E-10
WSW	2.612E-08	1.349E-08	8.428E-09	4.366E-09	2.761E-09	1.929E-09	1.436E-09	1.116E-09	8.951E-10	7.357E-10	6.163E-10
W	3.087E-08	1.601E-08	1.003E-08	5.211E-09	3.297E-09	2.304E-09	1.715E-09	1.333E-09	1.069E-09	8.785E-10	7.358E-10
WNW	2.514E-08	1.303E-08	8.166E-09	4.246E-09	2.689E-09	1.881E-09	1.401E-09	1.090E-09	8.751E-10	7.196E-10	6.031E-10
NW	3.868E-08	2.045E-08	1.298E-08	6.857E-09	4.366E-09	3.066E-09	2.291E-09	1.786E-09	1.436E-09	1.182E-09	9.921E-10
NNW	2.538E-08	1.320E-08	8.279E-09	4.303E-09	2.716E-09	1.894E-09	1.408E-09	1.093E-09	8.753E-10	7.185E-10	6.012E-10
N	2.759E-08	1.441E-08	9.066E-09	4.728E-09	2.988E-09	2.086E-09	1.550E-09	1.204E-09	9.644E-10	7.916E-10	6.623E-10
NNE	2.399E-08	1.242E-08	7.773E-09	4.028E-09	2.541E-09	1.773E-09	1.317E-09	1.022E-09	8.188E-10	6.721E-10	5.623E-10
NE	3.183E-08	1.658E-08	1.041E-08	5.414E-09	3.415E-09	2.381E-09	1.768E-09	1.372E-09	1.098E-09	9.012E-10	7.537E-10
ENE	3.135E-08	1.631E-08	1.023E-08	5.311E-09	3.345E-09	2.330E-09	1.729E-09	1.340E-09	1.072E-09	8.790E-10	7.346E-10
E	4.076E-08	2.125E-08	1.336E-08	6.969E-09	4.412E-09	3.085E-09	2.297E-09	1.785E-09	1.432E-09	1.176E-09	9.848E-10
ESE	3.712E-08	1.919E-08	1.199E-08	6.205E-09	3.913E-09	2.728E-09	2.026E-09	1.572E-09	1.259E-09	1.033E-09	8.645E-10
SE	3.011E-08	1.550E-08	9.655E-09	4.971E-09	3.122E-09	2.170E-09	1.608E-09	1.245E-09	9.952E-10	8.155E-10	6.812E-10
SSE	2.031E-08	1.052E-08	6.584E-09	3.419E-09	2.164E-09	1.513E-09	1.126E-09	8.756E-10	7.026E-10	5.774E-10	4.837E-10

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT — SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.216E-07	1.223E-07	5.021E-08	2.868E-08	1.901E-08	8.734E-09	2.926E-09	1.280E-09	7.429E-10	4.918E-10
SSW	4.532E-07	1.323E-07	5.453E-08	3.123E-08	2.074E-08	9.548E-09	3.205E-09	1.401E-09	8.128E-10	5.378E-10
SW	8.761E-07	2.570E-07	1.064E-07	6.115E-08	4.074E-08	1.884E-08	6.374E-09	2.805E-09	1.634E-09	1.084E-09
WSW	7.355E-07	2.116E-07	8.499E-08	4.776E-08	3.126E-08	1.405E-08	4.555E-09	1.953E-09	1.123E-09	7.387E-10
W	8.547E-07	2.469E-07	9.967E-08	5.621E-08	3.690E-08	1.665E-08	5.431E-09	2.333E-09	1.341E-09	8.821E-10
WNW	7.071E-07	2.030E-07	8.159E-08	4.589E-08	3.007E-08	1.356E-08	4.425E-09	1.905E-09	1.097E-09	7.225E-10
NW	9.889E-07	2.907E-07	1.203E-07	6.907E-08	4.596E-08	2.118E-08	7.111E-09	3.103E-09	1.797E-09	1.187E-09
NNW	6.876E-07	1.999E-07	8.127E-08	4.604E-08	3.031E-08	1.372E-08	4.481E-09	1.919E-09	1.100E-09	7.215E-10
N	7.396E-07	2.154E-07	8.784E-08	4.988E-08	3.290E-08	1.496E-08	4.918E-09	2.112E-09	1.212E-09	7.949E-10
NNE	6.623E-07	1.916E-07	7.745E-08	4.369E-08	2.868E-08	1.293E-08	4.200E-09	1.795E-09	1.029E-09	6.749E-10
NE	8.508E-07	2.485E-07	1.014E-07	5.759E-08	3.798E-08	1.723E-08	5.635E-09	2.411E-09	1.381E-09	9.050E-10
ENE	8.512E-07	2.476E-07	1.006E-07	5.692E-08	3.744E-08	1.695E-08	5.530E-09	2.360E-09	1.349E-09	8.827E-10

TABLE E-8, Contd

E	1.100E-06	3.196E-07	1.301E-07	7.379E-08	4.864E-08	2.208E-08	7.253E-09	3.124E-09	1.796E-09	1.181E-09
ESE	1.036E-06	2.990E-07	1.204E-07	6.779E-08	4.441E-08	1.997E-08	6.472E-09	2.763E-09	1.583E-09	1.038E-09
SE	8.483E-07	2.447E-07	9.830E-08	5.518E-08	3.607E-08	1.615E-08	5.190E-09	2.199E-09	1.253E-09	8.190E-10
SSE	5.699E-07	1.637E-07	6.587E-08	3.706E-08	2.429E-08	1.094E-08	3.564E-09	1.532E-09	8.813E-10	5.798E-10

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.0	REP. WIND HEIGHT	(METERS)	62.0
DIAMETER	(METERS)	0.0	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(M/SEC)	0.0	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)			
ELEVATED	LESS THAN	0.0		
MIXED	BETWEEN	0.0	AND	0.0
GROUND LEVEL	ABOVE	0.0		

AT THE MEASURED WIND HEIGHT (62.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS				WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS			
ELEVATED	LESS THAN	0.0			LESS THAN	0.0		
MIXED	BETWEEN	0.0	AND	0.0	BETWEEN	0.0	AND	0.0
GROUND LEVEL	ABOVE	0.0			ABOVE	0.0		

TABLE E-9

Ground-Level Release - D/Q

******************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS ********************

DIRECTION FROM SITE	DISTANCES IN MILES 0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	1.773E-08	5.997E-09	3.079E-09	1.891E-09	9.426E-10	5.717E-10	3.865E-10	2.801E-10	2.130E-10	1.678E-10	1.358E-10
SSW	1.703E-08	5.758E-09	2.957E-09	1.815E-09	9.051E-10	5.489E-10	3.711E-10	2.689E-10	2.045E-10	1.611E-10	1.304E-10
SW	2.942E-08	9.949E-09	5.108E-09	3.137E-09	1.564E-09	9.485E-10	6.413E-10	4.647E-10	3.533E-10	2.784E-10	2.254E-10
WSW	3.807E-08	1.287E-08	6.609E-09	4.058E-09	2.023E-09	1.227E-09	8.297E-10	6.012E-10	4.572E-10	3.602E-10	2.916E-10
W	4.188E-08	1.416E-08	7.271E-09	4.465E-09	2.226E-09	1.350E-09	9.127E-10	6.614E-10	5.029E-10	3.962E-10	3.207E-10
WNW	3.656E-08	1.236E-08	6.347E-09	3.897E-09	1.943E-09	1.178E-09	7.967E-10	5.773E-10	4.390E-10	3.459E-10	2.800E-10
NW	3.776E-08	1.277E-08	6.557E-09	4.026E-09	2.007E-09	1.217E-09	8.231E-10	5.964E-10	4.535E-10	3.573E-10	2.893E-10
NNW	3.257E-08	1.101E-08	5.654E-09	3.472E-09	1.731E-09	1.050E-09	7.098E-10	5.143E-10	3.911E-10	3.081E-10	2.494E-10
N	3.339E-08	1.129E-08	5.798E-09	3.560E-09	1.775E-09	1.076E-09	7.278E-10	5.274E-10	4.010E-10	3.159E-10	2.558E-10
NNE	3.521E-08	1.191E-08	6.113E-09	3.753E-09	1.871E-09	1.135E-09	7.673E-10	5.560E-10	4.228E-10	3.331E-10	2.697E-10
NE	3.996E-08	1.351E-08	6.938E-09	4.260E-09	2.124E-09	1.288E-09	8.710E-10	6.311E-10	4.799E-10	3.781E-10	3.061E-10
ENE	3.916E-08	1.324E-08	6.798E-09	4.174E-09	2.081E-09	1.262E-09	8.534E-10	6.184E-10	4.702E-10	3.705E-10	2.999E-10
E	4.873E-08	1.648E-08	8.460E-09	5.195E-09	2.590E-09	1.571E-09	1.062E-09	7.696E-10	5.852E-10	4.610E-10	3.732E-10
ESE	5.300E-08	1.792E-08	9.202E-09	5.650E-09	2.817E-09	1.709E-09	1.155E-09	8.371E-10	6.365E-10	5.014E-10	4.059E-10
SE	4.976E-08	1.683E-08	8.639E-09	5.305E-09	2.645E-09	1.604E-09	1.084E-09	7.858E-10	5.975E-10	4.707E-10	3.811E-10
SSE	2.880E-08	9.738E-09	5.000E-09	3.070E-09	1.531E-09	9.283E-10	6.276E-10	4.548E-10	3.458E-10	2.725E-10	2.206E-10

DIRECTION FROM SITE	DISTANCES IN MILES 5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	1.124E-10	5.506E-11	3.455E-11	1.746E-11	1.057E-11	7.086E-12	5.078E-12	3.813E-12	2.965E-12	2.368E-12	1.933E-12
SSW	1.079E-10	5.287E-11	3.317E-11	1.677E-11	1.015E-11	6.804E-12	4.876E-12	3.661E-12	2.847E-12	2.274E-12	1.856E-12
SW	1.864E-10	9.135E-11	5.732E-11	2.897E-11	1.753E-11	1.176E-11	8.424E-12	6.326E-12	4.918E-12	3.929E-12	3.207E-12
WSW	2.412E-10	1.182E-10	7.416E-11	3.748E-11	2.269E-11	1.521E-11	1.090E-11	8.185E-12	6.364E-12	5.083E-12	4.149E-12
W	2.653E-10	1.300E-10	8.158E-11	4.123E-11	2.496E-11	1.673E-11	1.199E-11	9.003E-12	7.000E-12	5.592E-12	4.564E-12
WNW	2.316E-10	1.135E-10	7.122E-11	3.600E-11	2.179E-11	1.461E-11	1.047E-11	7.860E-12	6.111E-12	4.882E-12	3.984E-12
NW	2.393E-10	1.173E-10	7.357E-11	3.719E-11	2.251E-11	1.509E-11	1.081E-11	8.120E-12	6.313E-12	5.043E-12	4.116E-12
NNW	2.063E-10	1.011E-10	6.344E-11	3.207E-11	1.941E-11	1.301E-11	9.324E-12	7.002E-12	5.444E-12	4.349E-12	3.550E-12
N	2.116E-10	1.037E-10	6.505E-11	3.288E-11	1.990E-11	1.334E-11	9.561E-12	7.179E-12	5.582E-12	4.459E-12	3.640E-12
NNE	2.231E-10	1.093E-10	6.859E-11	3.467E-11	2.098E-11	1.407E-11	1.008E-11	7.569E-12	5.885E-12	4.701E-12	3.837E-12
NE	2.532E-10	1.241E-10	7.785E-11	3.935E-11	2.382E-11	1.597E-11	1.144E-11	8.592E-12	6.680E-12	5.336E-12	4.356E-12
ENE	2.481E-10	1.216E-10	7.628E-11	3.856E-11	2.334E-11	1.565E-11	1.121E-11	8.419E-12	6.546E-12	5.229E-12	4.268E-12
E	3.087E-10	1.513E-10	9.493E-11	4.798E-11	2.904E-11	1.947E-11	1.395E-11	1.048E-11	8.146E-12	6.507E-12	5.311E-12
ESE	3.358E-10	1.646E-10	1.033E-10	5.219E-11	3.159E-11	2.118E-11	1.518E-11	1.140E-11	8.860E-12	7.077E-12	5.777E-12
SE	3.152E-10	1.545E-10	9.693E-11	4.899E-11	2.965E-11	1.988E-11	1.425E-11	1.070E-11	8.318E-12	6.644E-12	5.423E-12
SSE	1.825E-10	8.941E-11	5.610E-11	2.836E-11	1.716E-11	1.151E-11	8.245E-12	6.191E-12	4.814E-12	3.845E-12	3.139E-12

*********************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS ***********************

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.199E-09	9.884E-10	3.933E-10	2.149E-10	1.366E-10	5.868E-11	1.820E-11	7.212E-12	3.851E-12	2.384E-12
SSW	3.072E-09	9.491E-10	3.777E-10	2.064E-10	1.312E-10	5.634E-11	1.747E-11	6.925E-12	3.698E-12	2.289E-12
SW	5.308E-09	1.640E-09	6.525E-10	3.566E-10	2.266E-10	9.735E-11	3.019E-11	1.196E-11	6.389E-12	3.955E-12
WSW	6.867E-09	2.122E-09	8.443E-10	4.614E-10	2.932E-10	1.260E-10	3.906E-11	1.548E-11	8.267E-12	5.117E-12
W	7.555E-09	2.334E-09	9.288E-10	5.075E-10	3.226E-10	1.386E-10	4.297E-11	1.703E-11	9.094E-12	5.629E-12
WNW	6.595E-09	2.037E-09	8.108E-10	4.430E-10	2.816E-10	1.210E-10	3.751E-11	1.487E-11	7.938E-12	4.914E-12
NW	6.813E-09	2.105E-09	8.376E-10	4.577E-10	2.909E-10	1.250E-10	3.875E-11	1.536E-11	8.201E-12	5.076E-12
NNW	5.875E-09	1.815E-09	7.223E-10	3.947E-10	2.509E-10	1.078E-10	3.341E-11	1.324E-11	7.072E-12	4.377E-12
N	6.024E-09	1.861E-09	7.406E-10	4.047E-10	2.572E-10	1.105E-10	3.426E-11	1.358E-11	7.251E-12	4.488E-12
NNE	6.351E-09	1.962E-09	7.808E-10	4.267E-10	2.712E-10	1.165E-10	3.612E-11	1.432E-11	7.645E-12	4.732E-12
NE	7.209E-09	2.227E-09	8.863E-10	4.843E-10	3.078E-10	1.322E-10	4.100E-11	1.625E-11	8.678E-12	5.371E-12
ENE	7.064E-09	2.182E-09	8.684E-10	4.746E-10	3.016E-10	1.296E-10	4.017E-11	1.592E-11	8.503E-12	5.263E-12
E	8.791E-09	2.716E-09	1.081E-09	5.906E-10	3.754E-10	1.612E-10	5.000E-11	1.982E-11	1.058E-11	6.550E-12
ESE	9.561E-09	2.954E-09	1.175E-09	6.423E-10	4.083E-10	1.754E-10	5.438E-11	2.155E-11	1.151E-11	7.124E-12
SE	8.976E-09	2.773E-09	1.104E-09	6.030E-10	3.833E-10	1.646E-10	5.105E-11	2.023E-11	1.080E-11	6.688E-12
SSE	5.195E-09	1.605E-09	6.387E-10	3.490E-10	2.218E-10	9.528E-11	2.955E-11	1.171E-11	6.254E-12	3.871E-12

TABLE E-10

Atmospheric Relative Dispersion (χ/Q) and Deposition (D/Q) Factors at the Location of the Maximally-Exposed Individual

	Boundary Location*		χ/Q, sec/m^3			
Release Points	Compass Sector	Distance, (miles)	No Decay Undepleted	2.26-Day Decay Undepleted	8.00-Day Decay Depleted	D/Q, m^{-2}
62-meter stacks:						
L Area	ESE	7.06	2.428E-08	2.378E-08	2.193E-08	1.267E-10
F Area	SE	12.7	9.133E-09	8.824E-09	7.875E-09	4.795E-11
H Area	SE	11.4	1.057E-08	1.025E-08	9.189E-09	5.702E-11
Ground level:						
L Area	ESE	7.06	2.993E-08	2.934E-08	2.118E-08	1.811E-10
H Area	SE	11.4	1.192E-08	1.115E-08	7.747E-09	7.766E-11
D Area	ESE	13.1	1.223E-08	1.179E-08	7.737E-09	6.602E-11
M Area	SE	17.7	6.412E-09	6.108E-09	3.759E-09	3.666E-11

* SRP buffer-zone boundary location with respect to release point.

APPENDIX F

DOSE METHODOLOGY FOR ROUTINE RELEASES OF RADIOACTIVITY TO THE ATMOSPHERE

DOSE METHODOLOGY FOR ROUTINE RELEASES OF RADIOACTIVITY TO THE ATMOSPHERE

The Nuclear Regulatory Commission's computer program, GASPAR,[1] has been used to calculate the potential annual doses to offsite man in Section 3.5. The GASPAR code implements the air-release dose models of NRC Regulatory Guide 1.109,[2] utilizing regulatory guide parameters except for site specific data described here. The dose factors used for exposure to noble gases are the γ-factors in Table B-1 of the regulatory guide, plus lung exposure factors contained in the GASPAR code. The remainder of the dose factor library is that described in Appendix C of NUREG/CR-1276;[3] for the inhalation and ingestion pathways, this incorporates the age-specific 50-year dose commitment factors of Hoennes and Soldat (NUREG-0172)[4] with NRC-approved corrections in actinide factors.

For maximally-exposed individuals, the annual doses at the midpoint of an assumed 30-year operating period were calculated. As indicated in the regulatory guide, this is a simplified method of approximating the average deposition over the operating lifetime. For the 50-mile population, the annual doses based on one year of operating releases and the residual effects from the deposition for an additional 100 years were calculated (GASPAR-code parameter PLIFE = 100.5 years). The calculated population dose may also be regarded as a 100-year environmental dose commitment per year of operation.[5]

For the doses to the 50-mile population, the input data to the GASPAR code has been indicated in Section 3.5. More specifically, this consists of the data presented in Tables 3.5-1 and 3.5-3, and the compass-sector segment χ/Q and D/Q values shown in Appendix E. In addition, the absolute humidity during the growing season was taken to be 11.73 g/m^3, an average daytime value derived from Tables 2.4-2 and 2.4-3 of the L-EID,[6] which was also used in the individual dose calculations.

For the doses to the maximally-exposed individual, the XOQDOQ code (Appendix E) and the GASPAR code were combined into a computer procedure to determine the doses at the location of the maximum total-body dose rate (mrem/yr) to the age-specific individuals along the SRP buffer-zone boundary (the nearest possible approach of the residential population). The necessary χ/Q and D/Q values for the multipoint releases were generated internal to the procedure and are too numerous to tabulate; however, the set of these values leading to the maximum exposure have been shown in Table E-10 of Appendix E. The other input data has been given in Tables 3.5-1 and 3.5-2 of the main text.

REFERENCES FOR APPENDIX F

1. Eckerman, K. F., et al., "User's Guide to GASPAR Code." NUREG-0597, U.S. Nuclear Regulatory Commission, Washington, DC (June 1980).

2. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 20, Appendix I." USNRC Regulatory Guide 1.109, Revision 1, U.S. Nuclear Regulatory Commission, Washington, DC (1977).

3. D. B. Simpson and B. L. McGill. Users Manual for LADTAP II – A Computer Program for Calculating Radiation Exposure to Man from Routine Release of Nuclear Reactor Liquid Effluents. NUREG/CR-1276, ORNL/NUREG/TDMC-1, Oak Ridge National Laboratory, Oak Ridge, TN (1980).

4. Age Specific Radiation Dose Commitment Factors for a One-Year Chronic Intake. USNRC Report NUREG-0172, Battelle Pacific Northwest Laboratories, Richland, WA (1977).

5. "Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry." EPA-520/4-73-002, U.S. Environmental Protection Agency, Washington, DC (February 1974).

6. Environmental Information Document, L-Reactor Reactivation. DPST-81-241, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (April 1982).

APPENDIX G

SAMPLING STATION DESCRIPTIONS OF BIOLOGICAL MEASUREMENT PROGRAM

SAMPLING STATION DESCRIPTIONS OF BIOLOGICAL MEASUREMENT PROGRAM

The following is a brief description of the sampling locations used in the March through August, 1982, fisheries surveys of the Savannah River and creeks near the SRP.

Transect 1 (T1) - Upstream Reference

Transect 1, which serves as an upstream reference, is located about 100 meters above the confluence of the Savannah River and Upper Three Runs Creek and 200 meters above the 1G canal. This transect is not influenced by the Savannah River Plant operations or by the discharge of Upper Three Runs Creek.

Transect 2 (T2) - 1G Intake Canal

The 1G pumphouse is located at the end of a 550-meter-long intake canal. The width of the canal varies depending upon the river level which fluctuates seasonally. The minimum depth of the canal is 2 meters.

Transect 3 (T3) - Below 1G Intake Canal

Transect 3 samples are taken about 50 meters below the mouth of the 1G canal. This transect serves as a measure of the effects water removal by the 1G intake.

Transect 4 (T4) - Above 3G and 5G Intake Canals

Transect 4 is located about 50 meters above the mouth of the 3G intake canal. This transect serves as a reference transect to measure the intake of meroplankton into the 3G and 5G canals.

Transect 5 (T5) - 3G Canal

The 3G pumphouse is located at the end of a 410-meter-long intake canal. This canal has a minimum depth of 2 meters and a width that varies with seasonal river levels.

Transect 6 (T6) - Below 3G and 5G Intake Canals

Transect 6 is located about 50 meters below the 5G pumphouse cove. This transect serves as a measure of the effects of water removal by the 3G and 5G intakes.

Transect 7 (T7) - Above Four Mile Creek

Transect 7, which serves as a downstream recovery transect and a reference transect for the Four Mile Creek discharge, is located at approximately River Mile 151. This transect samples the area above where the discharge from Four Mile Creek enters the Savannah River. This transect location is the same as that of the upstream transect used by Georgia Power Company in their environmental monitoring program on the river.

Transect 8 (T8) - Downstream from Four Mile Creek

Transect 8 is located approximately 400 meters downstream from Four Mile Creek in the thermal zone. The transect is located so that the Georgia side sampling point is at ambient river temperature and the South Carolina side sampling point is in the plume. This transect location is the same as that of the downstream transect used by Georgia Power Company.

Transect 9 (T9) - Downstream from Steel Creek

Transect 9 is located approximately 400 meters downstream from Steel Creek. Steel Creek flows through the Savannah River swamp before entering the river. The mouth of Steel Creek currently receives thermal effluents from K Reactor which discharges into Pen Branch and joins with Steel Creek near its discharge point into the Savannah River. Steel Creek will receive the thermal effluents from a restart of L Reactor.

Station C1 - Upper Three Runs Creek

One location is sampled within 100 meters of the confluence of Upper Three Runs Creek and the Savannah River.

Station C2 - Four Mile Creek

One location is sampled in Four Mile Creek about 20 meters from the point where it joins with the Savannah River.

Station C3 - Steel Creek

One location is sampled in Steel Creek about 50 meters from the point where it joins with the Savannah River.

APPENDIX H

TAXONOMIC OPINIONS - STURGEON LARVAE

Department of Fishery and Wildlife Biology
Larval Fish Laboratory
(303) 491-5295 or 491-5089

Colorado State University
Fort Collins, Colorado
80523

TAXONOMIC OPINION: PROBLABLE IDENTITY OF

RECENTLY HATCHED STURGEON LARVAE COLLECTED

FROM THE SAVANNAH RIVER ON MARCH 26,

APRIL 21-22 AND MAY 21, 1982.

for

Robin Matthews
Savannah River Laboratory
E. I. du Pont de Nemours and Company
Building 773-11A
Aiken, South Carolina 29808
(P.O. AX-607-170-M)

28 February 1983

Taxonomist: Darrel E. Snyder

Based on differences in pigmentation, certain morphometric and meristic characters, and to some degree developmental state relative to size, two distinct larval forms were evident among the 11 sturgeon larvae submitted for identification. In arriving at this conclusion, it was assumed, based on my experience with other species of fish, that the differing characters of the largest specimen are typical of a species distinct from the other specimens and not just extreme variants of the species represented by them. Since only the Atlantic and shortnose sturgeons (Acipenser oxyrhynchus and A. brevirostrum, respectively) are known to occur in the region, these must be the species represented. The only uncertainty is which specimens represent which species.

All specimens are recently hatched protolarvae (probably less than two or three days old) with very large yolk sacs, undeveloped eyes and mouths, and minute, if any, pectoral fin buds. On the smallest (7.1 and 7.2 mm TL, total length) and the largest (9.5 mm TL) specimens, the most anterior portion of the dorsal finfold, just behind the head, was either barely evident (7.1 mm) or not yet formed resulting in a more posterior origin for that finfold (7.2 and 9.5 mm TL). This condition suggests that despite difference in size, these specimens are probably in an earlier stage of development than the remaining specimens which measure 7.7 to 8.7 mm TL and possess relatively large finfolds, including this anterior region of the dorsal finfold.

Selected morphometric and meristic data is detailed in the accompanying table. Aside from the already mentioned difference in dorsal finfold origin, the shallower finfolds of the largest specimen resulted in not only smaller values for total depth (including finfolds; relative to total length) at certain points posterior to the yolk sac but in a greater proportion of that depth being attributed to the body itself. These specimens were preserved in alcohol and accordingly the specific length measures probably reflect as much as 10% shrinkage over those dimensions when initially killed and fixed. To reduce the extent of shrinkage in preserved specimens and avoid deformation due to dehydration in alcohol, fixation in 5 to 10% formalin and preservation in the same or more dilute solutions, down to 3%, are recommended for future collections. These solutions should be buffered to near neutral if potential for future study of bone or cartilage, or otolith aging, is planned.

The very first and last few myomeres were often very difficult to discern and so the myomere data should be considered as approximations only. In general all the specimens had about 38±2 preanal myomeres (those anterior to a verticle from the posterior margin of the vent including the myomeres transected by that verticle). However, the largest specimen (9.5 mm TL) appeared to have about 24 to 25 postanal myomeres and 62 to 63 total myomeres while the rest had about 18 to 21 and 56-60 respectively.

Aside from the generally lighter, more faded appearance of melanophore pigmentation in the largest specimen, the most distinctive pigmental difference between this specimen and the others is the relative lack of dark pigmentation in the gut posterior to the yolk sac. In addition to that dark pigmentation, the others also exhibited dense pigmentation along the sides of the posterior portion of the head and generally over the entire yolk sac, or at least the upper portions. Much of the rest of their bodies was moderately to lightly pigmented with some intensification in the caudual region, sometimes extending into the basal portions of dorsal and ventral finfolds. The largest specimen exhibited moderate pigmentation over the sides and top of the posterior portion of the head and the upper surfaces of the yolk sac with little to no obvious pigmentation elsewhere.

The available descriptive literature is generally of little help in identifying recently hatched larvae of these species and in some instances added to the uncertainty in this taxonomic determination. Taubert and Dadswell (1980) provide a photograph of a 10 mm TL shortnose sturgeon that appears to be a somewhat later stage (eyes more developed, finfold somewhat enlarged) of the largest specimen examined for this report. However; for shortnose sturgeon between 9.1 and 14.7 mm TL they also reported myomere counts of 33 to 36 preanal, 20 to 22 postanal and 53 to 57 total, all notably less than for the 9.5 mm TL specimen documented in the accompanying table. Buckley and Kynard (1981) also published photographs of recently hatched shortnose sturgeon larvae (about 9.5 mm TL). These, like our largest specimen seem to have relatively shallow finfolds but their pigmentation is much more like that of our other specimens. Bath et al (1981) described and illustrated, via photograph, an 8.4 mm TL specimen that based on date and location of capture they suspect to be Atlantic sturgeon. It generally resembles our smaller specimens (e.g. 7.1 and 7.7 mm TL), including the larger finfolds, but pigmentation appears more like that of our largest specimen. These authors report myomere counts of 36 to 38 preanal, 19 to 23 postanal and

55-60 total myomeres for specimens measuring 8.4-14.3 mm TL that they suspect to be Atlantic sturgeon; these figures are similar to our own for all but the largest specimen. According to Bath et al (1981), the drawing of an 11.5 mm TL recently hatched sturgeon reprinted in Jones et al (1978), Lippson and Moran (1974), Mansueti and Hardy (1967) and Ryder (1890) as that of the Atlantic sturgeon actually represents a European species as originally illustrated in Parker (1882). Smith et al (1980) report a mean hatching size of 7.1 mm TL for Atlantic sturgeon.

Based on the above and other literature, shortnose sturgeon typically spawn earlier in the spring and yield notably larger fertilized eggs and hatched young (in spite of a much smaller adult size) than the Atlantic sturgeon. The largest specimen examined was captured one to two months earlier than the others provided for identification; it also appears to represent a developmental state more similar to the smaller of the latter group. These observations coupled with similarity to some published photographs of recently hatched shortnose sturgeon suggests that the largest specimen is probably a shortnose sturgeon and the others are probably Atlantic sturgeon. Greater confidence in this conclusion requires either more specimens like the larger one, preferrably with stages linking it to later larvae which are identifiable on the basis of mouth width, or much better comparative descriptions of the early larvae of the two species.

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Daniel E. Dingler

Selected morphometrics and myomere counts of re[illegible]ly hatched sturgeon larvae collected from the Savannah River in [illegible].

Specimens provided by Robin Matthews of the Savannah River Laboratory, E.I. due Pont de Nemours and Company of Aiken, South Carolina.

Probable Identity	-	*Acipenser oxyrhynchus*[a]											*A. brevirostrum*
Total Length (TL; mm)	-	7.2	7.7	7.7	7.8	8.2	8.4	8.4	8.5	8.7	7.7-8.7 (7.2 excluded)		9.5
Specimen Number	-	7	3	5	10	4	6	8	11	12			1
Collection Site	-	T6RTB	T6RBB	T4CBA	T7CBB	T4CBB	T3CBA	T6RBA	T3LBA	T3RBA			T1CBB
Collection Date	-	4/22	4/22	5/21	4/21	5/21	5/21	4/22	4/22	4/22			3/26
											$\bar{x} \pm sd$	range	
Lengths as %TL, Snout to:													
Posterior margin of 4th ventricle "keel" (top of head)	-	14	16	17	17	18	17	16	18	16	17±1	16-18	13
Origin of dorsal finfold	-	22	18	19	18	19	19	17	19	20	19±1	17-20	25
Origin of pectoral fin bud	-	b.	22	25	23	24	23	22	23	23	23±1	22-25	21
Posterior margin of yolk sac	-	47	47	48	46	47	47	48	45	47	47±1	45-48	46
Posterior margin of vent	-	71	73	73	74	72	70	73	70	71	72±2	70-74	70
Length of 4th ventricle keel (%TL)	-	7	8	9	9	10	9	9	10	10	9±1	8-10	7
Total depth as %TL at:													
About 4 myomeres behind yolk sac	-	13	16	19	18	17	18	18	20	18	18±1	16-20	15
Immediately posterior to vent	-	13	13	17	15	13	16	15	15	15	15±1	13-17	9
Maximum depth in caudal region	-	19	16	17	14	15	19	17	17	17	17±2	14-19	13
Body depth as % total depth:													
About 4 myomeres behind yolk sac	-	62	53	47	49	54	46	49	48	48	49±3	46-54	68
Immediately posterior to vent	-	33	42	33	37	42	38	39	33	35	37±4	33-42	54
Maximum depth in caudal region	-	14	25	23	21	21	21	19	21	20	21±2	19-25	17
Myomeres, approximate counts:													
Total	-	56-57+	57-60	59-60	57-59	58-60	59		59	54-58		54-60	62-63
Preanal	-	38-39	39	41	38-39	38-39	40	39	40	36-38		36-41	38
Postanal	-	18+	18-21	18-19	19-20	20-21	19		19	18-21		18-21	24-25

[a] Specimen #9, 7.1 mm TL (4/22/82, T3CBB), was too damaged for convenient analysis; except for larger finfolds, it was similar to 7.2 mm TL specimen.

b. No pectoral fin bud.

UNCLASSIFIED

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TAXONOMIC OPINION: PROBABLE IDENTITY OF ADDITIONAL RECENTLY-HATCHED STUREGON LARVAE COLLECTED FROM THE SAVANNAH RIVER ON MARCH 12, MAY 21, AND AUGUST 12, 1982

for

Robin Matthews
Savannah River Laboratory
E. I. du Pont de Nemours and Company
Building 773-11A
Aiken, South Carolina 29808
(P.O. AX 0598140)

April 6, 1983

Taxonomist: Darrel E. Snyder

Of the four additional sturgeon larvae recently sent for identification, the 10.1 mm TL specimen collected in March is certainly of another species than that represented by the others. It is very similar to the 9.5 mm specimen previously examined and believed to be shortnose sturgeon. The others are very similar to smaller specimens in the previous set of specimens and are probably Atlantic sturgeon. Please review comments in the February 28 report for specific criteria used in arriving at these conclusions. Selected morphometric and myomere count data is provided in the attached table.

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UCNI

Selected morphometrics and myomere counts of additional recently hatched sturgeon larvae collected from the Savannah River in 1982.

Specimens provided by Robin Matthews of the Savannah River Laboratory, E. I. du Pont de Nemours and Company of Aiken, South Carolina.

Probable Identity	-	*Acipenser oxyrhynchus*			*A. brevirostrum*
Total Length (TL; mm)	-	8.1	8.2	6.7	10.1
Specimen Number	-	-	-	-	-
Collection Site	-	T1CTB	T1CBB	T1CBB	T1CTB
Collection Date	-	5/21	5/21	8/12	3/12
Lengths as %TL, Snout to:					
Posterior margin of 4th ventricle "keel" (top of head)	-	17	17	17	17
Origin of dorsal finfold	-	19	20	26	17c.
Origin of pectoral fin bud	-	21	22	a.	23
Posterior margin of yolk sac	-	47	45	47	45
Posterior margin of vent	-	72	68	b.	71
Length of 4th ventricle keel (%TL)	-	10	10	9	10
Total depth as %TL at:					
About 4 myomeres behind yolk sac	-	19	17	14	16
Immediately posterior to vent	-	14	12	b.	12
Maximum depth in caudal region	-	16	16	12	14
Body depth as % total depth:					
About 4 myomeres behind yolk sac	-	53	50	63	50
Immediately posterior to vent	-	41	40	b.	42
Maximum depth in caudal region	-	19	19	19	21
Myomeres, approximate counts:					
Total	-	59	58	b.	62
Preanal	-	38	38	b.	38
Postanal	-	21	20	b.	24

a. No pectoral fin buds observed.
b. Specimen damaged in vicinity of vent precluding count or measure.
c. Anterior dorsal fin remains very low until about 35% TL when it rises abruptly.

APPENDIX I

SAVANNAH RIVER BIOLOGICAL MEASUREMENT PROGRAM

SAVANNAH RIVER BIOLOGICAL MEASUREMENT PROGRAM

The following is an outline of the Biological Measurements Program planned for the Savannah River by SRP through 1985. Both the nearfield program (near SRP) and farfield program (more distant from SRP) are given.

I. Nearfield Sampling Program

Entrainment

Weekly (February 1 - July 31, 1983-1985)

Stations

- Savannah River transects, 3 points (right, left, and mid-river) per transect.

    1. Above 1G pumphouse.
    2. Below 1G pumphouse.
    3. Above 3G and 5G pumphouses.
    4. Below 3G and 5G pumphouses.
    5. Transect above Beaver Dam Creek (approximately River Mile 153).
    6. Thermal transect approximately 0.25 miles downstream from Beaver Dam Creek.
    7. Recovery transect above Four Mile Creek (approximately River Mile 151).
    8. Thermal transect approximately 0.25 miles downstream from Four Mile Creek (at least one transect point at ambient river temperature).
    9. Recovery transect above Steel Creek (approximately River Mile 138).
    10. Transect approximately 0.25 miles downstream from Steel Creek in zone of predicted maximum thermal impact.
    11. Recovery transect below Steel Creek (approximately River Mile 139, above stream entering river from South Carolina bank).
    12. Transect above Lower Three Runs Creek (approximately River Mile 139, above stream entering river from South Carolina bank).

13. Recovery transect approximately 0.25 miles downstream from Lower Three Runs Creek.

- Canal mouth transects (3 points) in 1G and 3G canals.
- Creek mouth stations (single point at midstream) at confluence with Upper Three Runs, Beaver Dam, Four mile, Steel, and Lower Three Runs Creeks.

Methods:

- Surface and bottom ichthyoplankton collections using duplicate, 0.5 m, 505 micron plankton nets at each point. Daytime sampling. Collect all samples on a single day.
- Quantitative identification of fish larvae and eggs (to lowest practical level).
- Concurrent measurements of water temperature, flow, dissolved oxygen, pH, conductivity and alkalinity (surface and bottom except alkalinity, which will be surface only).

Annual Sample Number (weekly):

- River transects 4056 samples
- Canal transects 624 samples
- Creek stations 520 samples

Total annual entrainment samples (weekly): 5200

Monthly (March, April, May, and June 1983-1985)

Stations:

- Four river transects above and below the SRP 1G and 3G + 5G pumphouses.
- Canal mouth transects in 1G and 3G canals.

Methods:

- 24-hour icthyoplankton collections, collected at 6-hour intervals to evaluate diurnal cycles.
- Collection and identification of samples as described in weekly methods.
- Concurrent temperature, chemistry and flow measurements as described in weekly methods.

Annual Sample Number (Monthly):

864 diurnal samples

Total annual entrainment diurnal samples (monthly): 864

Impingement

September 1, 1982 - September 30, 1985

Stations

- 1G, 3G, and 5G trash collecting troughs at the SRP pumphouses.

Methods:

- Collect 24-hour accumulated samples from ends of each trough using nets for 100 randomly selected dates each year (108 dates for September 1, 1983 - September 30, 1983, 100 dates for subsequent survey years).
- Identify (to lowest practical level), count, weigh, measure, and determine sex and breeding condition of impinged fish.

Annual Sample Numbers:

300 samples

Total annual impingement samples - 300

Fish Population

Quarterly (May, August, November, February, 1982-1985)

Stations:

- Savannah River transects (2 points, right and left banks) as described for weekly entrainment samples, except eliminate the station above 3G and 5G.
- 1G and 3G canal mouth transects (right and left banks).
- Creek mouth stations (one point across stream) at confluence with Upper Three Runs, Beaver Dam, Four Mile, Steel, and Lower Three Runs Creeks.

Methods:

- Electrofish and hoop net to determine relative abundance of fish population. Repeated (4 times in a 2 week period) catch per unit effort (timed collection along 300 m bank distance).
- Identify, measure, weigh, count, temporarily tag (fin nick or dart tag) fish and release. On repeated collection, record number of recaptured fish.
- Concurrent surface and bottom water temperature, chemistry and flow measurements.

Annual Sample Number:

- River transects

  384 samples
- Canal transects

  64 samples
- Creek stations

  80 samples

  Total annual fish population samples = 528

Macroinvertebrate/Periphyton Support Studies

Monthly (September 1, 1982 - September 30, 1985)

Stations:

- Stations as described in weekly entrainment except delete stations below 1G pumphouse, above 3G and 5G pumphouses, and below 3G and 5G pumphouses.

Methods

- Quantitatively collect macroinvertebrates and periphyton from artificial substrates, Hester Dendy type, (macroinvertebrates), or Diatometers (periphyton), 4 week colonization period, 3 substrates at each location, surface and bottom samples.
- Identify, count and weigh macroinvertebrates by functional groups.
- Measure periphyton biomass.

Annual Sample Numbers (12 collecting trips per year)

- River transects

  1440 samples

- Creek stations

  360 samples

Total annual macroinvertebrate/periphyton samples (monthly) - 1800

Quarterly (February, May, July, October 1983-1985)

Stations:

- Stations as described in weekly entrainment except delete stations below 1G pumphouse, above 3G and 5G pumphouses, and below 3G and 5G pumphouses.

Methods:

- Quantitatively collect macroinvertebrate drift from river using methods as described for weekly ichthyoplankton collections.

- Identify and count macroinvertebrates by functional group.

Annual Sample Numbers

- River transects

  480

- Creek stations

  80

- Canal transects

  96

Total annual macroinvertebrate drift samples (quarterly) = 656

Additional Support Studies

- Biannual estimate of Upper Three Runs Creek flow intake into 1G canal (sodium ion study or model, once each year during high and low flow).

- Single comparison during peak spawning period of 760 micron and 505 micron plankton net collection efficiencies.

II. Farfield Sampling Program

Ichthyoplankton

Weekly (February 1 - July 31, 1983-1985)

Stations:

- 13 Savannah River transects, 3 points (right, left, and mid-river) per transect, at approximately 10 mile intervals from New Savannah River Lock and Dam to approximately river mile 40.
- 28 creek stations (single point at midstream) at all major named tributaries.

Methods:

- Surface and bottom ichthyoplankton collection as described in nearfield methods. Samples need not be collected in a single day.

Annual Sample Number:

- River transects 4056 samples
- Creek stations 2912 samples

Total annual farfield ichthyoplankton samples - 6968

APPENDIX J

CESIUM-137 MONITORING PROGRAM

CESIUM-137 MONITORING PROGRAM

The following outlines the Cs-137 transport monitoring program in detail:

I. Evaluate total Cs-137 in transport in Steel Creek prior to and following L-Reactor startup.

1. Composite weekly water samples will be collected at Steel Creek 5 (Hattieville Bridge) and Steel Creek mouth.
April 1983 —
to be determined

2. Determine total Cs-137 concentration and total suspended solids periodically as necessary to reflect changes.

II. Determine Cs-137 transport in Steel Creek during cold water flow testing of L Reactor. May — August 1983

1. Collect daily samples for two-week period at Steel Creek 2, Road A-14, Steel Creek 5 (Hattieville Bridge) and Steel Creek mouth. Reduce frequency as tests indicate steady-state conditions.

2. Determine total suspended solids, total Cs-137, soluble and suspended Cs-137.

III. Determine Cs-137 transport in Steel Creek during startup of L Reactor.
October 1983 —
to be determined

1. Collect daily samples for two-week period following L-Reactor startup at Steel Creek 2, Road A-14, Steel Creek 5 (Hattieville Bridge) and Steel Creek mouth. Reduce frequency as operation of L Reactor continues and terminate when transport reaches equilibrium.

2. Determine total suspended solids, total Cs-137, soluble and suspended Cs-137.

IV. Determine weekly Cs-137 and other cesium isotope concentrations in drinking water drawn from the Savannah River above and below SRP.

1. Install weekly drinking water sampler at the Beaufort-Jasper water treatment plant and begin routine-monitoring for cesium isotopes.
March 1983 —
December 1984

2. Install two additional drinking water samplers at Port Wentworth and North Augusta water treatment plants and begin routine monitoring for cesium isotopes.
   April 1983 – December 1984

V. Determine weekly comparative Cs-137 and other cesium isotope concentrations in the Savannah River near the raw water intakes to water treatment plants above and below SRP.

1. Continue weekly cesium isotope monitoring presently conducted at Highway 301 below SRP.
   Indefinite

2. Increase monthly cesium isotope monitoring presently conducted at Shell Bluff above SRP to a weekly measurement.
   April 1983 – December 1984

3. Initiate weekly cesium isotope monitoring of the Savannah River at Port Wentworth.
   April 1983 – December 1984

4. Install weekly raw water samplers for cesium analysis at the Beaufort-Jasper, Port Wentworth and North Augusta lift stations.
   May 1983 – December 1984

VI. Utilize the isotope dilution technique to the Savannah River dilution factor due to surface water runoff into the Beaufort-Jasper Water Treatment Plant raw water canal.

1. Conduct water sampling and cesium isotope measurements at selected points along the Beaufort-Jasper Water Treatment Plant raw water canal between the Savannah River and the treatment plant.
   April 1983

2. Conduct these measurements every three months for one year to determine seasonal and other effects.
   to be determined

VII. Evaluate present concentrations of cesium and other gamma-emitting radioisotopes in the Savannah River estuary prior to L-Reactor startup.

1. Conduct water sampling operations in the Savannah River estuary using high volume grab water sampler during ebb tide at selected sampling points to reaffirm past radioisotope flow patterns in the Savannah River estuary using new data.
   July 1983

2. Carry out three such operations over a twelve-month period to evaluate maximum variations in the data. to be determined

VIII. Determine possible points of cesium isotope buildup in Savannah River sediment below SRP.

1. Review EG&G Savannah River airborne gamma survey data and, if warranted, conduct underwater gamma survey of potential cesium isotope sediment buildup locations using remote detector system. June — August 1983

2. If necessary, provide absolute cesium isotope concentration data from core samples collected, based on underwater survey data. October 1983

APPENDIX K

PERMITS AND ENVIRONMENTAL COMPLIANCE DOCUMENTS

K.1 NEPA

K.2 Water

K.3 Air

K.4 Endangered Species

K.5 Wetlands

K.6 Historic Preservation

K.7 FAA Notification of Exemption

K.1 NEPA

K.1.1 Finding of No Significant Impact (FONSI)

K.1.2 Notice of Intent to Prepare an Environmental Impact Statement

L-Reactor Operation, Savannah River Plant Aiken, South Carolina; Finding of No Significant Impact

The Department of Energy (DOE) proposes to resume operation of L-Reactor at its Savannah River Plant at Aiken, South Carolina, as soon as it is ready for operation, scheduled for October 1983. The environmental impacts of the resumption of operation have been evaluated in an environmental assessment (DOE/EA-0195), prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) as implemented by regulations promulgated by the Council on Environmental Quality (CEQ) (40 CFR Parts 1500–1508, November 1978) and DOE implementing guidelines (45 FR 20694, March 28, 1980). Based on the analysis in the assessment, DOE has determined that the proposed resumption of L-Reactor operation is not a major Federal action significantly affecting the quality of the human environment. Therefore, no environmental impact statement is required.

The L-Reactor site is located in the south central portion of the Savannah River Plant. The plant occupies approximately 800 square kilometers adjacent to the Savannah River near Aiken, South Carolina. The plant has been used by the Federal government since 1951 for the production of defense nuclear materials.

L-Reactor began operation in 1954 and was placed in official standby status in 1968. The principal areas of environmental impact during the 1954–1968 operating period were the Steel Creek corridor, which leads from the reactor to the Savannah River and received the cooling water discharge, and the Steel Creek delta area. The Steel Creek corridor and delta are located on the Savannah River Plant site. The resumption of L-Reactor operation is expected to affect essentially the same areas previously affected. The analysis in the environmental assessment shows that foreseeable impacts from resumed operation related to water quality, air quality, solid waste, and radiological dose to the workforce and the public are expected to be somewhat less than those experienced during the 1954–1968 operating period. In all other respects, this analysis demonstrates that the differences in impacts expected to result from resumed operation and the previous operation are negligible. Accordingly, DOE has concluded that, based on the analysis in the environmental assessment, any differences in impacts between the previous operation and those foreseen from the proposed resumption of operation are not significant.

In addition, the analysis in the environmental assessment of foreseeable impacts of the resumption of L-Reactor operation relative to current environmental conditions shows the following impacts. Cooling water withdrawal will use less than 4% of the average annual flow of the Savannah River. Thermal discharge should impact only 3% of the wetlands on the Savannah River Plant site, which were also impacted during previous operation. No critical habitats of endangered or threatened species occur on the Savannah River Plant site and mitigation measures will be employed to minimize impacts to the American alligators in the impacted area. The expected radiation doses to the public from restart due to routine operations are small relative to natural background levels, and the risk from maximum credibile accidents is also predicted to be very low.

Therefore, considering the previous impacts in the area due to the operation of L-Reactor from 1954 to 1968, and viewed in the context of the physical setting and current use of the Savannah River Plant site, DOE has found that the impacts resulting from the resumption of L-Reactor operation should not be significant.

Copies of the L-Reactor environmental assessment are available from: Ronald W. Cochran, Director of Nuclear Materials Production, Office of the Assistant Secretary for Defense Programs, U.S. Department of Energy, Washington, D.C. 20545, 301–353–2402.

Issue Date: August 20, 1982.

William A. Vaughan,

Assistant Secretary, Environmental Protection, Safety, and Emergency Preparedness.

[FR Doc. 82-23196 Filed 8-20-82; 12:08 pm]

BILLING CODE 6450-01-M

DEPARTMENT OF ENERGY

L-Reactor Operation, Savannah River Plant, Aiken, South Carolina; Intent To Prepare an Environmental Impact Statement

AGENCY: Department of Energy.

ACTION: Notice of intent to prepare an environmental impact statement pertaining to the proposed resumption of L-Reactor operation at the Savannah River plant.

SUMMARY: The Department of Energy (DOE) announces its intent to prepare an Environmental Impact Stateament (EIS), pursuant to the Energy and Water Development Appropriations Act, 1984, and the National Environmental Policy Act (NEPA) of 1969, as amended, to address the proposed resumption of L-Reactor operation at the Savannah River Plant (SRP), Aiken, South Carolina. The proposal for resumption of L-Reactor is based on (1) requirements, approved by President Carter in 1980 and reaffirmed by President Reagan in 1982, for additional production capacity of defense nuclear material; and (2) studies by DOE showing L-Reactor to be one of the key elements in the initiatives required to meet the increased nuclear materials production requirements. The preparation and completion of the EIS will be on an expedited basis, in accordance with the Energy and Water Development Appropriations Act, 1984.

Scoping: DOE invites interested agencies, organizations, and the general public to submit comments or suggestions for consideration in connection with the preparation of the EIS. Written comments or suggestions to assist DOE in identifying significant environmental issues and the appropriate scope of the EIS are requested by August 10, 1983. Written comments should be submittd to Mr. M. J. Sires at the address listed below. Written comments post-marked after August 10, 1983, will be considered to the degree practicable. The DOE will also hold four public scoping meetings at the locations and times indicated below:

(1) Augusta, Georgia on August 1, 1983, at 9:00 am and 6:00 pm at the Augusta Hilton Convention Center, 730 Ellis Street, Augusta, Georgia 30904.

(2) Aiken, South Carolina on August 2, 1983, at 9:00 am and 6:00 pm at the Odell Weeks Activity Center, 1700 Whiskey Road, Aiken, South Carolina 29801.

(3) Beaufort, South Carolina on August 4, 1983 at 9:00 am and 6:00 pm at the Holiday Inn-Beaufort, Highway 21 at Lovejoy, Beaufort, South Carolina 29902.

(4) Savannah, Georgia on August 5, 1983, at 9:00 am and 6:00 pm at the Hyatt Regency, 2 West Bay Street, Savannah, Georgia, 31401.

Individuals desiring to make oral presentations at one of these meetings should notify Mr. Sires at the address listed below as soon as possible after the appearance of this notice in the Federal Register so that the Department may arrange a schedule for the presentations. Persons who have not submitted a request to speak in advance may register to speak at the meetings before each meeting commences. They will be called on to present their comments as time permits. In order to assure that everyone who wishes to present oral comments has the opportunity to do so, five minutes will be alloted to individuals, and ten minutes will be alloted to individuals representing groups. Comments received at these scoping meetings will also be considered in the preparation of the draft EIS.

Upon completion of the draft EIS, its availability will be announced in the Federal Register and local news media, and comments will be solicited. Comments on the draft EIS will be considered in preparing the final EIS. Transcripts of the scoping meeting will be prepared by the DOE. Members of the public may inspect the transcripts of the scoping meetings and other NEPA documents and major references used in the preparation of the EIS during normal business hours at the DOE Public Reading Room, 211 York St., NE, Aiken, SC.

Those interested parties who do not wish to submit comments or suggestions at this time but would like to receive a copy of the draft EIS for review and comment should notify Mr. M. J. Sires at the address given below.

ADDRESS: Written comments or suggustions on the scope of the EIS may be submitted to: Mr. M. J. Sires, III, Assistant Manager for Health, Safety, and Environment, U.S. Department of Energy, Savannah River Operations Office, P.O. Box A, Aiken, S.C. 29801, (803) 725–2597.

Envelopes should be maked "EIS for L-Reactor."

For general information on the DOE EIS process, please contact: Office of Environmental Compliance, EP-362, Office of the Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness, U.S. Department of Energy, Attn: Ms. Carol M. Borgstrom, Room 4G–085, Forrestal Building, 1000 Indenpendence Avenue SW., Washington, D.C. 20585, (202) 252–4600.

Blackground Information: The SRP is a controlled-access, major DOE installation stablished in the early 1950's for the production of nuclear materials for national defense. Plant facilities, which may be characterized as heavy industry, consist of five production reactors (three operational and two in standby status), electrical and steam generating plants, two chemical separations facilities, fuel and target fabrication facilities, a heavy-water production facility (in standby status), research laboratories, repair shops, warehouses, and administrative facilities. Reactor operation began at SRP in 1953 and five reactors operated between 1956 and 1964 (designated C, K, P, L, and R). R-Reactor was placed in standby status in 1964 due to decreasing demand for nuclear materials. In 1968, L-Reactor was also placed in standby status due to a continuing decrease in demand for nuclear materials for national defense.

Recent requirements for additional nuclear materials were approved by President Carter in 1980, and reaffirmed by President Reagan in 1982. This increased need for nuclear materials stems largely from efforts to modernize the weapons in the stockpile. The proposed restart of L-Reactor has been detrmined to be one of the key elements of the continuation of initiatives required to meet the increased nuclear materials production requirements. Funds for additional production capacity, and to restore and upgrade L-Reactor for potential restart were provided in a supplemental appropriation in FY 1981. The restart of L-Reactor as soon as possible, but no later than October 1983, was directed by President Reagan on November 18, 1982.

During the 15 years since L-Reactor was placed in standby status, modifications to the three operating reactors have been made to enhance their safety and operational reliability. Currently, L-Reactor, which has the same operations configuration, is being upgraded and restored to the same safety and reliability attained by the other operating reactors at SRP. Upgrading and restoration is scheduled to be completed by October 1983. Approximately 60 percent of the upgrading costs are for safety and environmental protection.

The Energy and Water Development Appropriations Act, 1984, directs Doe to prepare this EIS on an expedited basis. Specifically, DOE is to issue the Record of Decision, after the issuance of the final EIS, between December 1, 1983, and January 1, 1984. Given the extremely short time period available for preparation and completion of this EIS. DOE is considering, consistent with the provisions of the Energy and Water Development Appropriations Act, 1984, to reduce the comment period for the draft EIS to 30 days from the normally required minimum of 45 days. The draft EIS should be available for public review in late September 1983.

DOE prepared an environmental assessment (DOE/EA-0195) on the proposed restart of L-Reactor, which was published in August 1982, and a Finding of No Significant Impact was issued on August 23, 1982 (47 FR 36691). A floodplain/wetlands statement of finding for the proposed operation of L-Reactor was also issued by DOE on that date (47 FR 36691).

The Committe on Armed Services, United States Senate, conducted a hearing in North Augusta, South Carolina, on February 9, 1983 (Senate Hearing 98-18), concerning the environmental consequences of the proposed restart of the L-Reactor. At the request of Senators Thurmond and Mattingly, DOE agreed to conduct a 90-day public review and to hold four additional hearings on the February 9, 1983, Senate hearing record (48 FR 16535). DOE conducted hearings in Augusta and Savannah, Georgia, and in Aiken and Beaaufort, South Carolina, between May 23 and 27, 1983. The 90-day public review period ended on July 17, 1983. In mid-August DOE will submit a report to the Armed Services and Appropriations Committees of the Senate and House of Representatives summarizing the public comments.

Alternatives: The alternatives proposed to be considered in this EIS are outlined below:

1. Production Alternatives.

• L-Reactor operation for the production of plutonium (Preferred Alternative).

• Maintain L-Reactor in an upgraded standby status (No Action).

• DOE has also considered the following production alternatives:

—Restart of R-Reactor at SRP
—Restart Hanford Reactor
—Increase throughput-SRP reactors and N-Rector

DOE will discuss in the EIS the reasonableness of these production alternatives. Due to national security considerations, some discussions may have to be presented in a classfied supplement.

2. Given the operation of L-Reactor as DOE's preferred alternative, this EIS will present analyses on environmental issues identified below in considering potential mitigation altemnatives.

• Safety system alternatives.

—Confinement system
—Improved confinement system
—Containment dome
—Tall stack

• Cooling water alternatives.

—Direct discharge to Steel Creek
—Once-through systems
—Recirculation systems
—Modification of reactor operation

• Liquid waste disposal alternatives.

—Discharge to seepage basins
—In-plant waste treatment—solid waste disposal
—Additional effluent treatment and discharge to seepage basins
—Detritiation

Identification of environmental issues: The following issues will be analyzed for the proposed action during the preparation of the EIS. This list, based in part on the comments expressed at the public hearings on the environemental consequences of the proposed restart of the L-Reactor, is neither intented to be all inclusive, nor is it a predetermination of potential impacts. Additions or deletions to this list may occur as the result of the scoping process.

(1) *Socioeconomic:* Changes in property values, patterns of investment, and the economic viability of communities in areas surrounding the SRP as a result of the resumption of L-Reactor operation.

(2) *Endangered Species:* The biological evaluation and the development of needed mitigation plans as well as the DOE status in the consultation process required by Section 7 of the Endangered Species Act for the American alligator, red-cockaded woodpecker, shortnose sturgeon, and the wood stork (recently proposed for listing as an endangered species).

(3) *Fisheries:* Impingement and entrainment of fish, and fish eggs and larvae, respectively, due to the withdrawal of cooling water for L-Reactor; and a zone of passage for riverine fishes in the Savannah River adjacent to Steel Creek, potential for blockage of passage to the swamp, and associated loss of spawning habitat in the swamp during the discharge of cooling water by L-Reactor.

(4) *Ground-water Usage:* Continued drawdown of the Tuscaloosa Aquifer used as a regional source of drinking and industrial water resulting from the sustained ground-water withdrawal by L-Reactor and other existing and planned SRP facilities.

(5) *Radiocesium Remobilization:* The remobilization of radiocesium (previously deposited in Steel Creek) to the Savannah River, a source of drinking water, and a source of commercial and sport fish (also see Radiological Effects).

(6) *Radiological Effects:* Does commitments resulting from (a) normal L-Reactor operation, (b) accidental releases of radioactivity from L-Reactor, and (c) radiocesium remobilized from Steel Creek released to the Savannah River (also see Radiocesium Remobilization and Safety.)

(7) *Safety:* The consequences and risks of postulated accidents related to reactor operation and transport of radioactive materials to and from SRP. (See Mitigation Alternatives in the preceding section.)

(8) *Health Effects:* The potential for increased incidents of cancer death and genetic effects due to radioactive releases.

(9) *Ground-water Contamination:* Potential contamination of ground-water by the discharge of radioactive and nonradioactive chemical wastes to seepage basins in the L-Reactor area and the F- and H-Chemical Separations areas, and the potential for increased contamination of aquifers with chlorinated hydrocarbons by the incremental discharge of liquid waste (caused by L-Reactor operation) to the seepage basin in the Target Fuel Fabrication facilities.

(10) *Cumulative Thermal Effects:* Cumulative effects of cooling-water discharges to the Savannah River from C-, K-, and L-Reactor, the Vogtle Nuclear Power Plant, and the Urguhart Steam Generating Station.

(11) *Cumulative Radiological Effects:* Incremental dose commitment from radioactive releases (atmospheric and liquid) from SRP support facilities as the result of L-Reactor operation, and the cumulative dose commitment from (existing and planned) SRP and neighboring nuclear facilities.

Radioactive waste management practices at SRP have been addressed by related published NEPA documents, including:

• ERDA-1537, "Final Environmental Impact Statement—Waste Management Operations, Savannah River Plant, Aiken, South Carolina," September, 1977.

• DOE/EIS-0023, "Final Environmental Impact Statement—Long-Term Management of Defense High-Level Radioactive Wastes, Savannah River Plant, Aiken, South Carolina," November, 1979.

• DOE/EIS-0062, "Final Environmental Impact Statement—Waste Management Operations, Savannah River Plant, Aiken, South Carolina," Double Shell Tanks for Defense High-Level Radioactive Waste

Storage" (Supplement to ERDA–1537), April, 1980.

• DOE/EIS–0082, "Final Environmental Impact Statement—Defense Waste Processing Facility, Savannah River Plant, Aiken, South Carolina," February, 1982.

• DOE/EA–0179, "Environmental Assessment—Waste Form Selection for SRP High-Level Waste," July, 1982.

Dated in Washington, DC, this 18th day of July 1983, for the United States Department of Energy.

William A. Vaughan,

Assistant Secretary, Environmental Protection, Safety and Emergency Preparedness.

[FR Doc. 83–19687 Filed 7–18–83; 12:01 pm]

BILLING CODE 6450–01–M

K.2 WATER

K.2.1 Construction Permit, Domestic Wells

K.2.2 Construction Permit, Domestic Water Treatment

K.2.3 Construction Permit, Sanitary Waste Treatment System

UCNI

South Carolina Department of Health and Environmental Control

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2600 Bull Street
Columbia, S. C. 29201

CONSTRUCTION PERMIT

Permission is Hereby Granted to:
U.S. Department of Energy
Savannah River Operation Office
P.O. Box A
Aiken, South Carolina 29801
for the construction of a potable water source, treatment and/or distribution system in accordance with plans, specifications and design calculations dated April 27, 1981 *by* Michael Censurato, *P.E., S.C. Registration No.:* 8488 - .

PROJECT DESCRIPTION:
Two 500 gpm wells to replace the existing wells in supplying existing clearwells and distribution system in the L Area at Savannah River Plant, Barnwell County.

SPECIAL CONDITIONS:
1) Material and construction specifications for all piping shall be the same as those approved under Permit #28001, dated May 15, 1981.
2) Copies of all drillers records, logs, yield, and drawdown test results must be submitted prior to final inspection.
3) The chemical, physical, and bacteriological quality of the water must meet EPA primary and secondary standards or treatment may be required.

Permit Number: 200092 *Date:* 7/7/81

EXPIRATION DATE: *Unless construction is initiated prior to* 7/7/82, *it will be necessary to reapply since this permit will no longer be valid.*

This is a permit for construction only and does not constitute State Department of Health and Environmental Control approval, temporary or otherwise, to place this system in operation.

Robert S. Jackson MD
Robert S. Jackson, M. D.
Commissioner

M K Batavia, PE
Director, Water Supply Division

MY/dsd

cc: Mr. Michael Censurato, P.E.
Mr. George Nelson, Lower Savannah
Mr. Leonard F. Rice, Dist. San. Eng.
Barnwell Co. Health Department

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SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

UNCLASSIFIED

Sims-Aycock Buildings
2600 Bull Street, Columbia, SC 29201

CONSTRUCTION PERMIT

Permission is Hereby Granted to:
U. S. Department of Energy
Savannah River Operations Office
P. O. Box A
Aiken, South Carolina 29801
for the construction of a potable water source, treatment and/or distribution system in accordance with plans, specifications and design calculations dated January 5, 1981, by George E. Wells, III, P.E., S. C. Registration No.: 7979.

PROJECT DESCRIPTION:
Two (2) 500 gpm well pumps, two (2) degasifiers and associated auxiliaries to replace the existing surface water treatment plant in supplying the existing clearwells and distribution system in the L Area at Savannah River Plant, Barnwell County.

SPECIAL CONDITIONS:
Material and construction specifications shall be the same as those under Permit #28001 dated May 15, 1981 for K Area at Savannah River Plant.

Permit Number: 404252 Date: January 27, 1982

EXPIRATION DATE: Unless construction is initiated prior to January 27, 1983, it will be necessary to reapply since this permit will no longer be valid.

This is a permit for construction only and does not constitute State Department of Health and Environmental Control approval, temporary or otherwise, to place this system in operation.

Robert S. Jackson [signature]
Commissioner

M. K. Batavia, P.E. [signature]
Director, Water Supply Division

MY:hpj
cc: Mr. George E. Wells, III, P.E.
Mr. George Nelson, Dist. Director
Mr. Leonard F. Rice, Dist. San. Director
Barnwell County Health Department

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DHEC 1906 (1/79)

South Carolina Department of Health and Environmental Control

UNCLASSIFIED

COMMISSIONER
Robert S. Jackson, M.D.
2600 Bull Street
Columbia, S. C. 29201

July 9, 1981

Mr. M.J. Sires, Assistant Manager
Health, Safety & Environment
Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, S.C. 29801

Re: Savannah River Plant
Construction Permit No. 7947
Barnwell County

Dear Sir:

Enclosed is a State Construction Permit for the referenced wastewater treatment facility. The conditions of the permit are explicitly stated; construction is to be performed in accordance with this permit and the supporting engineering report, plans and specifications approved by this office.

Your District Environmental Engineer from this Department is George Nelson (address below). He, along with the Industrial & Agricultural Division of the Department of Health & Environmental Control, should be notified when construction is begun and when the facility is ready for operation. A final inspection must be made before the treatment facility is placed in operation. At the time of this inspection, you must submit a letter from a registered engineer certifying that the construction has been completed in accordance with the approved plans and specifications.

In accordance with State Law, your facility will be required to have an operator-in-charge who has been certified by the State Board of Certification of Environmental Systems Operators. Your facility has been classified in Group III, necessitating an operator holding a Grade B or higher certificate. You will not be given permission to operate your facility until a properly qualified operator(s) has been obtained. Questions in this matter should be directed to William B. Moore of the State Board of Certification of Environmental Systems Operators, Room 205, J. Marion Sims Building, 2600 Bull Street, Columbia, S. C. 29201.

Sincerely,

Robert G. Gross

Robert G. Gross, P.E., Director
Industrial & Agricultural Wastewater Division
Bureau of Wastewater & Stream Quality Control

Address of District Engineer:
117 Marion Street, N.E.
Aiken, S.C. 29801

GSH:jf

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SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

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CONSTRUCTION PERMIT

Permission is hereby granted to: Savannah River Plant
P.O. Box A
Aiken, S.C.

for the construction of a waste treatment and/or collection system in accordance with construction plans, specifications, engineering report and Construction Permit Application signed by J.E. Glenn, Registered Professional Engineer, S.C. Registration No: 1309.

Project Description:

Construction of package extended areation sewage treatment plant for L-Area and associated lift station (150gpm)

Effluent to be discharged to Steel Creek (Stream or Existing System) in the Savannah River basin at a daily rate not to exceed 35,000 gallons per day. County in which project is located: Barnwell Coordinates of the discharge point: Lat. 33° 12' 10"N Long. 80° 37' 21"W (to nearest five seconds)

Effluent concentrations of those constituents the system is designed to remove or reduce will be as follows:

	Monthly Average	Daily Maximum
BOD5	30 mg/l	45 mg/l
TSS	30 mg/l	45 mg/l
Fecal Coliform	200/100ml	400/100ml

Special Conditions:

Permit No: 7947 Date of Issue: July 7, 1981

Expiration Date: Unless construction is initiated prior to July 7, 1982, it will be necessary to reapply since this permit will no longer be valid.

Treatment Plant Classification: Group III.

In accepting this permit, the owner agrees to the admission of properly authorized persons at all reasonable hours for the purposes of sampling and inspection.

THIS IS A PERMIT FOR CONSTRUCTION ONLY AND DOES NOT CONSTITUTE STATE DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL APPROVAL, TEMPORARY OR OTHERWISE, TO PLACE THIS SYSTEM IN SERVICE.

UCNI

Robert G. Gross PE

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Bureau of Wastewater and Stream Quality Control

DHEC 1916 (11/80)

K.3. AIR

K.3.1 Coal-Fired Boiler Operational Permits

K.3.2 Emergency Diesel Generator Permits

K.3.3 Process Facility Operational Permits

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UCNI

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

FEB 1983

R. A. Caldwell, Director
Production Division

OPERATION PERMITS

The South Carolina Department of Health and Environmental Control (SCDHEC) has reissued operation permits, 0/P-02-263 through 0/P-02-281, for the operation of the coal-fired boilers at the Savannah River Plant powerhouses, and temporary operation permit, 0/P-02-310, for operation of a rented oil-fired boiler at 100-L Area. Permits 0/P-02-263 through 0/P-02-281 expire on November 30, 1983; permit 0/P-02-310 expires on May 31, 1983. This office needs to be advised 90 days prior to permit expiration of the need for renewal.

Additionally, permits 0/P-02-263 through 0/P-02-281 require that source testing be conducted beginning in June 1983; SCDHEC must approve the test methodology, and the boilers must be at maximum normal operating capacity during the test. Please provide the test schedule and protocol by May 1, 1983.

Original Signed By G. A. Smithwick
G. A. Smithwick, Director
Office of Environment

EEE:LCG:bmr

Attachment

cc w/att:
→ E. B. Sheldon, Du Pont, SRP

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South Carolina
Department of
Health and
Environmental
Control

2600 Bull Street
Columbia, S.C. 29201

January 18, 1983

U. S. Department of Energy
Savannah River Operations
P. O. Box A
Aiken, South Carolina 29801

Attention: M. J. Sires, Assistant Manager for Health, Safety and Environment

Subject: Renewal of Operation Permit(s)

Dear Sir:

Pursuant to Section 48-1-110, 1976 Codes of Laws of South Carolina, as amended, and South Carolina Air Quality Control Regulation 62.1, Section II official notice is hereby given for renewal of operating permit(s) indicated below:

Permit Number	Old Expiration Date	New Expiration Date	Original Issue Date
0/P-02-263 through 0/P-02-281	November 30, 1982	November 30, 1983	May 26, 1980
0/P-02-310	May 31, 1982	May 31, 1983	October 26, 1981

Please attach this letter to the permit(s).

Very truly yours,

William W. Culler, P.E., Director
Engineering Services Division
Bureau of Air Quality Control

WWC:BWB:ce

CC: James B. Spears, Lower Savannah District, EQC

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

FEB 0 7 1983

R. A. Caldwell, Director
Production Division

OPERATION PERMITS

The South Carolina Department of Health and Environmental Control has issued operation permits, O/P-02-354, O/P-02-355, and O/P-02-356, for the operation of emergency diesel generators at the 100-L Area. These permits expire on November 30, 1987. Please note the permit conditions. A copy of the permits is attached.

Original Signed By ...

G. A. Smithwick, Director
Office of Environment

EEE:LCG:bmr

Attachment

cc w/att:
E. B. Sheldon, Du Pont, SRP

South Carolina Department of Health and Environmental Control

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UCNI

COMMISSIONER
Robert S. Jackson, M.D.
2600 Bull Street
Columbia, S.C. 29201

OFFICE OF ENVIRONMENTAL QUALITY CONTROL

OPERATION PERMIT

DATE OF ISSUE: JANUARY 12, 1983 ORIGINAL DATE OF ISSUE: JANUARY 12, 1983

Operation Permit Number(s) 0/P-02-354, 0/P-02-355, and 0/P-02-356 are hereby issued to the U. S. Department of Energy, Savannah River Operations, P. O. Box A, Aiken, South Carolina 29801

For the operation of three (3) emergency diesel engines, one (1) GM Detroit Model 7163-7200 (6.21 X 10^6 BTU/hr, no. 191-L) and two (2) Cleveland Model 16-278A (9.66 X 10^6 BTU/hr each, nos. 108-1L and 108-2L) to provide emergency power to 100-L Reactor Area.

NOTWITHSTANDING ANY OF THE CONDITIONS LISTED BELOW, NO APPLICABLE LAW, REGULATION OR STANDARD WILL BE CONTRAVENED.

CONDITIONS

1. All official correspondence, plans, permit application forms and written statements are an integral part of this permit.
2. This permit to operate shall expire on November 30, 1987.
3. The permit to operate may be renewed only upon the written request of the permittee and upon evidence of satisfactory operational experience during the prior operating period. It is further subject to compliance with all laws, regulations, and standards applicable at the time of the renewal.
4. Malfunctions of the source or control equipment must be reported to this agency in accordance with the South Carolina Department of Health and Environmental Control Regulation 61-62.1, Section II, Paragraph D-3 adopted on January 10, 1978.

UCNI

This is pursuant to the provisions of Section 48-1-110, 1976 Codes of Laws of South Carolina, as amended, and the South Carolina Air Quality Control Regulation 62.1, Section II.

William W. Culler

William W. Culler, P.E., Director
Engineering Services Division
Bureau of Air Quality Control

UNCLASSIFIED

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

DEC 13 1982

C. G. Halsted, Jr., Director
Process and Weapons Division

OPERATION PERMITS

The South Carolina Department of Health and Environmental Control has reissued the following operation permits:

(1) O/P-02-284 for the atmospheric release of oxides of nitrogen (NOx) from Building 221-H;

(2) O/P-02-285 for the atmospheric release of NOx from Building 221-F; and

(3) I/O-02-018 for the operation of the pilot alpha waste incinerator at TNX Semiworks Area.

Permits O/P-02-284 and O/P-02-285 expire on March 31,1987; permit I/O-02-018 expires on January 31, 1984. Please note the permit conditions. A copy of each permit or renewal notice is attached.

Please advise this office 90 days prior to permit expiration of the need for renewal.

Original Signed By G. A. Smithwick

G. A. Smithwick, Director
Office of Environment

EEE:LCG:tgg

3 Attachments

cc w/atts:
E. B. Sheldon, SRP

South Carolina Department of Health and Environmental Control

UNCLASSIFIED

UCNI

OFFICE OF ENVIRONMENTAL QUALITY CONTROL
OPERATION PERMIT

DATE OF ISSUE: NOVEMBER 15, 1982   ORIGINAL DATE OF ISSUE: MAY 26, 1980

Operation Permit Number(s) O/P-02-284 is hereby issued to the Department of Energy, Savannah River Operations Office, P. O. Box A, Aiken, South Carolina 29801

For the operation of one (1) process for the dissolving of uranium - aluminum alloy in nitric acid with resultant release of nitrogen oxides. (Area H - Process 221-H.)

NOTWITHSTANDING ANY OF THE CONDITIONS LISTED BELOW, NO APPLICABLE LAW, REGULATION OR STANDARD WILL BE CONTRAVENED.

CONDITIONS

1. All official correspondence, plans, permit application forms and written statements are an integral part of this permit.
2. This permit to operate shall expire on March 31, 1987.
3. The permit to operate may be renewed only upon the written request of the permittee and upon evidence of satisfactory operational experience during the prior operating period. It is further subject to compliance with all laws, regulations, and standards applicable at the time of the renewal.
4. Malfunctions of the source or control equipment must be reported to this agency in accordance with the South Carolina Department of Health and Environmental Control Regulation 61-62.1, Section II, Paragraph D-3 adopted on January 10, 1978.

This is pursuant to the provisions of Section 48-1-110, 1976 Codes of Laws of South Carolina, as amended, and the South Carolina Air Quality Control Regulation 62.1, Section II.

William W. Culler

UCNI

William W. Culler, P.E., Director
Engineering Services Division
Bureau of Air Quality Control

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South Carolina Department of Health and Environmental Control

COMMISSIONER
Robert S. Jackson, M.D.
2600 Bull Street
Columbia, S.C. 29201

OFFICE OF ENVIRONMENTAL QUALITY CONTROL
OPERATION PERMIT

DATE OF ISSUE: NOVEMBER 15, 1982   ORIGINAL DATE OF ISSUE: MAY 26, 1980

Operation Permit Number(s) 0/P-02-285 is hereby issued to the Department of Energy, Savannah River Operations Office, P. O. Box A, Aiken, South Carolina 29801

For the operation of one (1) process for the dissolving of uranium in nitric acid; uranyl nitrate and the subsequent denitration accompanied by a release of NO_2. (Area F - Process 221-F.)

NOTWITHSTANDING ANY OF THE CONDITIONS LISTED BELOW, NO APPLICABLE LAW, REGULATION OR STANDARD WILL BE CONTRAVENED.

CONDITIONS

1. All official correspondence, plans, permit application forms and written statements are an integral part of this permit.
2. This permit to operate shall expire on March 31, 1987.
3. The permit to operate may be renewed only upon the written request of the permittee and upon evidence of satisfactory operational experience during the prior operating period. It is further subject to compliance with all laws, regulations, and standards applicable at the time of the renewal.
4. Malfunctions of the source or control equipment must be reported to this agency in accordance with the South Carolina Department of Health and Environmental Control Regulation 61-62.1, Section II, Paragraph D-3 adopted on January 10, 1978.

UCNI

This is pursuant to the provisions of Section 48-1-110, 1976 Codes of Laws of South Carolina, as amended, and the South Carolina Air Quality Control Regulation 62.1, Section II.

William W. Culler, P.E., Director
Engineering Services Division
Bureau of Air Quality Control

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South Carolina Department of Health and Environmental Control

2600 Bull Street
Columbia, S.C. 29201

November 16, 1982

Department of Energy
Savannah River Operations Office
P. O. Box A
Aiken, South Carolina 29801

Attention: M. J. Sires, Assistant Manager for Health, Safety and Environment

Subject: Renewal of Operation Permit(s) - Pilot-Plant Incinerator

Dear Sir:

Pursuant to Section 48-1-110, 1976 Codes of Laws of South Carolina, as amended, and South Carolina Air Quality Control Regulation 62.1, Section II official notice is hereby given for renewal of operating permit(s) indicated below:

Permit Number	Old Expiration Date	New Expiration Date	Original Issue Date
I/O-02-018	January 31, 1982	January 31, 1984	January 29, 1979

Please attach this letter to the permit(s).

Very truly yours,

William W. Culler, P.E., Director
Engineering Services Division
Bureau of Air Quality Control

WWC:JW:ce

CC: James Spears, Lower Savannah District, EQC

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K.4 ENDANGERED SPECIES

U.S. Fish and Wildlife Service Biological Opinion

United States Department of the Interior
FISH AND WILDLIFE SERVICE
PLATEAU BUILDING, ROOM A-5
50 SOUTH FRENCH BROAD AVENUE
ASHEVILLE, NORTH CAROLINA 28801

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February 25, 1983

Mr. M. J. Sires
Assistant Manager for Health,
Safety and Environment
Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

RE: 4-2-81-075

Dear Mr. Sires:

A. Introduction

This letter presents the Biological Opinion of the U.S. Fish and Wildlife Service concerning the effects of the proposed reactivation of L-Reactor at the Savannah River Plant (SRP), Barnwell County, South Carolina, on the endangered American alligator (Alligator mississippiensis). This is in response to your request for formal consultation received December 23, 1982, and involves only the alligator. This Opinion does not address requirements of environmental laws other than the Endangered Species Act.

A "no effect" determination was made for the red-cockaded woodpecker (Picoides borealis) on the basis of negative surveys conducted in the project area for this species. The wood stork (Mycteria americana), a species under status review during part of the consultation period, will soon be officially proposed for listing as an endangered species. Transient individuals of the species have been observed in recent years in the Steel Creek area during the summer. Although no nesting by wood storks has been reported on the SRP (the nearest known rookery is located 30 air miles away at Millen, Georgia), the thermal effluents resulting from the reactivation of L-Reactor will destroy potential feeding habitat for this wading bird in the Steel Creek delta. Once the species is officially proposed for listing, a conference is required with the Fish and Wildlife Service only if the Department of Energy determines that this project might jeopardize the continued existence of the wood stork. However, if this species is officially listed before the start-up of L-Reactor in the fall of 1983, an automatic "may effect" situation exists and formal consultation must be reinitiated with this agency.

B. Project Description

The subject of this consultation is the reactivation of L-Reactor, which has been inactive since 1968. L-Reactor, along with the other production reactors on the SRP, produces "defense nuclear materials" (primarily plutonium and tritium) to meet national requirements for nuclear weapons. A recent increase in the demand for these defense nuclear materials resulted in authorization for reactivation of the reactor. This reactor will use approximately 125 million gallons of cooling water at a time. This heated

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water will then be pumped directly into Steel Creek, as it was during the previous operation of this reactor from 1954 to 1968. Approximately 1,000 acres of wetland, including 420 acres of the Steel Creek corridor and 580 acres of the Savannah River Swamp, will be severely impacted. This area, which was similarly affected by the previous operation, is just now recovering and being revegetated by wetland emergents and submergent hydrophytes. Cypress killed in the previous operation have not regenerated. The thermal discharge, as it enters Steel Creek, will be about 79 degrees centigrade, flowing at approximately 11 cubic meters per second (this is a ten-fold increase in flow). The heated effluent will enter the swamp at temperatures ranging from 40 degrees centigrade to 44 degrees centigrade. Elimination of all emergent wetland flora and submergent hydrophytes as well as scrub-shrub and willow-dominated communities is expected. A few fish and invertebrates may persist along stream margins and backwater areas, but the vast majority of Steel Creek will be eliminated from use by most organisms. Because the temperature of the effluent will be greatly reduced by the time it reaches the Savannah River, no change in the river itself is expected.

C. Consultation History

An administrative record of this consultation is maintained and open for inspection at this office. Informal consultation on this project was initiated on January 30, 1981, and resulted in biological studies being concentrated on the effects of the project on the American alligator. Studies for species under status review, such as the wood stork and six species of plants, were also conducted. On June 21, 1982, a two-volume interim report entitled "An Evaluation of the Steel Creek Ecosystem in Relation to the Proposed Restart of the L-Reactor" were provided to this office along with sections of the environmental assessment prepared for the project. The complete Environmental Assessment was provided September 8, 1982. DOE requested that a meeting be scheduled at the Savannah River Plant after the documents had been reviewed by the Service. DOE expressed its desire to "formally begin the consultation process required by Section 7" after this meeting had taken place. A meeting was held September 16, 1982. At this meeting, further information and details of the biological studies done for the assessment by DOE staff, consultants, and Savannah River Ecology Lab personnel were presented. Formal consultation was initiated on receipt of the written request from DOE on December 23, 1982.

D. Biological Opinion

Indiscriminate taking of alligators and widespread habitat alteration were responsible for the reduction of the species' numbers throughout its range and subsequently necessitated its inclusion on the Federal list of endangered species. In recent years alligator populations have responded favorably to effective law enforcement efforts which restricted taking, and the species has recovered in portions of its range. The inland South Carolina population is still federally listed as endangered.

Various estimates place the alligator population on the SRP at between 120 and 300 animals. There are approximately 25 alligators inhabiting the Steel Creek area with evidence of regular reproduction in this population. Preliminary data suggests relatively high hatchling and juvenile survivorship in this area, which is probably due to the dispersed nature of the breeding habitat in the form of smaller lagoons, backwaters, and ponds. The proposed start-up was timed intentionally to minimize impacts upon the Steel Creek alligator population, which is expected to move to avoid thermal stress. Fall is considered the optimal time period for this purpose because any nests in the area would have hatched and young of the year would be sufficiently mobile to escape. Also, it is before the onset of very cold winter temperatures, when torpid individuals wintering along the banks of Steel Creek might not arouse in time to escape lethally high temperature levels. Although adults are expected to escape safely, there is more potential danger to the emigrating young from increased exposure to predation. The thermal effluent from L-Reactor will eliminate alligator habitat in Steel Creek, with the exception of some backwater areas. The 1,000 acres expected to be destroyed as a result of the start-up of L-Reactor represent approximately 3 percent of the total wetlands habitat on the SRP. Two lagoons adjacent to Steel Creek at Road A, which have been known to be used by females with young, will be protected from thermal effluent leakage by dikes or some similar obstruction. During the previous operation of L-Reactor, at least one alligator was observed to occupy one of these lagoons for a period of over a year while the reactor was active. Water temperature at that time in the lagoon was 30 to 35 degrees centigrade. Temperatures were lethal at the mouth of the lagoon.

Although the habitat for alligators in Steel Creek will be lost and the corridor will no longer be available as a safe travel path between the lagoons and backwater areas on either side of the creek, the impacts of the proposed project are not expected to be severe upon the SRP alligator population. Evidence indicates that available habitat is not saturated by the existing population. Alligators continue to occupy and successfully reproduce in the thermally influenced area of Par Pond reservoir northeast of this project. In fact, some observers have suggested that moderate thermal increases may have some favorable impacts on alligator populations, including accelerated growth rates of juveniles, which reduce the generation interval and enhance the reproductive potential of the population. Benefits are offset by the potential negative impacts of moderate thermal loading such as the induction of a premature reproductive season. Non-continuous reactor operation, resulting in rapid and unseasonal changes in water temperature may also affect the viability of sperm being produced by alligators. Most of these speculations apply to reservoir situations, however. In a stream situation, there will be few areas where thermal loading would be considered moderate instead of severe. The majority of the Steel Creek alligators are expected to move completely out of range of L-Reactor's thermal influence.

Since the start-up of L-Reactor will be a gradual process, with several days being required for water in Steel Creek to rise to maximum temperatures, no direct mortality of alligators from thermal impacts is expected to occur. Therefore, incidental taking is not considered applicable to this consultation. After careful review of all the information available for this project, it is my Biological Opinion that the proposed reactivation of L-Reactor is not likely to jeopardize the continued existence of the American alligator.

E. Additional Conservation Recommendations

During start-up of L-Reactor, it is particularly important that the Steel Creek corridor be monitored closely to assess actual impacts upon the alligator population. Radio telemetric studies which have been initiated with alligators here should be continued at least through the winter following the start-up to determine the response of the Steel Creek population to this project. Longer term telemetric studies, as well as additional population surveys in this area and adjacent areas, are strongly recommended.

If mortality of alligators should occur as a direct result of the thermal effluent entering Steel Creek, consultation should be reinitiated.

An excellent job appears to have been done on the biological work necessary to assess impacts from the proposed project on the alligator, and we would like to express our appreciation for your willingness to time the project start-up to minimize impacts on resident alligators. It is our hope that this consultation will be helpful to you in fulfilling your obligations under the Endangered Species Act and look forward to future cooperation between our agencies.

Sincerely yours,

Warren T. Parker
Field Supervisor
Endangered Species Field Office

cc:
Director, FWS, Washington, DC (AFA/OES)
Regional Director, FWS, Atlanta, GA (ARD-FA/SE)
Field Supervisor, ES, FWS, Charleston, SC

K.5 WETLANDS

K.5.1 Floodplains/Wetlands Notice - 7/14/82

K.5.2 Floodplains/Wetlands Statement of Findings - 8/23/82

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Federal Register / Vol. 47, No. 135 / Wednesday, July 14, 1982 / Notices 30563

DEPARTMENT OF ENERGY

Floodplain/Wetlands Notice for L-Reactor Resumption of Operation, Savannah River Plant, Aiken, S.C.

AGENCY: Energy Department.

ACTION: Floodplain/Wetlands Notice.

DESCRIPTION: The Department of Energy (DOE) is considering the resumption of operation of the L-Reactor at its Savannah River Plant, Aiken, South Carolina. The L-Reactor previously operated from 1954 to 1968 when it was placed in official standby status. The resumption of operation of the reactor will impact floodplain/wetlands adjacent to the Savannah River and a tributary (Steel Creek) located on the Savannah River Plant site. Any comments regarding the proposed floodplain/wetlands action may be submitted to DOE at the address provided below.

DATE: Comments received on or before July 29, 1982.

ADDRESS: John J. Jicha, Jr., Director of Production Operations, DP-131, Office of the Assistant Secretary for Defense Programs, U.S. Department of Energy, Washington, D.C. 20545 (301-353-3782).

Issued in Washington, D.C., July 8, 1982.

William A. Vaughan,

Assistant Secretary, Environmental Protection, Safety and Emergency Preparedness.

[FR Doc. 82-19034 Filed 7-13-82; 8:45 am]

BILLING CODE 6450-01-M

Floodplain/Wetlands Statement of Findings for the Proposed Operation of L-Reactor at the Savannah River Plant, Aiken, South Carolina

The Department of Energy proposes to resume operation of L-Reactor at its Savannah River Plant at Aiken, South Carolina as soon as it is ready for operation, presently scheduled for October 1983. L-Reactor began operating in 1954 and was placed on standby in 1968. The resumption of operation of the reactor will impact floodplain/wetlands adjacent to the Savannah River and a tributary (Steel Creek) located on the Savannah River Plant site. Impacts will result from the discharge of cooling water. A Floodplain/Wetlands Assessment was prepared as Appendix B of the L-Reactor Environmental Assessment (DOE/EA-0195), which describes the floodplain/wetlands impacts of the discharge and assesses the potential for mitigating those impacts by alternative cooling methods. Alternative cooling methods that were considered included recirculating and once-through systems. Recirculating alternatives were found not to be viable because of their impact on the schedule for reactor operation and high costs required for construction. Alternate once-through systems were not considered practicable since they would result in delays and higher costs without significantly different floodplain/wetlands effects than the existing discharge system. Floodplain/wetlands impacts from the discharge will be minimized to the extent practicable. Impacts to the American alligator in the affected area will be minimized by preventing hot water from entering two

lagoons that provide habitat for alligators adjacent to Steel Creek. Alligators located in the swamp area will be able to move to thermally unaffected areas.

The resumption of L-Rector operation will conform to any applicable State or local floodplain protection standards.

Consistent with the law and the policy set forth in Executive Orders 11988 and 11990, the Department of energy has found that there is no practicable alternative to impacting the floodplan/wetlands adjacent to the Savannah River and a tributary located on the Savannah River Plant site. The project will minimize potential harm to or within the floodplain/wetlands, to the extent practicable.

Dated: August 18, 1982.

Jan W. Mares,

Acting Under Secretary, Department of Energy.

[FR Doc. 82-23199 Filed 8-20-82; 12:00 pm]

BILLING CODE 6450-01-M

K.6 HISTORIC PRESERVATION

K.6.1 DOE Request for Archeological Determination to Advisory Council on Historic Preservation

K.6.2 U.S. Department of Interior Letter of Determination

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Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

JUL 19 1982

CONCUR

JUL 21 1982

ADVISORY COUNCIL
ON HISTORIC PRESERVATION

BY Jordan E. Tannenbaum

Mr. Robert Garvey, Executive Director
Advisory Council on Historic Preservation
1522 K Street, NW
Washington, DC 20005

Dear Mr. Garvey:

REQUEST FOR DETERMINATION OF NO ADVERSE EFFECT ON FIVE ARCHEOLOGICAL SITES ALONG STEEL CREEK, SAVANNAH RIVER PLANT, BARNWELL COUNTY, SOUTH CAROLINA

The Savannah River Operations Office of the U. S. Department of Energy is in the process of reactivating the "L" Area Reactor on the Savannah River Plant, South Carolina.

As part of the reactivation environmental assessment, five archeological sites were determined to be significant enough to warrant protection. A detailed discussion is set forth in Exhibit A, and further supported by Exhibits B through H.

Based on the enclosed documentation, we request a determination of no adverse effect. Please indicate your concurrence by signing one copy of this letter and returning it to this office.

The associated determination of eligibility for nomination to the National Register of Historic Places will be forwarded directly to your office by the Keeper of the National Register.

Thank you for your consideration in this matter. Questions your staff may have should be directed to Ron Jernigan, FTS 239-2685, or Commercial 803 725-3685.

Sincerely,

R L Morgan

R. L. Morgan
Manager

Enclosures:
(See attached list)
Separate Cover

Concurrence: See above signature

cc: Charles E. Lee, S.C. SHPO, w/o encls.
Glen T. Hanson, USCIAA, w/o encls.

Date: ____________

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AUG 0 9 1982

United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

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IN REPLY REFER TO: 710

JUL 28 1982

The Director of the National Park Service is pleased to inform you of our determination pursuant to the National Historic Preservation Act, as amended, and Executive Order 11593 in response to your request for a determination of eligibility for inclusion in the National Register of Historic Places. Our determination appears on the enclosed material.

As you know, your request for our professional judgment constitutes a part of the Federal planning process. We urge that this information be integrated into the National Environmental Policy Act analysis and the analysis required under section 4 (f) of the Department of Transportation Act, if this is a transportation project, to bring about the best possible program decisions.

This determination does not serve in any manner as a veto to uses of property, with or without Federal participation or assistance. The responsibility for program planning concerning properties eligible for the National Register lies with the agency or block grant recipient after the Advisory Council on Historic Preservation has had an opportunity to comment.

We are pleased to be of assistance in the consideration of historic resources in the planning process.

Attachment

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E.O. 11593

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DETERMINATION OF ELIGIBILITY NOTIFICATION

National Register of Historic Places

National Park Service

Project Name:

Location: Barnwell County

State: SC

Request submitted by: DOE R. L. Morgan

Date Received: 7/21/82

Additional information received:

36 CFR Part 63.3 Determination

Name of property	Eligibility: SHPO opinion	Eligibility: Secretary of the Interior's opinion	Criteria
38BR55	Eligible	Eligible	
38BR112	"	"	
38BR269	"	"	
38BR288	Eligible	Eligible	

for [signature]
Keeper of the National Register

Date: 7/28/82

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K.7 FAA NOTIFICATION

FAA Letter Notification of Exemption

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Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

August 13, 1982

L. D. Eggenberger, Chief, Telecommunications Branch, Personnel and Management Evaluation Division

SRP STRUCTURES EXCEEDING 200 FEET IN HEIGHT (MEMO E. J. STEVENS TO YOU DATED 8/9/82)

Upon inquiry to the Atlanta FAA Regional Office of August 12, 1982, I was advised by Eleanor Williams that it will not be necessary to mark or light our structures up to 210 feet in height. Her decision was based upon:

1. FAA Regulation 7400.2 (b), paragraph 1610.
2. The current "Notice" appearing on the Charlotte Sectional Aeronautical Chart dated 9/3/81, which affects SRP and;
3. The distance from Bush Field and the Barnwell Airport.

L. L. Turner, Chief
Transportation Branch
Contracts and Servcies

ACT:LLT:frb

cc: S&S Div.

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Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29801

August 13, 1982

L. D. Eggenberger, Chief, Telecommunications Branch, Personnel and Management Evaluation Division

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L. L. Turner, Chief
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Contracts and Servcies

ACT:LLT:frb

cc: S&S Div.

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